EMERGENCY MANAGEMENT & 911 COMMUNICATIONS DISPATCH CENTER

Clarendon County
1091 Capital Way, Manning, SC 29102
May 5, 2025

Volume 3 of 3

Caplea Coe Architects, Inc.
1643 Means Street
Charleston, SC 29412
(843) 577-6073

SECTION 260500 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL CONDITIONS

1.1 WORK INCLUDED

A. The work covered under these sections of the specifications consists of furnishing all labor, equipment, supplies and materials, and of performing all operations, including cutting, channeling, chasing, excavating, and backfilling necessary for the installation of complete wiring systems, raceways, wiring, and electrical equipment in accordance with this section of the specifications and the accompanying drawings.

B. The Electrical Work shall include, but not be limited to, the following:

1. Electrical distribution system
2. Wiring devices
3. Raceway systems
4. Conductors and cables
5. Lighting and lighting controls
6. Fire Alarm System
7. Emergency and Standby Power Systems
8. Uninterruptible Power Supply (UPS) Systems

1.2 RELATED WORK

A. Related work to Division 26:

1. Division 1
2. The provisions, conditions, and requirements preceding and including general and supplemental conditions apply to and are a part of Divisions 26, 27, and 28.

1.3 DEFINITIONS

A. Provide: Furnish and install complete ready for use, including all accessories required for operation.

B. Furnish: Purchase and deliver to the project site complete with every necessary appurtenance, support and accessories required for operation.

C. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.

1.4 DESCRIPTION OF SYSTEMS

A. Furnish and install all materials for systems, resulting upon completion, in functioning systems in compliance with performance requirements specified. The omission of express reference to any parts necessary for or reasonably incidental to a complete installation shall not be construed as a release from furnishing such parts.

B. The wiring specified and shown on the drawings is for complete and workable systems. Any deviations from the wiring shown due to a particular manufacturer's requirements shall be made at no cost to either the contract or to the Owner. Changes in electrical service to equipment due to substitutions of equipment by any Divisions of this specification shall be at no additional cost to the Owner.

1.5 QUALITY ASSURANCE

A. All equipment and materials required for installation under these specifications shall be new and without blemish or defect. All equipment shall bear labels attesting to Underwriters Laboratories approval where subject to Underwriters Laboratories label service.

B. Equipment and material which are not covered by UL Standard will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe will be considered, if inspected or tested in accordance with national industrial standards, such as NEMA, ICEA or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

C. All equipment of one type (such as panelboards, breakers, etc.) shall be the products of one manufacturer.

1.6 REQUIREMENTS OF REGULATORY AGENCIES/CODE COMPLIANCE

A. Contractors shall submit all items necessary to obtain all required permits to the appropriate Regulatory Agencies, obtain all required permits, and pay all required fees.

B. All work shall conform to the following Building Codes:

1. National Electrical Code (NEC-2020)
2. South Carolina Building Code (SCBC 2021)

C. All work shall conform to all federal, state and local ordinances.

D. References to the National Electrical Code and National Fire Protection Association (NFPA) are a minimum installation requirement standard. Design drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the NEC and NFPA.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All products shall be new (except where noted) and unused and without blemish or defect.

2.2 SUBSTITUTIONS

A. Products included in the specifications and drawings indicate a basis-of-design. Where less than (3) manufacturers are indicated for a product, equal substitutions will be considered provided that adequate information is provided to demonstrate compliance with the design intent of the specifications and drawings.

B. Submittals shall be concise and clear. Submittals which include manufacturer's catalog data on other products or non-applicable options do not satisfy this requirement.

C. Submittals shall be accompanied by samples, descriptive literature and engineering information, as necessary, to fully identify and appraise the product.

D. Items approved shall not be construed as authorizing any deviations from the plans and specifications unless such deviations are clearly indicated in the form of a table of compliance that is enclosed with the submittals. The table of compliance shall clearly identify all deviations from the specifications with clear proof of equality for each case of deviation. Each item in the table of compliance shall be marked to show specification reference including the section and paragraph numbers.

E. Contractor shall be responsible for verifying all dimensions with available space conditions (with provisions for proper access, maintenance, part replacement, and for coordination with other trades--electrical, plumbing, structural, etc.) for proper services, and construction requirements. Contractor to bear any additional cost for required changes in associated items which are directly or indirectly related to a substituted unit.

F. The Contractor shall furnish drawings showing all installation details, shop drawings, technical data and other pertinent information as required.

G. Approval of the equipment does not relieve the contractor of the responsibility of furnishing and installing the equipment at no additional cost.

H. Where Contractor substitutes equipment manufactured by an alternative vendor, the Contractor shall become responsible for the operation of the product in the intended system, including all related costs required to make the design work, function, and fit in the allocated space.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260501 - ELECTRICAL COORDINATION

PART 1 - GENERAL CONDITIONS

1.1 INTERPRETATION OF CONTRACT DOCUMENTS

A. This section of the specifications and related drawings describe general provisions applicable to every section of Division 26.

B. Attention is directed to Instructions to Bidders and to Division 1, General Conditions, which are binding in their entirety on this portion of the work, in particular to paragraphs concerning materials, workmanship and substitutions.

C. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

D. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not eliminate the requirement for field coordination for the indicated work.

E. Information as to the general construction shall be derived from structural and architectural drawings and specifications only.

1.2 EXISTING CONDITIONS

A. The Contractor shall visit the premises and thoroughly familiarize himself with details of the work, working conditions, verify dimensions in the field, advise the Architect/Engineer of any discrepancy, and submit shop drawings of any changes he proposes to make, in quadruplicate for approval, before starting the work. Contractor shall install equipment in a manner to avoid building interference.

1.3 SHOP DRAWINGS

A. The Contractor shall not purchase any materials or equipment prior to receipt of approved shop drawings.

B. Prior to assembling or installing the work, prepare and submit shop drawings for the following items electrical equipment as specified in subsequent sections.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements.

D. Shop drawing sets shall be suitably bound and indexed. Loose sheets are not acceptable.

E. Catalog cuts submitted for approval shall be legible and shall clearly identify equipment being submitted. Items of the submittal **that have been faxed or scanned are not** acceptable.

F. Before preparing drawings, Contractor shall consult contract drawings and specifications in detail, obtain manufacturer's recommended installation instructions, and have shop drawings prepared based on specific equipment and material intended for installation. A principal of the contracting firm shall sign the shop drawings (indicating conformance with plans and specifications) before submission

G. Approval on shop drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless he has in writing (and in letter form) called attention to such deviations at the time of submission and secured written approval; nor shall it relieve him from responsibility for errors in shop drawings or schedules.

H. Submittals for individual systems and equipment assemblies which 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 for approval.

1.4 AS-BUILT DRAWINGS

A. The Contractor shall keep a record set of drawings on the job and, as construction progresses, shall show the actual installed location of items, material, and equipment on these record set drawings.

B. At the time of final inspection, two corrected sets of drawings shall be delivered to the Architect. Drawings costs to be by the Contractor.

C. Corrected sets shall be made by obtaining a sepia of the applicable contract drawings. Sepia prints shall be corrected deleting incorrect locations and showing installed locations in accordance with information transferred from job drawings.

D. Provide an additional set of corrected drawings in a moisture proof storage tube and mount the tube in the main electrical room.

1.5 OWNER'S MANUAL

A. The Contractor shall submit to the Architect three identical manuals that contain manufacturer's brochures of items installed by the Electrical Contractor.

B. The cover of the manual shall state the following information:

1. Project Name
2. Location
3. Owner
4. Architect
5. Electrical Engineer
6. Electrical Contractor (name, address, phone number)
7. General Contractor
8. Project Supervisors (general and electrical)
9. Date Of Project Completion

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

A. After final tests and adjustments have been completed, a competent employee of the Contractor shall be provided to instruct the Owner's Representative in the details of operation and maintenance for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is qualified to take over operation and maintenance procedures. Instruction periods shall be as designated by the Owner and shall not necessarily be consecutive.

1.7 MAINTENANCE MATERIALS

A. All special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner's Representative and a receipt requested for same.

B. Where specified, provide Owner's Representative with spare parts, equipment and materials and request a receipt for same.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the National Electrical Code, install an identification sign which will clearly indicate information required for use and maintenance of items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchgear and motor control assemblies, control devices and other significant equipment.

B. Nameplates shall be laminated black phenolic resin with a white core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.

1. Nameplates shall be attached with screws or rivets.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection:

1. Prior to any Work, the Contractor shall carefully inspect the installed Work of other Trades and verify that such Work is complete to the point where his installation may properly commence.
2. Verify that equipment may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the Architect Engineer.

2. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

C. Return to original (pre-construction) condition any paved areas, sidewalks, planting, etc., disturbed during electrical system installation.

3.2 INSTALLATION

A. Install equipment in strict accordance with the manufacturer's recommendations and the shop drawings approved by the Engineer.

B. Secure equipment using fasteners suitable for the use, materials, and loads encountered. If requested, submit evidence proving suitability. Do not attach electrical materials to roof decking, removable or knockout panels, or temporary walls and partitions, unless indicated otherwise.

C. Coordinated electrical systems, equipment and materials complete with auxiliaries and accessories shall be installed. Remove, modify, relocate and reinstall the existing electrical equipment and materials as shown.

D. Equipment location: Shall be as close as practicable to locations shown on drawings.

E. Working spaces shall be not less than specified in the National Electrical Code for voltages specified.

F. Inaccessible Equipment:

1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
2. "Conveniently 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.

G. Equipment and Materials:

1. New equipment and materials shall be installed unless otherwise specified.
2. Equipment and materials shall be designed to assure satisfactory operation and operating life for environmental conditions where being installed. NEC and other code requirements shall apply to the installation in areas requiring special protection such as explosion-proof, vapor-proof, watertight and weatherproof construction.

3.3 COORDINATION WITH OTHER TRADES

A. Coordinate work of each section with work of other sections to avoid interference. Bidders are cautioned to check their equipment against space available as indicated on drawings and shall make sure that proposed equipment can be accommodated. If interferences occur, Contractor shall bring them to the attention of Architect/Engineer, in writing, prior to signing of contract; or, Contractor shall, at his own expense, provide proper materials, equipment, and labor to correct any damage due to defects in his work caused by such interferences.

3.4 WORK PERFORMANCE

A. Arrange, phase and perform work to assure uninterrupted electrical service for other buildings. See General Methods of Procedure under Section GENERAL REQUIREMENTS.

B. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior condition.

C. Coordinate location of equipment and conduit with other trades to minimize interferences.

D. Cutting of Holes:

1. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed.
2. Holes shall be located so as not to affect structural sections such as ribs or beams.
3. Holes shall be laid out in advance. The Architect shall be advised prior to drilling through structural sections, for determination of proper layout.

E. Where conduits, wireways, busduct, and other electrical raceways pass through fire partitions, fire walls or walls and floors, install a UL listed firestop assembly that matches the rating and is intended for the penetrated construction to provide an effective barrier against the spread of fire, smoke and gases. Penetrations shall be made and the fire-stopping installed in accordance with manufacturers written instructions and UL details.

3.5 PROTECTION AND CLEANING 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, moisture, cold and rain.

B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them with securely fastened protective rigid or flexible waterproof coverings.

C. Conduit shall be protected by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation in the piping.

D. During construction cap the top of conduits and raceway installed vertically.

E. During installation, equipment, controls, controllers, circuit protective devices, etc., shall be protected against entry of foreign matter on the inside; and be vacuum cleaned both inside and outside before testing, operating and painting.

F. Damaged equipment shall be placed in first class operating condition or be returned to source of supply for repair or replacement.

G. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory, and removed prior to final inspection.

H. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer so repaired areas are not obvious.

3.6 DISPOSITION OF EXISTING MATERIAL AND EQUIPMENT

A. Material and equipment which is noted, specified, or required by the Owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the Owner and stored where directed on the site.

B. Carefully remove and store on the site material and equipment noted or specified to be reused or relocated. Thoroughly clean this equipment prior to installation.

C. Remove other materials or debris resulting from demolition operations from the site.

3.7 EXCAVATING, TRENCHING, BACKFILLING AND RESURFACING

A. Perform work as required, indicated, and in compliance with site work. Excavation depths indicated are below finished grade.

B. Do not excavate below required depth except as necessary for removal of unstable soil. Unless indicated otherwise, pitch electrical conduit runs downward away from buildings.

C. Where backfill compaction is critical (e.g. under floor slabs, roadways, sidewalks, trenches deeper than four feet), test the degree of compaction each 75 linear feet of trench and each two feet of depth.

D. Repair the excavated area to original pre-excavation condition. Repair and replace sidewalks, roadways, etc.

3.8 IDENTIFICATION

A. Upper case letters of uniform height; centered on device, coverplate, or enclosure; engraved letters filled with a contrasting color; and characters made clearly and distinctly.

B. Use abbreviations defined in the contract documents whenever possible. Use plan designations for labeling, unless indicated otherwise. Indicate loads served using designations from electrical schedules and designations from the trade furnishing the equipment served.

C. Label inside covers in exterior locations and outside covers in unfinished areas of the following with a permanent ink marking pen:

1. Junction boxes or portions of junction boxes with 277 or 480 volt wiring;
2. Communications system pull and junction boxes
3. Pull, junction boxes, and raceway installed above ceilings and for future use.

D. Label feeder conductors and branch circuit conductors with self-adhesive, numbered labeling tapes; Brady Co. or equal. Indicate feeder numbers on feeders and terminal numbers for control conductors. Label conductors at origin and destination points and at junction boxes where two or more feeder or control circuits are present.

3.9 ACCESS TO EQUIPMENT

A. All equipment shall be installed in location and manner that will allow for convenient access for maintenance and inspection.

3.10 CONNECTION OF EQUIPMENT FURNISHED AND INSTALLED UNDER OTHER DIVISIONS OF THE WORK

A. This Contractor shall rough-in and make final electrical connection to equipment requiring electrical connections with such equipment being furnished and installed under other Divisions of the Work.

B. Installations shall be functional and code complying.

C. This Contractor shall provide whatever incidental devices are necessary for final connection, such as, but not necessarily limited to outlet boxes, receptacles, connectors, clamps and switches.

D. Connection of Kitchen/Food Service Equipment shall be as follows:

1. Furnish and install conduit and wiring for Food Service Equipment, including junction boxes and receptacles at walls.
2. Coordinate with equipment supplier for specific types of receptacles required for plug-in equipment. Receptacles shown on electrical plans are symbolic only and are not intended to indicate exact types of connection.
3. Furnish and install disconnect switches between rough-in points and final connection points on equipment.

E. Connection of elevator equipment shall be as follows:

1. Rough-ins and connections vary between elevator manufacturers. Rough-ins shown on electrical plans are symbolic and do not represent rough-ins specific to each elevator manufacturer specified for use within the contract documents. Coordinate necessary rough-ins with elevator equipment supplier/installer. See architectural specifications for elevator manufacturers, coordinate rough-ins with elevator equipment provider.
2. Furnish and install rough-ins, conduit and conductors for elevator power, controls and maintenance in accordance with the NEC and elevator manufacturer’s specific requirements.
3. Furnish and install disconnect switches, fused and non-fused, with necessary interface contacts between rough-in points and final connection points on equipment.
4. Furnish and install conduit, conductors, contactors, relays, shunt trip breakers, and miscellaneous equipment required to perform the following functions associated with elevator operation:

    a. Connection to automatic transfer switch(es) pre-transfer interfaces.
    b. Shunt trip circuit breakers where required.
    c. Interface with building fire alarm and communications systems.
    d. Rough-in and connection of sump pumps, oil separators, oil detection systems and other systems necessary for elevator operation furnished by other trades of work.

3.11 GENERAL COMPLETION AND DEMONSTRATION

A. Results expected:

1. Systems shall be complete and operational, and controls shall be set and calibrated.
2. Testing, start-up and cleaning work shall be complete.

B. Demonstration:

1. Upon notification by the Contractors, the Engineer will visit the project for a demonstration of the building system and an inspection of the completed work.
2. Items which do not comply with the Contract Documents or which function incorrectly will be listed, and the list will be submitted by the Engineer to the Contractors for repairs.
3. After corrections have been made the Contractors shall notify the Architect/Engineer who will recheck the systems for compliance of items listed.

3.12 COORDINATION WITH COMMISSIONING AGENT

A. Contractor shall coordinate their work with the Owner's Commissioning Agent. Provide necessary labor, materials, test equipment, etc. Attend meetings with the Commissioning Agent and participate in the development and implementation of the Commissioning Plan.

B. Perform necessary corrective work to comply with deficiencies noted by the Commissioning Agent.

3.13 CLEANING

A. Periodically during construction and prior to Owner acceptance of the building, Contractor shall remove from the premises and dispose of packing material and debris.

END OF SECTION

SECTION 260519 - WIRE AND CABLE - BUILDING WIRE (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 SCOPE

A. This section includes the furnishing, installation, and connection of the building wire for power and lighting circuits.

B. Unless otherwise specified in other sections of these specifications, control wiring shall be provided, installed, and connected to perform the functions specified in other sections of these specifications.

C. Unless otherwise specified in other sections of these specifications, communication, fire alarm, data/IT, security, and signal wiring shall be provided, installed, and connected to perform the function specified in other sections of these specifications.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26000 sections

1.3 WORK INCLUDED

A. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the electrical cable and wiring system shown on the drawings and hereinafter specified.

1.4 APPLICABLE PUBLICATIONS

A. The following specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this specification to the extent indicated by the references thereto. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date of Invitation for Bids shall be applicable. In text such specifications and standards are referred to by basic designation only.

1. National Fire Protection Association (NFPA) Publications
   No. 70 . . . . National Electrical Code (NEC)
2. Underwriters' Laboratories, Inc. (UL) Publications:
   No. 44 . . . . Rubber-Insulated Wire and Cables
   No. 83 . . . . . .Thermoplastic-Insulated Wires

No 493 . . . . . .Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
No. 486. . . . . .Wire Connectors and Soldering Lugs

PART 2 - PRODUCTS

2.1 MATERIALS

A. Building Wire (Power and Lighting):

1. Cable and wire shall be in accordance with UL, NEC, as shown on the drawings, and as hereinafter specified.
2. Conductors:

   a. Shall be annealed copper.
   b. Shall be stranded for sizes No. 8 and larger. Sizes No. 10, and smaller shall be solid.
   c. Size shall be not less than shown on the drawings. Minimum size shall be No. 12 AWG.

3. Insulation: Unless otherwise shown on the drawings, insulation shall be as follows:

   a. THHN - THWN – Dry, Damp, Wet Locations
   b. XHHW – Dry, Damp, Wet Locations.

4. Color Code:

   a. All secondary service, feeder, and branch circuit conductors shall be color coded as follows:

208/120 Volt	Phase	480/277 Volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray

   b. All No. 12 and No. 10 branch circuit conductors shall have solid color compound or solid color coating.
   c. No. 8 AWG and larger phase conductors shall have either:

      1) Solid color compound or solid color coating.
      2) Stripes, bands, or hash marks of colors specified above.
      3) Colored pressure-sensitive plastic tape. Tape shall be applied in half overlapping turns for a minimum of three inches for all terminal points, and in all junction boxes, pull boxes, troughs, manholes, and handholes. Tape shall be 3/4-inch wide with colors as specified above. The last two laps of tape shall be applied with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

   d. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

B. Splices and Joints:

1. Shall be in accordance with UL and NEC.
2. Branch circuits (No. 10 AWG and smaller):

a. Connectors shall be solderless, screw-on, pressure cable type, 600 volt, 105 degree C, with integral insulation. They shall be approved for copper conductors, and shall be reusable.
b. The integral insulator shall have a skirt to completely cover the stripped wires.
c. The number, size, and combination of conductors as listed on the manufacturers packaging shall be strictly complied with.

3. Feeder Circuits:

a. Connectors shall be indent, hex screw, or bolt clamp-type. Material shall be high conductivity and corrosion-resistant.
b. Connectors for cable sizes 250 MCM and larger shall have not less than two compression indents.
c. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined.
d. Plastic electrical insulating tape:

1) Tape shall be flame retardant, cold and weather resistant.

C. Control Wiring:

1. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring.
2. Wire size shall be large enough so that the voltage drop under inrush conditions will not adversely affect operation of the controls.

D. Wire Lubricating Compound shall be suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, as shown on the drawings, and as hereinafter specified.

B. All wiring shall be installed in raceway systems, except where direct burial is shown on the drawings.

C. Cables and wires shall be spliced only in outlet boxes, junction boxes, pull boxes, manholes, or handholes.

D. Cable supports shall be installed for all vertical feeders in accordance with the NEC. They shall be of the split wedge type which firmly clamps each individual cable and tightens due to cable weight.

E. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.

F. Cable and wire entering a building from underground shall be sealed between the wire and conduit, where the cable exits the conduit, with a nonhardening approved compound.

G. Wire Pulling:

1. Suitable installation equipment shall be provided to prevent cutting or abrasion of conduits during pulling of feeders.
2. Ropes used for pulling feeders shall be made of suitable nonmetallic material.
3. Pulling lines for feeders shall be attached by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All cables to be pulled in a single conduit shall be pulled in together.

3.2 FIELD TESTING

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.

B. Test shall be performed by megger and conductors shall test free from short-circuits, grounds, and opens.

C. Conductors shall be tested phase-to-phase and phase-to-ground.

END OF SECTION

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. This section includes the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, grounding systems.

B. The term ground, as used in this specification, shall mean any or all of the grounding types specified.

1.2 RELATED WORK/SECTIONS:

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1.
2. All other Division 26 sections.

1.3 QUALITY ASSURANCE:

A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.

B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.

C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

D. ANSI/NECA/BICSI Standards: Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings – ANSI/NECA/BICSI Standard 607.

E. Manufacturer Standards: Standards and Guidelines for Communications Sites – Motorola R-56.

PART 2 - PRODUCTION

2.1 GENERAL:

A. Provide electrical grounding systems with assembly of materials, including cables/wires, connectors, terminals, solderless lugs, grounding rod/electrodes, bonding jumper braid and additional accessories needed for complete installation. Where materials or components are

not indicated, provide products complying with standards listed under section 1.3 above and established industry standards.

2.2 GROUNDING CONDUCTORS:

A. Shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the drawings, or specified.

B. Branch circuit grounding conductor size shall not be less than #12 AWG and not less than required by the NEC.

2.3 GROUND RODS:

A. Ground rods shall be copperclad steel, 3/4-inch diameter by minimum ten feet long.

2.4 GROUNDING CLAMPS:

A. Clamps for connection of grounding electrode conductors to metal piping 1" and less in diameter shall be cast brass/bronze and of the single screw type design.

B. Clamps for bonding metal piping for 1" through 6" in diameter shall be bronze or brass and of the U-bolt type.

2.5 CONNECTIONS AT GECB AND MGECB:

A. Grounding conductor connections shall be made utilizing listed two-hole compression or exothermically welded lugs.

B. Securing hardware shall be constructed from 300 series stainless steel unless noted otherwise. Hardware shall be sized to match the lug hole size for the conductor.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING:

A. General: Install electrical grounding systems in accordance with applicable portions of NEC, with NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.

C. Weld grounding conductors to underground grounding rods/electrodes.

D. Connection to structural steel building components shall be made utilizing exothermic welding. Bolted connections for bonding to steel building components shall only be used in load bearing masonry construction when connecting to bar joist roofing systems.

3.2 FEEDERS AND BRANCH CIRCUITS:

A. Install green insulated equipment grounding conductors with all feeders and branch circuits. Conductors shall be sized in accordance with NEC Article 250.

3.3 EQUIPMENT GROUNDS:

A. All equipment that has electrical connections (lights, receptacles, panels, and utilization equipment) shall have a ground wire connected that is directly tied to the ground bus of the panel which serves it.

B. Fixed electrical appliances and equipment shall have a ground lug installed and provided by this contractor for termination of the green ground conductor.

3.4 CONDUCTIVE PIPING:

A. Bond all conductive piping systems in the building whether furnished and installed by this contractor or not to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

3.5 GROUND ROD INSTALLATION:

A. Distance: Drive each rod vertically for not less than ten feet.

B. Multiple Rods: Where required to obtain the specified ground resistance, install multiple rods.

C. Where ground connections will be permanently concealed, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with clamp type ground connectors.

D. Where rock prevents the driving of vertical ground rods, install grounding electrodes in trenches and of suitable length to achieve the specified resistance.

3.6 FIELD QUALITY CONTROL:

A. Upon completion of installation of electrical grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground over 3 ohms, take appropriate action to reduce resistance to 3 ohms, or less, by driving additional ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance. Ground resistance tests shall be performed utilizing fall-of-potential test method for ground resistance measurements.

B. Record results of all ground resistance tests and corrective actions and include copies within the Operation and Maintenance Manual.

END OF SECTION

SECTION 260533 - CONDUITS/RACEWAYS AND FITTINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, grounded raceway systems.

B. Types of raceways in this section include the following:

1. Rigid metal conduit (RMC or GRC)
2. Intermediate metal conduit (IMC)
3. Electrical metallic tubing (EMT)
4. Flexible metal conduit (FMT)
5. Liquidtight flexible metal conduit (LFMC)
6. Rigid PVC conduit (PVC)

C. The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26000 sections

1.3 QUALITY ASSURANCE

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

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to raceways systems; and provide products and components which have been UL listed and labeled.

C. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC OR GRC)

A. Rigid metal steel conduit shall conform to ANSI C80.1 and Underwriter's Laboratories UL-6 specification, ANSI C80.1.

B. Conduit shall be hot-dipped galvanized to provide a corrosion resistant coating.

C. Fittings: Fittings shall be ANSI/NEMA FB 1 threaded type, hot dipped or electronic plated. Threaded conduit to be secured to boxes, cabinets, etc., by means of galvanized threaded bushings on the inside and bond-type locknuts on the inside and outside of such boxes and cabinets. Fittings shall be watertight and the same material as conduit installed with factory manufactured elbows.

2.2 RIGID INTERMEDIATE STEEL CONDUIT (IMC)

A. Intermediate Metallic Conduit shall conform to ANSI C80.1 and proposed Underwriter's Laboratories UL 1242 specification.

B. Conduit shall be hot-dipped galvanized to provide a corrosion resistant coating. Intermediate Metallic Conduit (IMC) shall have galvanized/metallized thread protection, and pipe interior shall be protected by corrosion inhibiting coating.

C. Fittings: Shall be similar to GRC.

D. Maximum allowable size shall be (4) inches.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Electrical metallic tubing shall conform to ANSI C80.3 and Underwriter's Laboratories UL 797.

B. EMT shall be hot-dipped galvanized steel with internal coating of silicone epoxy lubricant to assist in wire pulling.

C. Fittings: Shall be compression type, steel or malleable iron. Set screw or indentation type of fittings are not acceptable.

2.4 FLEXIBLE METAL CONDUIT (FMC)

A. Flexible metal conduit shall conform to UL 1.

B. Flexible conduit to be of hot-dipped galvanized interlocked spirally wound steel strip.

C. Fittings shall be multiple point type, threading into the internal wall of the conduit convolutions, and shall have insulated throat. Connectors to be galvanized and be suitable for connection to associated boxes and conduits.

2.5 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Liquid-tight flexible metal conduit shall conform to UL 360.

B. Liquid-tight flexible metal conduit shall consist of flexible galvanized steel tubing over which is extruded a liquid-tight jacket of polyvinyl chloride (PVC). Conduit shall be provided with a continuous copper bonding conductor wound spirally between the convolutions.

C. Fittings used shall be reusable type of malleable iron/steel construction, electro zinc plated inside and outside, furnished with nylon insulated throat and taper threaded hub. Connectors to be galvanized and be suitable for connection to associated boxes and conduits.

2.6 RIGID PVC (PVC)

A. Conduit shall be UL rated 90°C and to UL-651. Fittings shall conform to UL-514.

B. Conduit shall be S40 wall thickness made from polyvinyl chloride (recognized by UL) compound which includes inert modifier to improve weatherability and heat distortion. Conduit and couplings shall be homogenous plastic material free from visible cracks, holes, or foreign inclusions. Conduit bore shall be smooth and free from blisters, nicks, or other imperfections which could mar conductors or cables.

C. Bends: 90° bends shall be made with galvanized rigid steel elbows. Bends other than 90° shall be made from S80 PVC conduit.

2.7 CONDUIT SUPPORTS

A. Parts and hardware shall be zinc-coated or have equivalent corrosion protection.

B. Pipe straps: Fed. Spec. FF-S-760, type 1, style A or B.

C. Individual conduit hangers: Shall be designed for the purpose, and have pre-assembled closure bolt and nut, and provisions for receiving hanger rod.

D. Multiple conduit (trapeze) hangers shall be not less than 1-1/2 x 1-1/2 inch, 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8 inch diameter steel.

E. Solid masonry and concrete anchors: Fed. Spec. FF-S-325 shall apply. Anchors shall be GROUP III self-drilling expansion shields, or machine bolt expansion anchors GROUP II type 2 or 4, or GROUP VII.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE

A. Conduits utilized shall be metallic conduit types listed in this specification. Metallic conduit types shall be applied for specific system types as follows:

1. Power distribution feeders such as feeders for switchboards, panelboard, transformers, etc.:

a. Exposed or concealed - RMC or IMC
b. Below slabs on grade or underground outside of building - PVC

2. Feeders to motors: Same requirements as power distribution feeders.
3. Branch circuits from panelboards (not described above):

a. wet or damp locations exposed or concealed - RMC or IMC
b. Dry locations exposed or concealed - EMT.
c. Below slabs on grade or underground outside of building - PVC

4. HVAC equipment feeders 1-1/2" trade size and larger: Same requirements as power distribution feeders.
5. HVAC equipment feeders smaller than 1-1/2” trade size: Same requirements as branch circuits from panelboards.
6. Low voltage systems such as building automation and control systems, information technology systems: Same requirements as branch circuits.

3.2 CONDUIT INSTALLATION

A. Installation shall be in accordance with UL, NEC, as shown on the drawings, and as hereinafter specified.

B. Contractor shall lay out and install conduit runs to avoid proximity to hot pipes. In no case will a conduit be run within three inches of such pipes, except where crossings are unavoidable and then conduit shall be kept at least one inch from the covering on pipe crossed.

C. Conduits shall be supported as required to comply with applicable paragraphs of the NEC.

D. Conduit installation shall be as follows:

1. Installed as complete runs before pulling in cables or wires.
2. Flattened, dented, crushed or deformed conduit is not permitted and shall be removed and replaced at no cost to the Owner.
3. Installed so they will not obstruct headroom, walkways, doorways or work by other trades.
4. Cut square with a hacksaw, reamed, burrs removed, and drawn up tight.
5. Mechanically continuous.

a. Metallic raceway shall also be electrically continuous.

6. Supported within one foot of changes of direction, and within one foot of each enclosure to which connected.
7. Ends of empty conduit to be closed with plugs or caps at rough-in stage to prevent entry of debris until wires are pulled in.
8. Conduits shall be secured to cabinets, junction boxes, pull boxes, and outlet boxes by bonding type locknuts.
9. See architectural detail for conduit penetrations of roof membrane.

E. Conduit Bends:

1. Shall be made with standard conduit bending machines.

2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Conduits shall not be bent with a pipe tee or vice.

F. Conduit shall be securely fastened in place at intervals as specified by the code using suitable straps, hangers and other supporting assemblies. Strap hangers and supporting assemblies:

1. Shall be of rugged construction capable of supporting weight with a reasonable factor of safety.
2. Spacers and supporting straps shall be of rugged malleable iron or steel construction hot dipped galvanized.
3. Shall be adequately protected against corrosion.

G. In wet locations or in locations where corrosive conditions are present, vertical and horizontal runs of conduit shall be firmly supported so that there is at least 1/4" air space between the conduit and the wall or supporting surface. Spacers and supporting straps shall be of malleable iron construction, hot dipped galvanized.

H. Flexible conduit when installed shall have sufficient slack to avoid sharp flexing and straining due to vibration and thermal expansion/construction. Conduit shall be installed in such a manner that liquids will tend to run off the surface instead of draining towards the fittings.

I. Concealed work installation:

1. In cast-in-place:

   a. Conduits may be installed in concrete that is at least than 3 times conduit trade size in thickness but in no case less than 3” thick.
   b. Conduit shall be run in direct lines.
   c. Conduit may be installed through concrete beams where shown on the structural drawings or as approved by the Engineer prior to installation.

      1) Submit drawings showing locations size, and position of each proposed penetration for review prior to installation.

   d. Spacing between conduits in slab shall be approximately six conduit diameters apart except one conduit diameter at conduit crossings.
   e. Conduits shall be installed approximately at the center of the slab.
   f. Couplings and connections shall be concrete tight. Thread compounds shall be UL approved conductive type to ensure low resistance ground continuity through the conduits.
2. In CMU (Concrete Masonry Unit) Walls:

   a. Conduits shall run vertically within CMU walls except where noted on the drawings or as approved by the Engineer prior to construction.

3. Conduit shall be run parallel or perpendicular to the building lines.
4. Branch circuit conduits, and conduits feeding ceiling lighting shall be supported independently from suspended ceiling, lighting fixtures, or air conditioning ducts.
5. Recessed lighting fixtures shall be connected to conduit with not over six feet of flexible metal conduit.

J. Exposed work installation:

1. Conduit shall be run parallel or perpendicular to the building lines.
2. Horizontal runs shall be installed close to the ceiling or beams and secured with approved conduit straps.
3. Horizontal or vertical runs shall be supported at not over eight foot intervals.

K. Installation underground or below slabs on grade:

1. Tops of conduits shall be:

   a. Not less than 24 inches and not less than shown on the drawings below finished grade.
   b. Not less than 30 inches and not less than shown on the drawings below road and other paved surfaces.

2. Conduits shall be installed below power company direct burial primary feeders where encountered. Coordinate spacing below primary feeder with utility company.
3. Underground conduits shall be encased in not less than 3" of red cast-in-place concrete (all around) where run outside of buildings or equipment pads.

L. Transition from PVC to metallic conduit:

1. Where PVC conduit exits permitted locations, coated rigid galvanized or IMC conduits shall be utilized for the transition. Acceptable coatings are factory applied PVC or field applied spray bituminous or tape coatings intended for the application.

   a. Where conduits transition under pad-mounted equipment enclosures such as switchboards, generators or pad-mounted transformers, it shall be acceptable to utilize PVC for the transition.

2. Transition to metallic conduits shall occur minimum 12 times conduit trade diameter prior to exit from permitted locations. Distance shall be measured from point of exit for horizontal transitions and from center of conduit at point of exit for horizontal to vertical transitions.

M. Surface metal raceways:

1. Surface metal raceways shall be used only where shown on the drawings.

3.3 MOTORS AND VIBRATING EQUIPMENT

A. Flexible metal conduit shall be used for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Flexible metal conduit shall be liquid-tight when installed in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, and locations subject to seepage or dripping of oil, grease or water. Flexible metal conduit shall be installed with green ground wire.

3.4 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Pipe straps or individual conduit hangers shall be used for supporting individual conduits.

C. Multiple conduit runs shall be supported by trapeze hangers. Trapeze hangers shall be designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 pounds. Each conduit shall be attached by U-bolt or other approved fastener.

D. Conduit shall be supported independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, etc.

E. Solid Masonry and Concrete: Fasteners shall be as follows:

1. New construction: Generally, steel or malleable iron concrete inserts in concrete prior to pouring.
2. Existing construction:

a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8-inch embedment.
b. Power set fasteners shall be approved, and not less than 1/4-inch diameter with depth of penetration not less than three inches.
c. Anchors or fasteners attached to concrete ceilings shall be vibration and shock resistant.

F. Hollow masonry. Toggle bolts are permitted. Bolts supported only by plaster are not acceptable.

G. Metal structures. Fasteners shall be machine screw or devices specifically designed and approved for the application.

H. Attachments by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking is not permitted.

I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

J. Vertical supports. Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown on the drawings. Supports for cable and wire shall have fittings which include internal wedges and retaining collars.

3.5 LOW VOLTAGE SYSTEM CONDUIT

A. Minimum size conduit shall be 3/4", but not less than shown on the drawings.

B. Conduit bends and elbows shall be long radius.

3.6 PULL WIRES

A. Install a # 14-gauge fish wire in empty conduits, except telephone and communications. Install a nylon pull string in telephone and communication conduits.

END OF SECTION

SECTION 260535 - ELECTRICAL BOXES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the furnishing, installation and connection of all outlet boxes, junction boxes, and floor boxes as shown on the drawings or as required to house the intended wiring, devices or equipment.

B. Types of electrical boxes and fittings specified in this section include the following:

1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
4. Bushings.
5. Locknuts.
6. Knockout closures.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1.
2. All other Division 26000 sections.

B. Other systems specified in Division 26000 may call for special boxes not covered in section 26 0535.

1.3 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

B. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL listed and labeled.

C. NEMA Compliance: Comply with applicable requirements of NEMA Stds./Pub No.'s OS1, OS2, and Pub 250 pertaining to outlet and device boxes, covers, and box supports.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. Outlet and Device Boxes (dry interior locations): Provide galvanized coated sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as required by particular application, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with conduit size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

B. Outlet and Device Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations.

   1. Plaster rings and device mounting rings shall be of proper depth such that the device mounting surface is flush with the finished wall/ceiling surface.

C. Outlet and Device Boxes (damp and wet locations): Provide corrosion resistant cast metal raintight outlet and wiring device boxes of types, shapes and sizes required for each application, including depth of boxes, with threaded conduit holes for fastening electrical conduit, and cast metal face plates. Where weatherproof devices are indicted, provide spring hinged watertight caps suitable configured for each application, including face plate gaskets and corrosion resistant plugs and fasteners.

D. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suite each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

E. Bushings, Knockout Closures, and Locknuts: Provide corrosion resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

C. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

D. Provide knockout closures to cap unused knockout holes where blanks have been removed.

E. Avoid installing boxes back-to-back in walls.

F. Position recessed outlet boxes accurately to allow for surface finish thickness. Boxes shall be installed such that the device mounting surface is flush with the wall/ceiling finished surface.

G. Set floor boxes level and flush with finish flooring material. Provide trim flange to match finish floor material.

H. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

3.2 GROUNDING

A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 260548 - SEISMIC SUPPORT OF ELECTRICAL EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SCOPE OF WORK

A. General:

1. Furnish all labor, materials, tools and equipment and perform all operations in connection with the installation of seismic support of electrical equipment systems and appurtenances where shown on the drawings and specified hereinafter.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26 sections
3. All Division 28 sections

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. All seismic equipment and design shall comply with all local codes and ordinances and meet or exceed the standards and procedures (latest editions) of the following:

a. IBC

B. Seismic control equipment shall be sized and provided by manufacturer. Seismic bracing shall be a factory manufactured item listed in the manufacturers catalog for the intended use.

C. Manufacturer:

1. The seismic control supports manufacturers shall be as manufactured by one of the following or approved equal:

a. Mason Industries
b. Amber Booth
c. Peabody

1.4 SUBMITTALS

A. The manufacturer shall submit drawings including floor plans, sections and elevations showing piping, duct, and equipment. Drawings shall indicate location and type of all components provided.

B. A schedule shall show capacity and load of each component at each location.

C. Design shall be based upon actual installation and not contract drawing schematics.

D. Submittals shall include:

1. Sketches showing seismic loading, location of bracing and types and sizes of bracing assemblies.
2. Submit seismic protection ratings in three principle axes certified by an independent laboratory.
3. Submit calculations for shear, pull-up, primary overturning, and secondary overturning.
4. Submit drawings indicating auxiliary supports and method of attachment.
5. Calculations shall be submitted and signed by a licensed professional engineer.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and applicable conduit shall be mounted on or suspended from approved foundations and supports as specified herein and as shown on the drawings.

B. Steel components shall be phosphated and painted. All nuts, bolts, and washers shall be zinc electroplated.

2.2 BRACING HANGERS

A. Seismic bracing shall be a factory manufactured item listed in the manufacturers catalog for the intended use.

B. Equipment sway bracing shall be provided for all items supported by off-the-floor structures or structures suspended from floors or roof above.

1. Braces shall consist of angles, rods, bars, or pipes run at 45% angles from the equipment frame to the building structure secured at both ends with bolts 1/2" or larger.
2. Bracing shall be provided in two planes of direction, 90 degrees apart, for each item of equipment.

2.3 ANCHOR BOLTS AND NUTS FOR PAD MOUNTED EQUIPMENT

A. Pad mounted equipment shall be anchored with a minimum of four (4) bolts. Each bolt shall be 6" in length or at least 10 times longer than the nominal diameter of the bolt with a 90-degree hook on the non-threaded end.

B. Nuts shall be heavy duty hexagon nuts.

C. Minimum bolt sizes are as follows:

1. Equipment up to 500 pounds, 3/8" diameter.
2. Equipment from 500 to 1000 pounds, 1/2" diameter.

3. Equipment from 1000 to 5000 pounds, 5/8" diameter.
4. Equipment from 5000 to 10000 pounds, 3/4" diameter.

2.4 ELECTRICAL EQUIPMENT

A. Systems include but are not limited to the following:

1. Electrical switchgear
2. Electrical conduit 2-1/2" inside trade diameter or greater
3. Panelboards
4. Dry Type Transformers
5. Emergency Lighting Systems
6. Lighting fixtures:

    a. Lighting fixtures installed in suspended ceiling systems shall conform to the guidelines of CISCA.
    b. Recessed lighting fixtures shall be independently supported from the structure. The suspended ceiling system shall not be used to support the fixtures.
    c. Surface mounted fixtures shall be attached to the ceiling system with positive clamping devices that completely surround the ceiling members. Safety devices shall be attached between the clamping device and the adjacent ceiling hanger or to the structure above.
    d. Pendant hung lighting fixtures shall be supported directly from the structure above using No. 9 gauge wire without using the ceiling suspension system for direct support.

7. Fire Alarm Systems

B. Electrical conduit of any size suspended by individual hangers of less than 12 inches from top of conduit to the supporting structure, do not have to be seismically braced.

C. Slab or floor mounted equipment not subject to movement or vibration.

1. Equipment shall be direct anchored.

D. Roof Mounted Equipment:

1. Equipment shall be direct anchored.
2. Curbs and equipment supports shall be attached to roof structure.

2.5 SEISMIC ACCESSORIES

A. Provide all necessary brackets, bolts, fasteners, predrilled bases, oversized bases, accessory components, and materials to install systems in accordance with manufacturer's requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. If the equipment to be mounted is not furnished with integral structural frames and external mounting lugs (both of suitable strength and rigidity), approved structural subbase shall be installed in the field which shall support the equipment to be hung and to which shall be attached the hangers.

3.2 SUPERVISION

A. The manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the Architects and Engineers in writing certifying the correctness of installation and compliance with approved submittal data.

END OF SECTION

SECTION 260923 – AUTOMATIC LIGHTING CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install, and connect all conduit, fittings, boxes, controls, control wiring, and all other devices, whether specified/indicated or not, to produce a complete and functional automatic lighting control system.

1.2 RELATED WORK/SECTIONS:

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1 of the building construction documents.
2. All other Division 26 sections.
3. All Division 27 and 28 sections.

1.3 SUBMITTALS:

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500, ELECTRICAL GENERAL REQUIREMENTS.

B. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

C. 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.

D. Submit scaled lighting plans clearly marked by manufacturer showing proper product, location, and orientation of each sensor. Scale shall match that used in the Contract Documents.

E. Submit manufacturers cut sheets, including sensor performance information indicating compliance to the specification.

1.4 AS BUILT DRAWINGS:

A. Section 260500, ELECTRICAL GENERAL REQUIREMENTS, shall apply.

1.5 RESPONSIBILITY

A. All equipment to be the responsibility of the single lighting control manufacturer.

B. All variations from the specified equipment must be approved by the Architect, Owner and Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products indicated in the documents are part numbers and catalogue numbers of Watt Stopper, Inc. which is the basis of design.

B. For prior approval, provide all of the information required for review a minimum of ten (10) calendar days prior to the initial bid date.

2.2 OCCUPANCY DETECTION AND CONTROL SENSORS AND SUPPORT COMPONENTS

A. All products numbers listed are Watt Stopper. See plans for part numbers and device descriptions. Provide latest version of devices superseding part numbers shown on plans.

B. Wall switch sensors shall be capable of detection of motion at desk top level up to 300 square feet, and half-step motion up to 1,000 square feet.

C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,000 watts at 277 volts, and shall have 180 degree coverage capability.

D. Bi-level wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,000 watts at 277 volts.

E. Passive Infrared and Dual Technology sensors shall have fully automatic operation.

F. All sensors shall be capable of operating normally with electronic ballast, PL lamp systems, and rated motor loads.

G. 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.

H. All sensors shall have tool-less accessible, user adjustable controls for time delay and sensitivity. Controls shall be concealed to limit tampering.

I. 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.

J. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005% tolerance to assure reliable performance and eliminate sensor crosstalk. Sensors using multiple frequencies are not acceptable.”

K. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working.

L. 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 to achieve this function are not acceptable.

M. All sensors shall have no leakage current to load in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.

N. All sensors shall have UL rated, plastic enclosures.

O. Wall switches shall be provided with oversized stainless steel device plates.

2.3 CIRCUIT CONTROL HARDWARE:

A. For ease of mounting, installation and future service, control unit(s) shall be able to mount within J boxes and be an integrated self-contained unit consisting internally of load switching control relay and a transformer to provide low voltage power to a minimum of three (3) sensors.

1. Relay Contacts shall have ratings of:

13A 120 VAC Tungsten

20A 120 VAC Ballast

20A 277 VAC Ballast

2.4 CONTROL WIRING:

A. Control wiring between sensors and controls units shall be Class II, 1824 AWG stranded U.L. Classified, PVC insulated or Teflon jacketed cable approved for use in plenums, where applicable.

B. Control wiring shall be installed in conduit, size as required for cabling.

PART 3 - EXECUTION

3.1 GENERAL

A. It shall be the contractor's responsibility with the manufacturer’s assistance 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. The contractor shall arrange a pre-installation meeting with a factory authorized manufacturer representative to verify placement of sensors to insure proper system operation.

B. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within in the room(s).

C. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

D. Proper judgment shall be exercised by the contractor in executing the installation, taking into consideration the device installation and to overcome local difficulties due to space limitations or interference with system performance due to building structural, finish and HVAC components.

E. The contractor shall obtain factory assistance and guidance in the initial sensor sensitivity adjustments and aiming of the sensors to provide specified system performance.

3.2 CONTROL WIRING:

A. Control wiring shall be installed in conduit, size as required for cabling.

3.3 TESTING AND START-UP

A. Upon completion of installation and initial adjustments the Contractor shall notify the manufacturer who shall provide a factory trained engineer to check, program and test the equipment and make adjustments as necessary to comply with the performance requirements specified within.

3.4 OWNER TRAINING

A. Provide four (4) hours of training for an Owner representative scheduled at the convenience of the Owner.

1. Person conducting the training shall be a factory authorized representative knowledgeable in the systems specified within.
2. The Contractor shall contact Owner and schedule training with Owner.

3.5 GUARANTEE

A. Guarantee shall be total and complete and shall be for one (1) year starting with the date of total project acceptance.

END OF SECTION

SECTION 262413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the switchboard shown on the drawings and hereinafter specified.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26000 sections

1.3 QUALITY ASSURANCE

A. Switchboards shall comply with the following standards:

1. UL Listing/Approval
2. UL Standards:
    a. Switchboard UL891
3. National Electric Code
4. NEMA Standard - PB2
5. Surge protective devices (SPD) shall comply with:
    a. Latest editions of UL 1449 and 96A.
    b. IEEE standards C62.45-2002, C62.41.1, C62.41.2
    c. NEMA LS1
    d. NEC Article 241
    e. NFPA 780

1.4 SUBMITTALS

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500, Electrical General Requirements.

B. Submit complete, dimensioned detail drawings for each switchboard.

C. Scaled drawings of housekeeping pad showing feeder windows, reinforcement bars, anchor hardware, etc. being provided for installation of switchboard.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) connect factory-installed space heaters to temporary electrical service to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

D. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION

A. Furnish and install where indicated a dead front type, completely metal enclosed, self-supporting structure independent of wall supports. Voltage rating shall be as indicated on the drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard, 93" high, maximum. All edges of front covers or hinged front panels shall be formed.

B. Equipment shall comply with the latest applicable standards of NEMA, ANSI & U.L.

C. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

D. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

E. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating. Color shall be ANSI 61 gray.

F. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

G. All bus bars shall be silver-plated copper. All bus work shall be rated to withstand maximum short-circuit stresses when connected to a supply system having fault capacity of indicated

on the drawings. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Provide full capacity neutral. A ground bus and lug shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. Distribution section vertical bus bars shall extend the entire mounting length. All hardware used on conductors shall be high-tensile strength and zinc plated. All terminals shall be of the anti-turn solderless type suitable for Cu or A1 cable of sizes indicated.

H. Furnish cable pull sections or top cable pull boxes, where required, complete with cable tie down supports. Where cable pull section or pull boxes contain utility service cables provide utility acceptable sealing means.

2.2 CUSTOMER METERING

A. The switchboard shall be equipped with metering. Metering equipment shall be by Square D or equal by approved switchboard manufacturer and shall include, but not be limited to, the following:

1. Current transformers.
2. Voltage (potential) transformers if required by metering equipment.
3. Microprocessor based power, energy and power quality meter(s) as noted on switchboard one-line diagrams and/or switchboard schedules. Provide Square D Powerlogic indicted by type:

Type 1	PM5563 with PM55563RD remote display
Type 2	PM5100 Series

4. Customer Metering shall be equipped with remote access via web server integral to switchboard. Provide necessary interface equipment, software and custom programming to connect metering to the buildings local area network.

    a. Additional web pages shall include as-built riser diagram and O&M manuals for switchgear.

5. Provide networked remote displays where noted on plans.

2.3 SWITCHBOARD CIRCUIT BREAKERS - SCHEDULE

A. Main Circuit Breakers Greater than 1200A.

1. Switchboard main circuit breakers shall be equipped with solid state LSIG trip units.
2. Circuit breakers used as mains shall be UL listed for application in their intended enclosure for 100% of their continuous ampere rating.
3. Shall be provided with a true, two-step stored energy mechanism providing a maximum of five (5) cycle closing. All the energy required for closing the breaker shall be completely stored and held in readiness pending a release to close action. Manual operated breakers shall be convertible to motor operation by insertion of an internally mounted motor operator without voiding U. L. label. Both manual and motor operated breakers shall have multiple charge/close provisions providing the following possible sequence: Charge-close-recharge-open- close-open. As a safety feature, provisions shall be available to manually discharge the stored energy without closing the breaker.

Anti-pump provisions shall be provided as standard for motor operated breakers and optional for manual breakers with spring release solenoids.

4. The breaker control face plate shall include color coded visual indicators to indicate contact "open" and "closed" positions as well as mechanism "charged" and "discharged" positions. Local control push buttons shall be provided for "opening" and "closing" the breaker. For motor operated breakers, a local "charge" push button, control switch, red and green indicating lights shall be provided.
5. The following shall be provided:

    a. Provisions shall be available for remote "manual" charging or automatic re-charging following an "open" operation. The "spring charged" visual indicator shall show "charged" only when the total closing energy required is completely charged.
    b. Provisions shall be available to block local manual closing as well as padlocking the breaker in the "open" position.

6. Provide trip devices which are interchangeable between compatible breaker frames. Suitable interlocking shall be provided between trip devices and related frames to ensure correct application. The continuous ampere rating of the breaker shall be determined by the insertion of an interchangeable rating plug that matches the load and cable requirements. The rating plug shall be interlocked with the tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. Rating plugs shall be keyed to prevent incorrect application between different frame ratings.
7. Ground fault trip shall be provided for the main circuit breaker as an integral part of the breaker.

B. Main and Distribution Circuit Breakers 1000A and 1200A:

1. Switchboard branch circuit breakers shall be 100% rated solid-state trip molded case circuit breakers complete with built in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have easily changed trip rating with trip ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breaker cannot be latched with rating plug removed. The breaker shall have built-in test points for testing long delay and instantaneous and ground fault functions of the breaker by means of a 120-volt operated test kit. Provide one (1) test kit capable of testing all breakers 450 amperes and above.
2. Solid-state instantaneous element shall be LSIG type and shall be continuously adjustable from approximately four (4) to eight (8) times the trip rating, with short time adjustment from instantaneous to ten (10) cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.
3. Solid-state trip distribution circuit breakers provided shall be capable of coordination with upstream main devices within the switchboard.

C. Main and Distribution Circuit Breakers 150A through 800A:

1. Switchboard branch circuit breakers shall be 80% rated solid-state trip molded case circuit breakers complete with built in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have easily changed trip rating with trip ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breaker cannot be latched

with rating plug removed. Breaker shall have built-in test points for testing long delay and instantaneous and ground fault functions of the breaker by means of a 120-volt operated test kit. Provide one (1) test kit capable of testing all breakers 450 amperes and above.

2. Solid-state instantaneous element shall be LSI type and shall be continuously adjustable from approximately four (4) to eight (8) times the trip rating, with short time adjustment from instantaneous to ten (10) cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.
3. Solid-state trip distribution circuit breakers provided shall be capable of coordination with upstream main devices within the switchboard.

D. Molded Case Circuit Breakers - Main and Distribution Circuit Breakers 125A or smaller:

1. Breakers 125A and smaller shall be 80% rated molded case, thermal-magnetic trip with inverse time current characteristics.

2.4 GROUND FAULT PROTECTION SYSTEMS

A. Equipment Ground Fault Protection For 277Y480V circuit Breakers 1000A or Greater:

1. Circuit breakers shall be provided with integral equipment protection for grounded systems. The circuit breaker shall be suitable for use on three phase, four wire systems.
2. The ground fault pick-up shall be adjustable with a maximum setting of 1200 amp in compliance with the NEC. The time delay shall be adjustable in three (3) discrete bands for maximum system selective coordination.
3. Provide a separate neutral current transformer for three phase four wire systems as required.
4. Ground fault sensing system shall be residual type.
5. The trip system shall include a Ground Fault memory circuit to sum the time increments of intermittent arcing ground faults above the pickup point. When the summation of time is equal to the present time delay, the trip unit will initiate a tripping signal. If, however, an interval of greater than five (5) minutes occurs where the ground fault is not above the pickup setting, the memory will reset and resume summing at zero.
6. Provide a means of testing the ground fault system to meet the on-site testing requirements of NEC Article 230.95(C).
7. Provide local visual trip indication for ground fault trip occurrences.

2.5 ENERGY REDUCTION MAINTENANCE SETTING SWITCH (ERMS):

A. For each Main or Feeder circuit breaker with a rating of 1200A or more, provide a Maintenance OFF ON selector switch on the breaker compartment door to temporarily switch the circuit breaker to ERMS mode tripping characteristics during maintenance activities.

B. The trip unit shall provide a separate trip curve for arc energy-reducing maintenance setting (ERMS).

C. Trip unit shall operate in Fast Instantaneous trip mode (25 to 30 ms), when ERMS trip curve is active.

D. A lock feature shall be provided so that the ERMS may be locked in the ON position.

E. A blue indicating light shall be provided to indicate trip unit is in the ERMS ON mode.

2.6 MIMIC BUS

A. Show the entire single line switchboard bus work, as depicted on the factory record drawing, on an engraved laminated plastic (Gravoply) nameplate. The nameplate shall be at least .0625” thick and located at eye level on the front cover of the switchboard

2.7 SURGE PROTECTIVE DEVICES (SPD):

A. Switchboards shall be provided with SPD. SPD shall be integral, and factory installed within switchboards. SPD utilized shall be a standard product of the switchboard manufacturer.

B. SPD shall be parallel protective devices utilizing Metal Oxide Varistors (MOVs) for the primary suppression components. MOVs shall be furnished with UL recognized surge rated fuses rated 200kAIR for protection and shall incorporate a thermal cutout device.

C. Switchboard SPD shall be furnished as an assembly with a factory disconnect switch to facilitate replacement of SPD components.

D. SPD shall be provided with:

1. Active indicator lamps which extinguish or change color when protection has failed.
2. Form C dry contact for auxiliary alarm monitoring.
3. Audible alarm with silence switch.

E. SPD shall safely reach an end-of-live condition when subjected to fault current levels between 0 and 200kA.

F. SPD shall be covered by a 10 year unconditional warranty.

G. SPD shall:

1. Be Type 1 or Type 2 SPD.
2. Provide L-L, L-N, L-G and N-G modes of protection for 1 phase 3 wire and 3 phase 4 wire systems. L-L and L-G modes of protection shall be provided for 1 phase 2 wire and 3 phase delta systems.
3. Nominal discharge current (In) shall be 20kA.
4. Maximum VPR shall be as follows:

    a. 480/277V: 2000V L-L, 1200V L-N, 1200V L-G, 1200V N-G
    b. 208/120V: 1200V L-L, 700V L-N, 700V L-G, 700V N-G
    c. 240/120V: 1200V L-L, 700V L-N, 800V L-G, 700V N-G

5. Single pulse surge current capacity shall be minimum 400,000A per phase

2.8 SPECIFIED EQUIPMENT

A. Switchboards and switchboard circuit breakers shall be manufactured by the following, or approved equal:

1. Siemens (basis of design)
2. ABB (General Electric)
3. Eaton

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install switchboard in accordance with NEMA PB-2.1, NFPA 70, and the manufacturer's instructions.

B. Locations and Layout: The exact relative locations (and physical layout) of equipment in the switchboard may be varied as required to suit manufacturer's design, provided the required functions and operations are accomplished; however, the identification of the units as indicated on drawings shall be followed exactly to facilitate checking and building maintenance procedures.

C. Anchoring:

1. Under each switchboard location, provide a 4-inch high reinforced concrete pad. Arrange it to extend two inches beyond the base of the switchboard all around.
2. Each section shall be bolted to the concrete pad. Provide concrete anchor bolts imbedded into the pad. The bolts shall be 3/4” diameter, 5” long minimum. Use two 1-1/4” fender washers and a lock washer under each nut. Torque to 70 lb.-ft or as required by manufacturer. All anchor hardware shall be cadmium plated grade 5 or higher.
3. Provide minimum 4 anchors per section.
4. Expansion type anchors are not acceptable.

D. Front access only switchboards shall be spaced minimum ½” from wall.

E. Cleaning and Touch-Up: Clean all dirt and debris from the inside and outside of the switchboard before placing in operation. Touch-up scratched or marred surfaces to match original finish.

F. Connections: Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

G. Adjustment: Adjust all operating mechanisms and moving parts for free mechanical movement. Set all solid state trip unit settings to match overcurrent ratings shown on contract documents. Solid-state trip distribution circuit breakers shall also be set to coordinate with main circuit breakers within the board. Coordinate settings with manufacturer.

H. Tests prior to energizing: Perform the following electrical tests.

1. Check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
2. Check for electrical continuity of circuit, and for short circuits.

I. Demonstration: Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning of all devices and components.

J. Instructions: Furnish the services of a competent instructor for one 3-hour period for instructing personnel in the operation and maintenance of the switchboard.

K. Cabling for metering run outside the switchboard shall be installed in 1” conduit.

L. Provide factory start-up for customer metering.

3.2 INSPECTIONS

A. Remove and reinstall any and all panel covers as directed by the Engineer.

END OF SECTION

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the furnishing and installation, at locations shown on the drawings, of approved panelboards of a type indicated and specified herein.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26000 sections

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NEMA PB 1.

E. Comply with NEC.

F. Panelboards shall comply with UL 67.

G. Surge protective devices (SPD) shall comply with:

1. Latest editions of UL 1449 and 96A.
2. IEEE standards C62.45-2002, C62.41.1, C62.41.2
3. NEMA LS1
4. NEC Article 241
5. NFPA 780

H. Cabinet and boxes shall comply with UL 50.

1.4 SUBMITTALS

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500, Electrical General Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

C. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Service Conditions: NEMA PB 1.

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate circuit breakers and fused switch sizes for branch circuit and feeders serving equipment furnished by other trades of work prior to submitting panelboard shop drawings. Note overcurrent protection size adjustments in panelboard submittals.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 LABELING

A. All panels shall be UL labeled.

B. All panels used as a service entrance shall be labeled as such.

C. A nameplate shall be provided listing panel type and ratings.

2.2 GENERAL PANELBOARD CONSTRUCTION

A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Distribution, Lighting, and Appliance Panelboards: Provide dead-front safety constructed factory assembled circuit breaker type panelboards in sizes and ratings as indicated. Construct with rectangular shaped copper or tin plated aluminum bus bars which are securely mounted and braced, and with lugs bolted to main bus bars.

C. Provide anti-turn solderless pressure type lug connectors approved for copper conductors, and construct unit for connecting feeders at top of panel.

D. Equip with full-sized neutral bus bar with suitable lugs for circuits requiring neutral connection. Provide suitable lugs on neutral bus for each outgoing feeder required.

E. Provide main and branch circuit breakers for branch circuit and distribution panelboards. Breakers shall be molded case bolt-in type, heavy-duty, quick-make, quick-break, with toggle handles that indicate when tripped. Where multipole breakers are indicated, provide with common trip so that overload on one pole will trip all poles simultaneously.

1. Circuit breakers for branch circuit panelboards and circuit breakers 125A and smaller for distribution panelboards shall be thermal-magnetic type.
2. Circuit breakers 150A through 800A for distribution panelboards shall be solid state trip LSI type, 80% rated.
3. Circuit breakers 1000A and larger for distribution panelboards shall be solid state trip LSIG type, 100% rated.

F. Provide bare uninsulated grounding bars suitable for bolting to enclosures.

G. Load center type panelboards are not acceptable, unless specifically called for in drawings.

H. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness, with baked gray enamel finish over a rust inhibitor coating. Construct with multiple knockouts and wiring

gutters. All panelboard locks shall be keyed alike. Door hinges shall be piano hinges. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed. Equip with interior circuit-directory frame, and card with clear plastic covering.

1. Surface mounted panelboard fronts shall be door-in-door type, with locks and keys for both inner and outer doors.
2. Flush mounted panelboard fronts shall be hinged front type, with lock for inner door and screw fasteners for outer door.

I. Panelboard Accessories: Provide panelboard accessories and devices including, but not limited to circuit breakers and fuses as recommended by panelboard manufacturer for ratings and applications indicated.

J. Panelboards shall be shown in the following schedule, or approved equal, and shall be completely factory assembled. Do not purchase panelboards or cabinets until shop drawings have been approved.

1. Branch Circuit Panelboards (120/208 or 120/240 V Operation). Minimum cabinet width shall be 20":

Square D (basis of design)	NQ
Siemens	P1
ABB	RQ
Eaton	PRL1a

2. Branch Circuit Panelboards (277/480 V Operation). Minimum cabinet width shall be 20":

Square D (basis of design)	NF
Siemens	P2/P3
ABB (General Electric)	RE
Eaton	PRL3

3. Distribution Panelboards:

Square D (basis of design)	I-Line
Siemens	P4/P5
ABB	ReliaGear neXT
Eaton	PRL4

4. Fused Switch Distribution Panelboards:

Siemens	P5
ABB	ADS
Eaton	PRL4

5. Fused Coordination Panelboards:

Bussman/Eaton (basis of design)	QSCP

Siemens SQSCP

K. Where a specific interrupting rating is shown on the drawings, panelboards and associated circuit breakers shall be fully rated for that value as a minimum. Series rating of equipment is not acceptable.

2.3 SURGE PROTECTIVE DEVICES (SPD):

A. Unless otherwise noted SPD shall be integral and factory installed within panelboards. SPD shall be a standard product of the panelboard manufacturer.

B. SPD shall be parallel protective devices utilizing Metal Oxide Varistors (MOVs) for the primary suppression components. MOVs shall be furnished with UL recognized surge rated fuses rated 200kAIR for protection and shall incorporate a thermal cutout device.

1. Type 1 SPD connected ahead of the service disconnect shall be furnished as an assembly with a factory disconnect switch to facilitate replacement of SPD components.

C. SPD shall be provided with:

1. Active indicator lamps which extinguish or change color when protection has failed.
2. Form C dry contact for auxiliary alarm monitoring.
3. Audible alarm with silence switch.

D. SPD shall safely reach an end-of-live condition when subjected to fault current levels between 0 and 200kA.

E. SPD shall be covered by a 10 year unconditional warranty.

F. SPD shall:

1. Be Type 1 or Type 2 SPD.
2. Provide L-L, L-N, L-G and N-G modes of protection for 1 phase 3 wire and 3 phase 4 wire systems. L-L and L-G modes of protection shall be provided for 1 phase 2 wire and 3 phase delta systems.
3. Nominal discharge current (In) shall be 20kA.
4. Maximum VPR shall be as follows:

a. 480/277V: 2000V L-L, 1200V L-N, 1200V L-G, 1200V N-G
b. 208/120V: 1200V L-L, 700V L-N, 700V L-G, 700V N-G
c. 240/120V: 1200V L-L, 700V L-N, 800V L-G, 700V N-G

5. Single pulse surge current capacity shall be as follows:

a. PL1 – 400,000 per phase
b. PL2 – 160,000 per phase
c. PL3 – 80,000 per phase (branch circuit panelboards)
d. PL3 – 40,000 per phase (Fused coordination panelboards)

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS

A. General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A.

D. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

E. Provide properly wired electrical connections within enclosures.

F. Fill out panelboard's circuit directory card upon completion of installation work. Type text, handwriting is not acceptable. Directory shall reflect actual installation configuration and shall incorporate final room numbers. Room numbers shown on architectural plans shall not be used for the directory.

G. Installation shall comply with the NEC.

H. Anchor to walls per manufacturer's recommendation.

I. Lace all feeder cables with tie wraps in panel housing. All wiring shall be run square inside housing.

J. Vacuum panel housing to remove all dust and dirt from housing prior to final inspection.

K. Cover panel housing prior to room painting. Clean all paint from panel.

L. Provide engraved plastic identification label black face with white lettering, indicating panelboard name, voltage system, and upstream distribution including room name and number. Attach identification labels to panel with rivets or sheet metal screws.

    1. Labels for panels fed from the emergency power system shall have red faces with white lettering.

M. Adjust current setting of solid state trip units to match scheduled overcurrent ratings.

3.2 GROUNDING

A. Provide equipment grounding connections for panelboards as indicated. Tighten connections to comply with tightening torques specified in UL Stds. 486A to assure permanent and effective grounds.

3.3 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.

B. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energization, check panelboards for electrical continuity of circuits, and for short circuits.

D. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units and then retest to demonstrate compliance.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. This section includes the furnishing, installation, and connection of wiring devices as shown on the plans.

B. Types of electrical wiring devices in this section include the following

1. Receptacles
2. Switches
3. Faceplates
4. Motor rated toggle switches

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following

1. Division 1
2. Other Division 26000 sections

B. See section on Substitutions.

1.3 QUALITY ASSURANCE

A. NEC Compliance Comply with NEC as applicable to installation and wiring of electrical wiring devices.

1.4 SUBMITTALS

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500 - Electrical General Requirements.

B. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

C. The specific item proposed, and its area of application shall be marked on the catalog cuts.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES

A. General Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Stds. Pub. No. WD 1 and meet UL/Federal Spec WC-596.

B. Final device colors shall be selected by the architect.

C. Wiring Devices 15 and 20A, 120 V devices shall employ modular connections without exposed wiring terminals. Acceptable products are as follows.

1. Legrand/P&S Plugtail
2. Hubbell SnapConnect
3. Leviton Lev-Lok

D. Wiring devices shall be as listed in the following table, or approved equal

Description	Legrand	Hubbell	Leviton
Single Pole Toggle Switch	PT20AC1	SNAP1221	M1221
Three Way Toggle Switch	PT20AC3	SNAP1223	M1223
20A 125V 2P 3W Grounded Duplex Receptacle (NEMA 5-20R)	PT5362A	SNAP5362A	M5362
20A 125V 2P 3W Grounded Duplex Receptacle Power Indicating (NEMA 5-20R)	PTTR8300PI	SNAP5362IL	M8300ILI
20A 125V 2P 3W Grounded Duplex Ground Fault Interrupter (NEMA 5-20R)	PT2097	GFRST20SNAP	M5362G
20A 250V 2P 3W Grounded Single Receptacle (NEMA 6-20R)	5871	HBL5461	5461

Description	Legrand	Hubbell	Leviton
30A, 208/120V 3P 4W Dryer Receptacle (NEMA 14-30R)	3864	HBL9430A	278
50A, 208/120V 3P 4W Range Receptacle (NEMA 14-50R)	3894	HBL9450A	279
30A, 600V 2P Motor Rated Toggle Switch	7802	HBL7832	MS302

2.2 WET AND DAMP LOCATION RECEPTACLES

A. Type “DL” - Damp Locations Damp location receptacles shall be duplex GFI receptacles similar to those under 262726 WIRING DEVICES, Part 2.1.B, mounted in cast metal outlet box fitted with a gasketed metal cover with spring door. Damp location receptacles shall be flush mounted unless noted otherwise. Wiring device utilized shall be listed weather resistant per NEC.

B. Type “WP” - Wet Locations Weatherproof receptacles shall be duplex GFI receptacles as specified under 262726 WIRING DEVICES, Part 2.1.B, mounted in cast metal outlet box fitted with a gasketed "while-in-use" metal cover, Hubbell WP26E or Pass & Seymour WIUC10-CAGV or approved equal. Weatherproof receptacles shall be flush mounted in exterior walls. Wiring device utilized shall be listed weather resistant per NEC.

2.3 RECEPTACLES INSTALLED IN DESIGNATED CRITICAL OPERATIONS AREA (DCOA)

A. Non-locking 120V receptacles installed in DCOA shall power indicating type.

B. Device plates for receptacles installed DCOA shall be identified in red, ¼” tall text “COPS” at the front top of the device plate. The panelboard and circuit number shall be indicated in similar text at the front bottom of the device plate.

2.4 DEVICE PLATES

A. Outlet boxes shall be provided with a device plate.

B. Unused telephone outlets shall be fitted with a blank plate.

C. Provide device plates for single and combination wiring devices, of types, sizes, and with ganging cutouts as indicated. Select plates which mate and match wiring devices to which attached. Metal screws shall be used for securing plates to devices; screw heads colored to match finish of plates.

D. Device plates shall be uniform in design and finish for switches, receptacles, and other outlets. Plates shall be one piece of the required number of gangs; sectional plates shall not be used.

E. Plates shall be jumbo oversize satin finished stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

A. Install wiring devices as indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes which are clean, free from excess building materials, dirt, and debris.

D. The devices shall be installed in such a manner as to allow the device plates to be installed without distortion of the device plate or gaps between the device plate and wall.

E. Install device plates after painting work is completed.

F. Unless otherwise specified, install device plates on all device and outlet boxes including telephone outlet boxes. As a minimum, blank plates shall be included for 25% of telephone/data outlets shown on the drawings.

G. Tighten connector and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturers' torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A. Use properly scaled torque indicating hand tool.

3.2 PROTECTION OF FACEPLATES AND RECEPTACLES

A. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING

A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

3.4 TESTING

A. Prior to energizing circuitry, test wiring for electrical continuity, and for short circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION

SECTION 262816 - SAFETY/DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the furnishing, installation, connection, and wiring of safety switches.

1.2 QUALITY ASSURANCE

A. Safety/Disconnect switches shall conform to Underwriter's Laboratories UL 98, "Enclosed and Dead-Front Switches."

1.3 SUBMITTALS

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500, ELECTRICAL GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 GENERAL SAFETY/DISCONNECT SWITCH FEATURES

A. Switches shall be NEMA type HD (Heavy Duty) and UL listed.

B. All switches shall have switch blades which are fully visible in the "OFF" position when the switch door is open. All current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall have removable arc suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable, and UL listed for 60 degrees C and 75 degrees C, aluminum or copper wires.

C. Switches shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not the cover. Provisions for padlocking the switch in the "OFF" position with at least three locks shall be provided. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position, and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is "ON" or "OFF".

D. Switches shall be horsepower rated for AC and/or DC as indicated by the plans. All fusible switches rated 100 thru 600 amperes at 240 volts and 30 thru 600 amperes at 600 volts shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses and have provisions for field installation of a UL listed rejection feature to reject all fuses except Class R. The UL listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes. 800 and 1200 ampere switches shall have provisions for Class L fuses and shall have a UL listed short circuit rating of 200,000 rms symmetrical amperes.

E. Disconnect switches shall be equipped with ground lug.

2.2 NEMA 1 AND 3R HEAVY DUTY SAFETY/DISCONNECT SWITCHES

A. Switches shall be furnished in NEMA 1 general purpose enclosures unless exposed to weather which shall be NEMA 3R. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R covers shall be securable in the open position. NEMA 3R enclosures for switches thru 200 amperes shall have provisions for interchangeable bolt-on hubs. Hubs shall be as indicated on the plans. NEMA 3R enclosures shall be manufactured from galvanized steel. Enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

2.3 SPECIFIED MANUFACTURERS

A. Specified manufacturers shall be as follows, or approved equal

1. ABB
2. Square D
3. Siemens
4. Eaton

PART 3 - EXECUTION

3.1 INSTALLATION LOCATION

A. As a general rule, install switches on the equipment it serves, if shown that way on the drawings.

B. Switches shall be mounted so as to be accessible.

3.2 CONDUIT BUSHINGS

A. Use plastic bushings where conduit enters switch.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. Provide factory assembled engine generator set(s) (heretofore referred to as the “EPS”) and associated equipment as shown on the contract documents and specified herein to provide a NFPA 110 Level 1, Type 10, Class 72 emergency power supply system (EPSS).

B. Types of equipment and work required include the following:

1. Diesel fueled EPS and support accessories
2. Sub-base fuel tank and associated piping
3. Weatherproof Sound Attenuating Enclosure
4. EPS Foundations
5. Alarm and Annunciator panels
6. Dual Purpose Generator Docking Station
7. Installation
8. Startup
9. Testing and configuration
10. Demonstration and training

1.2 RELATED WORK/SECTIONS:

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1 including general provisions of the Contract and Supplementary Conditions.
2. All other Division 26000 sections.

1.3 QUALITY ASSURANCE:

A. NEC Compliance: Comply with applicable requirements of NEC Articles 445, 700, 701, and 702 pertaining to generators, emergency and standby systems.

B. NFPA Compliance: Comply with applicable requirements of NFPA 20 “Standard for the Installation of Stationary Pumps for Fire Protection”, NFPA 30, “Flammable and Combustible Liquids”, NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines" and NFPA 110, “Emergency and Standby Power Systems”.

1. Level 1 prototype tests in accordance with NFPA 110 standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

C. UL Compliance: Provide standby power generator system components, including transfer switch, which are UL listed and labeled to the following standards: UL508 – Industrial

Control Equipment, UL508A - Industrial Control Panels, UL142 – Sub-base Tanks, UL1236 – Battery Chargers. The EPS shall be UL 2200 listed. All transfer switches shall be UL listed per Standard 1008, CSA Approved.

D. NEMA Compliance: Comply with applicable requirements of NEMA MG 1-1998, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators",

E. IEEE Compliance: Standard 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

F. FCC Compliance: Part 15, Subpart B.

G. CSA Compliance: CSA 282, 1989 Emergency Electrical Power Supply for Buildings

H. ISO Compliance:

1. ISO 8528 - Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets - Part 5 - Generator Sets, latest edition: The EPS shall perform within the performance class operating limit values for performance class G3.
2. ISO 9001: The generator EPS manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation and service, in accordance with ISO 9001.

I. The manufacturer of the EPS(s) shall have produced similar equipment for a minimum period of 15 years.

1.4 SUBMITTALS:

A. Shop Drawings: Submit manufacturer's data on the EPS, associated components and transfer switches specified here-in. Submittal shall include the following:

1. Documentation of compliance with codes and standards listed under section QUALITY ASSURANCE of this specification.
2. Performance information for the EPS, including load starting capabilities, EPS reactive power capability curves and regenerative power ratings.
3. Emissions certifications.
4. Seismic certifications. See division 26 specification SEISMIC SUPPORT OF ELECTRICAL EQUIPMENT.
5. Layout drawings for major system components and assemblies. Indicate necessary clearance space for removal of engine generator elements for maintenance purposes.
6. Wiring diagrams for system showing interconnection of components. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-wired.
7. Documentation of component tests and performance data noted within other sections of this specification.

B. Equipment Operation and Maintenance Manuals: Prior to EPSS demonstration, submit one (1) copy of the equipment manual containing all shop drawings, wiring diagrams, and layout drawings. Include copies of startup/test reports, equipment warrantee and maintenance instructions.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Equipment delivery shall be scheduled just prior to installation date to minimize on-site storage time and possible damage from adverse conditions. During time equipment is stored on site, equipment shall be located in a dry, covered space completely protected from weather and physical damage prior to installation. Storage conditions shall meet additional requirements of equipment manufacturer.

1. Equipment shall be considered in storage until such time startup of the emergency power system has occurred.

1.6 WARRANTY:

A. All the emergency power supply system components specified herein shall be warranted for a period of five years or fifteen hundred EPS operating hours, whichever occurs first, from the date of initial startup.

B. There shall be one source of responsibility for the warranty; parts and service through the EPS manufacturer representative. Multiple warranties for individual components (engine, alternator, controls, transfer switches, etc.) from individual suppliers or representatives is not be acceptable.

C. The warrantor shall maintain qualified factory trained service personnel with experience on specified equipment and shall be located within 2 hour travel time of the project location.

PART 2 - PRODUCTS

2.1 EPS:

A. EPS performance and capacity ratings are specified as installed on site unless noted otherwise.

B. The EPS(s) shall be Cummins Power Generation (Basis of design), Caterpillar or MTU engine generator(s), with ratings noted below at 0.8 PF, 60 Hz, 3 phase, 4 wire, 120/208 volts on an emergency/standby power rating at 1800 RPM, 104 degree F ambient temperature at minimum 500ft above sea level.

1. EG-1: 400kW/500kVA

C. The EPS components shall be mounted on a structural steel base frame to maintain proper alignment between components, and shall incorporate vibration isolators.

D. The EPS shall be equipped with a weatherproof sound attenuation housing which shall reduce the engine generator sound pressure levels to a maximum of 75dBA measured at 7 meters. Housing shall be rated for minimum 130 MPH wind speed.

1. The enclosure for EG-1 shall be capable of resisting penetration by small arms fire in accordance with 2019 NFPA 1221, paragraph 4.7.4.6.2.

E. The EPS shall meet current federal, state and local emissions regulations for emergency application diesel fueled EPS.

2.2 ENGINE:

A. The engine shall be a stationary, liquid-cooled, four stroke diesel cycle engine suitable for use with number 2 diesel fuel. Engine shall be arranged for direct connection to the alternator.

1. Turbocharging with air charge cooling is acceptable where required by engine manufacturer to meet specified unit rating.

B. Engine shall include the following features:

1. Remote two-wire starting, solenoid shift, electric starter with two independent systems to disconnect the starting circuit upon engine starting. The starter shall be capable of a single cranking limiter cycle without overheating or sustaining damage.

a. A single cranking limiter cycle which shall be a minimum of 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods

2. Positive displacement, engine driven, full pressure lubricating oil pump, oil cooler, full flow oil filter with replaceable elements, dipstick oil level indicator, and oil drain. Oil drain shall be piped to unit housing exterior and provided with a removable plug.
3. Primary and secondary fuel filters with replaceable elements, and an engine driven, mechanical, positive displacement fuel pump, with automatic fuel shutoff all mounted on the engine.
4. High pressure electronic fuel injection.
5. Replaceable dry element air cleaner.
6. Engine protective devices shall have sensing elements located on the engine to initiate alarms and engine shutdowns. These shall interface with the ENGINE GENERATOR CONTROL on the EPS. Type and quantities as required to provide minimum functionality listed for the ENGINE GENERATOR CONTROL.
7. Engine gauges, including hour meter, water temperature and oil pressure gauges and battery charging alternator ammeter.
8. Engine mounted, belt driven battery charging alternator.
9. Engine mounted, belt driven cooling pump(s), size and quantity as required by engine manufacturer.
10. Engine mounted thermostatically controlled water jacket heater.

a. Water jacket heater shall be rated 208 volts, single-phase, 60 Hz.

2.3 ENGINE COOLING SYSTEM:

A. Engine shall be liquid cooled by a thermostatically controlled radiator system with expansion tank and pusher fan belt driven by engine. System shall be mounted to engine-generator frame. Provide engine manufacturer’s recommend coolant solution.

B. An air-to-air intercooler system for turbo-charged units shall be provided where required by the manufacturer to meet required engine HP at 100% KVA rating of the EPS.

C. All cooling components shall be installed within the weatherproof housing. Pipe system drain lines to unit housing exterior. Drain line shall have removable cap to prevent plugging from debris and insects.

2.4 ENGINE EXHAUST SYSTEM:

A. Exhaust silencer shall be provided. It shall be chambered construction of the critical type.

B. Stainless steel seamless flexible exhaust connections shall be provided as required for connection between the engine exhaust manifold and the exhaust silencer piping.

C. Mount and install all exhaust components inside the weatherproof housing. All components shall be sized to assure proper operation without excessive backpressure.

2.5 ENGINE FUEL SYSTEM:

A. Provide a steel, UL listed, dual-wall sub-base diesel fuel oil storage tank. Tank shall be complete with necessary pipe connections for connection to the engine-generator and approved fill and vent fittings. The sub-base tank shall be located in base of the EPS, within, or part of, the weatherproof enclosure.

B. Connections between the sub-base tank and engine fuel connections shall be flexible. All fuel hose and fittings shall be rated for minimum 300 degrees F at 100 psi.

1. Connections shall be factory installed.

C. Furnish and install a low fuel supply sensing device in fuel tank. Device shall signal the alarm annunciator panel specified herein. Sensing device shall be adjusted to signal low fuel level when the tank contains less than one third of its capacity.

D. The sub-base fuel tank shall be sized by engine-generator manufacturer to provide adequate fuel storage to operate the generator for a minimum of 72 hours at EPS full load rating.

2.6 ENGINE STARTER BATTERY SYSTEM:

A. An engine starter battery and battery charger system shall be provided. Components shall be factory mounted within the EPS housing.

B. Battery - Provide heavy duty diesel starting flooded cell lead acid batteries, quantity and rating as required for two complete cranking limiter cycles. Batteries shall be installed on a rack within the EPS housing. All necessary intercell connection and battery cables shall be provided.

1. Battery shall be certified compliant with NFPA 110 for Level 1 applications.

a. Provide battery calculations showing batteries are capable of supporting specified cranking cycles at minimum ambient starting temperature.

2. Batteries shall not be installed until after battery charger is capable of operation.
3. Required battery capacity shall be permanently mark at the battery charger location.

C. Battery Charger – Provide a constant voltage, current limited, battery charger. Charger shall have float, taper, and equalize charge functions and shall be rated for 120 VAC normal power supply. The Battery charger shall:

1. Be suitable for installation within the unit housing.

2. Have fused AC input and fused DC output.
3. Include LED fault displays for AC Fail, High Battery, and Low Battery. Each fault shall also operate a Form C contract.

    a. Battery/Charger faults shall be annunciated in accordance with NFPA 110 for a level 1 system.

4. Be capable of fully charging the engine starter batteries within 24 hours from a complete discharge state without sustaining damage to batteries or charger.
5. Include an ammeter and voltmeter functions for monitoring battery status and charging. Meters shall have an accuracy of 5% or better.
6. Be permanently marked with maximum supported battery capacity, nominal output current and voltage.

2.7 ALTERNATOR:

A. The Alternator shall be a self-aligning, four pole of the synchronous type with revolving field. The winding pitch shall be 2/3. The design shall utilize amortisseur windings and shall be furnished with a direct drive centrifugal blower for proper cooling and minimum noise.

B. The alternator shall be directly connected to the engine flywheel housing and driven through a flexible coupling to insure permanent alignment. Coupling shall be designed to prevent shaft current from flowing.

C. The alternator windings shall utilize class H insulation. The alternator shall be sized such that the temperature rise at 100% of EPS rating shall not exceed 105 degrees C at 40 degree C ambient temperature.

D. The alternator exciter shall be a 3-phase, full-wave rectified exciter utilizing heavy duty silicon diodes mounted on the common rotor shaft.

E. Voltage regulator supply shall be obtained from a permanent magnet generator (PMG) on common shaft with alternator field and exciter windings. The PMG/exciter shall be sized to provide sufficient excitation to supply 300% of the generator’s rated output current for 10 seconds.

2.8 EPS CONTROL:

A. The unit shall be furnished with a microprocessor based integrated control and monitoring system that is factory wired, tested and shock mounted by the unit manufacturer. The control system shall be in a rigid metal enclosure, side mounted on the alternator end of the unit.

B. The control shall include an operator display panel providing the following functionality:

1. Run-Stop-Remote selector switch.
2. Individual status lamps indicating:

    Generator Running – Green

    Not-in-auto mode – Red flashing

Low oil pressure – Yellow

High engine temperature – Yellow

Low oil pressure shutdown – Yellow

Over speed shutdown – Yellow

Fail to start - Yellow

3. Alphanumeric display panel allowing configuration of operating parameters including cranking cycles, alternator voltage, alternator frequency, time delay start and time delay stop. Display shall also allow the viewing of engine operational parameters such as engine speed, coolant temperature, coolant level, starting battery voltage, battery charger status and oil pressure as well as event logs, hour meter and fault history.
4. Provide an emergency stop pushbutton switch. Switch shall be a Red "mushroom head" push button. Depressing the emergency stop switch shall cause the EPS to immediately shut down, and be locked out from automatic restarting.

    a. The switch shall include a lockout provision for use in safely disabling the EPS for necessary service.
    b. Depressing the emergency stop switch shall be annunciated as “Not-in-auto” at the EPS and at the remote annunciator(s).

C. Engine Control Functions:

1. The control system shall accept 3 wire start wiring configuration utilizing form C contacts at transfer equipment to initiating starting. Where the installation has multiple instances of transfer equipment, combine start wring signals by connecting normally closed contacts in series and normally open contacts in parallel. The generator control system shall recognize the change of state of either the normally open or normally closed switch or both simultaneously as a signal to start.
2. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.
5. The control system shall include sender failure monitoring logic for oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

D. Alternator Control Functions:

1. Engine generator control shall include a digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided for control of the alternator. It shall be immune from malfunction due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase

line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot.

2. Controls shall be provided to monitor the output current of the EPS and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the EPS on any phase for more than 60 seconds.
3. Controls shall be provided to individually monitor all three phases of the output current for 1, 2, or 3-phase short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the EPS when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
4. Controls shall be provided to monitor the KW load on the EPS, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the EPS is overloaded.
5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the EPS when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

E. Provide EPS with overcurrent protection. Overcurrent protection shall be in the form of a listed protective relay or 100% rated circuit breaker with solid state LI trip unit. Rating of overcurrent protection shall be based on EPS full load rating.

1. Instantaneous trip feature of circuit breaker(s) shall be turned off.

F. A 120 volt space heater with thermostat shall be provided within the EPS onboard control panel to eliminate condensation.

2.9 EPS AUXILIARY EQUIPMENT AND ACCESSORIES:

A. Each EPS shall be furnished with a dry contact for remote indication of alarm conditions. Contact shall be normally closed and shall open when an alarm or pre-alarm is present on the remote annunciator or the EPSS is placed in a non-automatic operation mode.

B. Each EPS shall be furnished with a 120V, 20A GFCI duplex service receptacle installed in weather-proof aluminum box with weather-proof cover. Receptacle shall be located within unit housing.

C. EPS annunciation shall be accomplished utilizing a serial remote annunciator via RS-485 serial connection to the EPS controller. A remote annunciator shall be provided for each EPS. The annunciator shall be a standard product of the unit manufacturer and shall utilize LED (light-emitting-diode) indicators to indicate condition status. The annunciator shall also include a lamp test button and audible alarm with silence button. The following conditions shall be indicated as a minimum:

1. Overcrank
2. Low Water Temp
3. High Engine Temperature Pre-alarm
4. High Engine Temperature

5. Low Oil Pressure Pre-alarm
6. Low Oil Pressure
7. Overspeed
8. Low Fuel Level
9. Low Coolant Level
10. EPS not in Automatic
11. High Battery Voltage
12. Low Battery Voltage
13. Battery Charger Malfunction
14. Generator Running
15. EPS Supplying Load
16. Normal Utility Power
17. Fault/Common Alarm

2.10 REMOTE MONITORING SYSTEM

A. Provide a web-based remote monitoring system for EPS operational data, event logs and SMTP (email) notifications.

B. Remote access shall be accomplished through an embedded web-server connected to the EPS via an RS-485 serial connection to the EPS controller.

C. The remote monitoring system shall obtain power from the EPS starting battery.

2.11 DUAL PURPOSE GENERATOR DOCKING STATION

A. Provide a portable generator docking station (DPDS) for connection of a temporary portable generator to support article 700 branch power in the event the EPS must be removed from service for maintenance that does not require modifications to the installed electrical system.

B. DPDS shall be Trystar SBDS series, NEMA 3R enclosure, docking station or equal by Berthold or Power Temp Systems, ratings and mounting as follows:

1. DPDS-EG-1: 1600A, 120/208V, 3 phase 4 wire, pad-mounted

C. The DPDS shall be furnished with a circuit breaker kirk key interlocked with the access door to the temporary generator cam lok (male) connectors. Circuit breaker shall isolate EPS from the load and temporary generator connection.

1. Products that utilize kirk key interlock with circuit breaker(s) onboard generator are not acceptable.

D. DPDS shall be equipped with:

1. Phase rotation monitor.
2. NEMA L14-30 and NEMA 5-20R GFCI receptacles for shore power to support a portable generator.
3. Load bank dump receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. EPSS with all control wiring, EPS(s), transfer switch(es), annunciators, all other system components shall be installed as indicated on the drawings, as specified herein, and in accordance with approved shop drawings, manufacturer's instructions, and manufacturer's standard specification and dimension sheets.

B. Conduits at the EPS shall be connected utilizing liquid tight metallic flexible conduit, field coordinate conduit stub-up locations with shop drawings prior to generator pad pour.

C. Label all EPS output circuit breakers indicating transfer switch or load served.

D. Generator start signal wiring shall be kept independent of power wiring. Start wiring shall be continuous without splices between terminations at equipment. Provide (3)#14 AWG, Label conductors at terminations. Label text and conductor insulation colors as follows:

1. Normally Closed: Label “START-NC”, insulation color shall be purple
2. Common: Label “START-C”, insulation color shall be brown
3. Normally Open: Label “START-NO”, insulation color shall be pink

3.2 STARTUP, CONFIGURATION AND TESTING:

A. Engage manufacturer’s factory trained technician to check out the complete installation and to perform startup of the EPSS. This shall include:

1. Commissioning and startup of the EPS. This shall include configuration of EPS parameters and testing of all engine generator shutdowns and alarms.
2. Configuration and testing of EPS remote monitoring system.
3. Resistive load bank testing for each EPS at 100% of EPS kW for 4 contiguous hours.

    a. Engine oil pressure, engine temperature and alternator output current and alternator output voltage shall be logged during testing on 15 minute intervals and shall be included in operation and maintenance manuals for records.

4. Coordinate testing of generator with transfer switch testing.

3.3 DEMONSTRATION:

A. Upon completion of startup, testing and calibration, the EPSS shall be demonstrated to the Engineer. Any deficiencies noted during demonstration shall be corrected and the EPSS re-demonstrated at the discretion of the Engineer.

3.4 OWNER TRAINING:

A. After demonstration and acceptance, Owner training shall be performed by a factory trained employee of the EPS manufacturer. Training shall include instruction of the correct operation of the EPSS as well as basic testing, trouble shooting and maintenance of the system. The training session shall be scheduled at a time of the Owner’s choosing.

1. Video recordings of the training session shall be made at the Owner’s discretion.

2. The session shall not be scheduled upon the same day as system startup-configuration-testing or Engineer demonstrations.

B. Three copies of the equipment operation and maintenance manuals described under section 1.3 SUBMITTALS shall be supplied to owner prior to final acceptance for use during the training session.

3.5 FUEL:

A. Furnish all fuel required for check-out, start-up, and testing. After testing and Owner training has been complete the fuel tank shall be filled with #2 diesel fuel.

END OF SECTION

SECTION 263353 - UNINTERRUPTIBLE POWER SUPPLY

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Provide three-phase continuous duty, on-line, double conversion, uninterruptible power supply system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the buildings electrical systems (normal and emergency) to provide power conditioning, back-up and distribution for critical electrical loads.

1. UPS shall be certified NFPA 111 Type O, class 0.25, level 1 rated UPS.

B. The UPS shall include

1. Main UPS cabinet housing the Rectifier, DC-DC converter module, inverter module and battery string.
2. External maintenance bypass and distribution.

C. See plans for quantity of UPS to be provided.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following

1. Division 1 including general provisions of the Contract and Supplementary Conditions.
2. Other Division 26000 sections.

1.3 QUALITY ASSURANCE

A. NEC Compliance Comply with applicable requirements of NEC Articles 480 and 645.

B. UL Compliance UPS shall be listed and labeled UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States. Battery Energy Storage systems shall be tested and listed to UL 9540A

C. CSA Compliance UPS shall comply with CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.

D. NEMA Compliance Comply with NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.

E. IEC Compliance

1. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1 General and safety requirements for UPS used in operator access areas.
2. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2 General and safety requirements for UPS used in restricted access locations.
3. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3 Method of specifying the performance and test requirements.

    a) Classification of UPS under 62040-3 shall be VFI-SS-111

F. IEEE Compliance IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.

G. CISPR 22 FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices (prior to Feb 16, 2006).

H. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment.

I. ISO 9001 The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation and service, in accordance with ISO 9001.

1.4 SUBMITTALS

A. Shop Drawing Submittal Provide bound submittals with sufficient documentation to demonstrate compliance with the contract documents. Documentation shall be specific to the project and shall include separately indexed sections containing the following information

1. UPS description
2. Documentation of compliance with standards referenced under section QUALITY ASSURANCE.
3. UPS site planning and unpacking
4. UPS installation
5. Optional accessory installation
6. UPS theory of operation
7. Operating procedures
8. Detailed list of system alarms, warnings and operational status indications
9. UPS maintenance
10. Performance and technical specifications
11. Feeder wiring requirements and recommendations for supply, bypass and load connections.
12. System wiring diagrams. Clearly differentiate between factory and field wiring.
13. Physical features and requirements
14. Cabinet dimensions

B. Equipment Operation and Maintenance Manuals Equipment operation and maintenance manuals shall contain all shop drawings, wiring diagrams, and layout drawings corrected to reflect actual field installation and shall include copies of startup/test reports, equipment warrantee and maintenance instructions.

1.5 QUALIFICATIONS

A. The UPS manufacturer shall have a minimum of twenty years of experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.

B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.

C. The UPS manufacturer shall maintain a staffed 7 x 24 x 365 call center for technical and emergency support.

D. Field Engineering Support The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices must be submitted with the proposal. Third-party maintenance will not be accepted.

E. Spare Parts Support Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.

F. Maintenance Contracts A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment delivery shall be scheduled just prior to installation date to minimize on-site storage time and possible damage from adverse conditions. During time equipment is stored on site, equipment shall be located in a dry, covered space completely protected from weather and physical damage and contamination from construction debris prior to installation. Storage conditions shall meet additional requirements of equipment manufacturer.

1. Equipment shall be considered in storage until such time startup of the UPS has occurred.

1.7 WARRANTY

A. All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.

B. One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner.

C. One-year service protection package shall include 7x24 on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with guaranteed response times of 4, or 2 hours in certain major metropolitan areas. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.

D. Manufacturer shall also include Start-up services consisting of 5x8 Start-up services of UPS and batteries, with option for 7x24 Start-up. On-site user training, Site Audit, installation and commissioning of monitoring service and validation of one-year limited factory warranty will be performed during the start-up.

E. Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits.

F. Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The UPS shall be Liebert EXM (basis of design).

1. UPS by other manufacturers will be considered for prior approval. Provide approval submittal containing documents listed under section 1.4.A of this specification in accordance with the prior approval requirements of division 1 and 26 for review.

a. Submittals must be by the bidding contractor proposing to utilize the alternate product for consideration.

2.2 UPS SYSTEM DESCRIPTION

A. UPS System Components The UPS system shall consist of the following main components

1. Liebert EXM Single module UPS system containing the Rectifier(s), Inverter(s), Battery Charger, static bypass switch and battery string(s).
2. Liebert Maintenance bypass cabinet.

2.3 UPS MODES OF OPERATION

A. The UPS shall operate as an on-line reverse transfer system in the following modes

1. Normally The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.
2. ECO Mode The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.
3. Battery Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
4. Recharge Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.
5. Bypass If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load.
6. Maintenance Bypass An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.
7. Off-Battery If the battery only is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker (in the case of external batteries). The UPS shall continue to function and meet all the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

2.4 UPS RATINGS AND OPERATING CHARACTERISTICS

A. UPS Continuous Ratings. The UPS shall be a 100kVA/100kW frame, with modules to provide 60kVA/60kW initial capacity.

1. UPS continuous rating shall be the maximum continuous output power possible from the UPS for a load power factor range of 0.5 lagging to unity without derating.

2. Capacity limited to 80kVA/80kW by distribution, configure UPS to allow for this capacity by installation of additional modules.

B. UPS Environmental Operating Conditions UPS shall withstand any combination of the following external environmental conditions without operational degradation or capacity derating

1. Operating Temperature 32 degrees F to 104 degrees F (excluding derating of batteries).
2. Storage Temperature -4 degrees F to 158 degrees F.

a. Batteries shall not be stored in temperatures above 104 degrees F.

3. Relative Humidity (operating and storage) 95% maximum non-condensing.
4. Elevation Operational 3300 ft (2000 m) maximum without de-rating.

C. Input Characteristics

1. Nominal input voltage and system 208 VAC, 3 phase 3 wire.
2. Operating input voltage range +20%, -15% of average nominal input voltage without battery discharge at full load. -40% at half load
3. Operating input frequency range shall be 40 to 70Hz.
4. Input power factor 0.99 lagging at full load with nominal input voltage.
5. Maximum inrush current shall not exceed 1.5 times rated current.
6. Input current total harmonic distortion (THD) shall be less than 5%.
7. Power walk-in Ramp-up to full load adjustable from 1 to 5 seconds.
8. Input surge withstand capability The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

D. Output Characteristics

1. Nominal output voltage and system 208VAC, 3 phase 3 wire.

a. +/-1% RMS average for balanced three phase load
b. +/-5% RMS average for 100% line to line unbalanced load

2. Voltage distortion 1% THD maximum into a 100% linear load, 3% THD maximum into a 100% non-linear load with crest factor ration of 31.
3. Frequency Regulation 60Hz, +/-0.05% free running
4. Bypass Frequency Synchronization Range +/-0.5, 1.0, 2.0, 3.0 Hz adjustable by factory service personnel.

a. +/-2.0 Hz default setting.

5. Frequency Slew Rate 0.1 to 3 Hz/sec.

a. 0.6 Hz/sec default setting.

6. Phase Imbalance 120 degrees, +/-1 degree for balanced loads, +/-1.5 degrees for unbalanced loads.
7. Overload tolerance at full output voltage with +/-1% voltage regulation

a. 100% Continuous
b. 105% to 110% full load for 60 minutes
c. 110% to 125% full load for 10 minutes
d. 125% to 150% full load for 60 seconds
e. >150% full load for minimum 200 milliseconds

8. Output voltage for 100% step-loading and 100% step-unloading shall not exceed +/-30% nominal rating and shall recover to 10% nominal voltage within 60ms.

a. Response curve for UPS under these conditions shall be within the limits of IEC 62040-32010 Figure 2, Curve 1.

9. Static transfer time No break, completed in less than 4ms.
10. Acoustical noise Noise generated by the UPS under normal operation shall not exceed 57.8dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
11. EMI Suppression The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices prior to Feb 16, 2006, CISPR.
12. Electrostatic discharge (ESD) The UPS shall meet IEC 801-2 specifications. The UPS shall withstand a 25 kV pulse without damage and with no disturbance or adverse effect to the critical load.
13. Efficiency The UPS efficiency shall be 93% or higher between 25% to 100% of rated capacity.

2.5 UPS SYSTEM COMPONENTS

A. Rectifier The rectifier shall convert incoming AC power to regulated DC output for supplying the DC-DC converter. The rectifier shall be a high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The rectifier module shall have the following design and operational characteristics

1. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
2. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
3. The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for additional passive input filter(s).

    a) Input current THD shall be less than 5% at rated load and nominal voltage in double-conversion mode.

B. DC-DC Converter The DC-DC converter shall automatically regulate the output of the rectifier to levels appropriate for charging the battery string and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and shall be a pulse width-modulated design and shall utilize IGBTs. The DC-DC converter shall have the following design and operational characteristics

1. The AC ripple content of the battery charger output shall not exceed 1% RMS of the float voltage.
2. Overvoltage protection shall be provided to protect the battery.
3. Temperature-compensated charging shall be provided to protect batteries from excessive charge current.
4. Battery charging function shall be automatically terminated when an over temperature condition is sensed in the battery cabinet.
5. Manually initiated battery load testing function shall be provided. This function when initiated shall lower the charging voltage such that the battery supplies powers the load for a short time while the UPS monitors the battery voltage to determine battery capacity. The test shall terminate automatically upon detection of battery failure.
6. Provide generator load control by suppressing battery charging levels while running on emergency power.

a) Under this mode of operation, the unit shall exit Eco Mode and the UPS shall operate as a double conversion UPS.

C. Inverter The inverter shall convert DC from the DC-DC converter to AC for support of the UPS load. The inverter shall be an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall have the following design and operational characteristics

1. The inverter shall be capable of disconnecting from the AC output without the use of a series static switch/isolator or switching to bypass.
2. The inverter shall be sized to provide a minimum 150% overload at full rated voltage for 60 seconds without damage. The inverter shall also be able to withstand phase-to-phase, phase-to-ground and three phase faults for short circuit currents up to 200% rated current without damage.
3. The UPS control system shall monitor the inverter output and shall isolate it from the load if malfunction is detected.
4. The inverter shall monitor the battery voltage and shall have protection to prevent battery damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damage to the battery.

D. Static Bypass The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally commutated static switch for high-speed transfers. The bypass shall have the following design and operational characteristics

1. The static switch shall be rated for continuous duty operation at full rated load.
2. Transfers to bypass shall be automatically initiated for sustained overload or inverter malfunction.
3. Automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load. Automatic re-transfers shall be inhibited for the following conditions

    a. When transfer to bypass is activated manually or remotely.
    b. In the event of multiple transfers/re-transfer operations the control circuitry shall limit “cycling” to three (3) operations in any ten-minute period. The fourth transfer shall lock the critical load on the bypass source.
    c. UPS failure.

4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass. Manual transfers shall be make-before-break utilizing the inverter and the bypass static switch.
5. All transfers to bypass shall be inhibited for the following conditions

    a. Bypass voltage out of limits
    b. Bypass frequency out of limits (+/- 3 Hz, adjustable, factory set)
    c. Bypass out of synchronization
    d. Bypass phase rotation / installation error

6. The bypass shall be capable of being manually energized using the control panel or remotely through a building alarm input.

7. In the event of excessive inrush current or load in excess of the inverter rating, the bypass static switch shall temporarily connect to the bypass AC source and shall permit up to 1000% of nominal rated current for 600 milliseconds with voltage regulation dependent on bypass source. If the load condition has not cleared after 600 milliseconds, the UPS shall initiate transfer to bypass source.
8. The static switch power source shall be obtained from the UPS input.
9. Back-feed protection of the bypass source shall be provided in accordance with UL1778.

E. Active ECO-Mode When activated, the UPS shall be capable of using the bypass source to support the load via the static bypass switch provided the bypass source is within the limits of an acceptable power source. In this mode, the inverter shall be able to instantaneously able to assume the load and turn off the static bypass switch should the bypass source go outside the limits of an acceptable power source.

F. Battery management system The UPS shall contain a battery management system which has the following features

1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.

G. Wiring Terminals The UPS module shall contain mechanical compression terminals (adequately sized to accommodate 75°C wiring) for securing user wiring to the following locations

1. Rectifier/charger input connections 3-wire plus ground
2. Bypass input connections 3-wire plus ground
3. DC link connections for battery cabinets (positive and negative)
4. AC output connections 3-wire plus ground

2.6 BATTERY ENERGY STORAGE SYSTEM

A. The battery energy storage system shall be a Samsung UL9540A Battery Energy Storage System utilizing lithium-ion batteries.

B. The battery plant shall be capable of supporting full rated UPS output for a minimum of 15 minutes at EOL battery rating.

C. Provide unit with factory battery disconnect switch.

2.7 MAINTENANCE BYPASS AND DISTRIBUTION CABINET

A. The UPS shall be provided with a separate matching Maintenance Bypass and Distribution Cabinet. Cabinet shall allow connection of loads served by UPS system and complete isolation of UPS module from commercial AC input and critical load while providing bypass power to critical load.

1. The cabinet shall not hamper servicing of the UPS while in bypass mode.

B. The cabinet shall contain a maintenance bypass switch that shall work in concert with the UPS internal static bypass switch to provide make-before-break operation and shall be interlocked with UPS to prohibit improper operation.

2.8 SYNCRONIZATION CONTROLS

A. Provide controls and interconnections between separate UPS systems as required to ensure proper operation of automatic static transfer switches supplied by those separate UPS. See specification section STATIC TRANSFER SWITCHES.

2.9 UPS REMOTE STATUS PANEL

A. The UPS system shall be equipped with a remote status panel (RSP) to remotely monitor alarm conditions and real time status of the UPS system.

B. The RSP shall utilize LED's to visually display the UPS system alarms and state with both textural and graphic one-line annunciation.

C. The RSP shall also include an audible alarm with local silence button.

D. Normal and alarm conditions indicated shall include

1. UPS AC input state
2. UPS Output state
3. UPS Charger/Rectifier state
4. UPS Inverter state
5. UPS System battery state
6. UPS master alarm (fault)
7. UPS Load on bypass
8. UPS Low Battery
9. UPS Overload

E. The RSP shall be similar to a Pythia Technologies UPS Remote Status Panel.

2.10 MECHANICAL DESIGN

A. Enclosures The UPS shall be housed in free-standing dead front enclosures equipped with casters and leveling feet. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.

B. Ventilation The UPS shall be designed for forced air cooling.

C. No side clearance or access shall be required for the system.

D. Cable entry Standard cable entry for the UPS cabinet shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS cabinet for routing user input and output wiring.

E. Front access All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.

F. Service area requirements The 208Vac system shall require no more than forty-two (42) inches of front service access room and shall not require side or rear access for service or installation.

2.11 UPS CONTROL, METERING AND HUMAN-MACHINE INTERFACE

A. UPS control system The UPS control system shall have the following design and operating characteristics

1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate variances from component tolerance or drift and provide consistent operational responses.
2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.
3. Start-up and transfers shall be automatic functions.

B. Metered values The UPS control shall meter electrical parameters of system. Voltage and current parameters shall be monitored using true RMS measurements for accuracy to +/-3% of voltage, +/-5% AC current. The system shall monitor the following parameters as a minimum

1. Input voltage, line-to-line
2. Input current per phase
3. Input frequency
4. Input apparent power (kVA)
5. Battery voltage
6. Battery charging/discharging current
7. Output voltage, line-to-line
8. Output frequency
9. Bypass input voltage, line-to-line
10. Bypass input frequency
11. Load current
12. Load real power (kW), total and percent of full capacity)
13. Load apparent power (kVA), total and percentage
14. Load percentage of capacity
15. Battery temperature, each battery string
16. Battery state of change

C. Human-Machine Interface The UPS shall be equipped with a menu driven human machine interface (HMI) consisting of a backlit LCD display and push buttons. The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and allow for entry of UPS settings. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.

D. Displayed parameters The HMI shall display the following minimum UPS operating parameters

1. Rectifier (Off/Soft Start/Main Input On/Battery Input On)

2. Input Supply (Normal Mode/Battery Mode/All Off)
3. Battery Self-Test (True/False)
4. Input Disconnect (Open/Closed)
5. EPO (True/False)
6. Charger (On/Off)
7. Output Disconnect (Open/Closed)
8. Maintenance Disconnect (Open/Closed)
9. Bypass Disconnect (Open/Closed)
10. Inverter (Off/Soft Start/On)
11. Bypass (Normal/Unable to Trace/ Abnormal)
12. Output Supply (all Off/Bypass Mode/Inverter Mode/Output Disable)
13. Inverter On (Enable/Disable)

E. Control Panel Controls The UPS control panel shall allow viewing of the following via the HMI

1. EVENTS Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list of the latest 2048 events.
2. METERS Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including voltage, current and frequency. In addition, the battery display shall show runtime remaining.
3. CONTROLS Displays a System Controls screen for the following functions

    a) Start Inverter (and transfer to inverter)
    b) Stop Inverter (after transferring to bypass)
    c) Startup Screen
    d) Battery Test Set point Adjustment
    e) Configure Manual Battery Test
    f) Initiate Manual Battery Test
    g) System Settings (Time, Date, Language, LCD Brightness, Password, Audio level)
    h) Alarm Silence Command
    i) Fault Reset Command
    j) ECO Mode

4. BATTERY STATUS Displays DC alarm conditions, battery temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test and battery time remaining during discharge.
5. ALARMS The following alarm messages shall be displayed

    a) Mains Voltage Abnormal
    b) Mains Under voltage
    c) Mains Freq. Abnormal
    d) Charger Fault
    e) Battery Reserved
    f) No Battery
    g) Parallel Communications Fail
    h) Bypass Unable to Track
    i) Bypass Abnormal
    j) Inverter Asynchronous

k) Fan Fault
l) Control Power Fail
m) Unit Overload
n) System Overload
o) Bypass Phase Reversed
p) Transfer Time-Out
q) Load Sharing Fault
r) Bypass Overcurrent

6. SETUP Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.
7. RETURN Confirms selection or returns to previous screen.

2.12 COMMUNICATIONS

A. Communications Bay The UPS shall be equipped with a field configurable communications bay that will accommodate three (3) communication devices.

1. Communication shall be via a SNMP card providing Web-based UPS remote monitoring and management capabilities.

B. Dry Contacts The UPS shall be equipped with the following dry contact outputs

1. Summary Alarm
2. Bypass Active
3. Low Battery
4. AC Input Failure

C. Input Contacts The UPS shall be equipped with four (4) user programmable inputs. Inputs shall be compatible with an isolated, external, normally open contact.

1. One (1) of the four (4) contacts shall be utilized for interface with transfer switch dry contacts to signal the UPS is running on generator power and to enter generator load control mode.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

3.2 COMMISSIONING

A. Factory start-up Factory Start-up service shall be provided and shall include visits as required to perform all procedures and tests specified within the UPS Installation and Operation manual and within this specification.

B. UPS manufacturer shall also offer the following services

1. Pre-energize visit to inspect installation and provide guidance to installers as required.
2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.

C. The following procedures and tests shall be performed by Field Service personnel during the UPS startup

1. Visual Inspection

   a. Visually inspect all equipment for signs of damage or foreign materials.
   b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.

2. Mechanical Inspection

   a. Check all the power connections for tightness.
   b. Check all the control wiring terminations and plugs for tightness or proper seating.

3. Electrical Pre-check

   a. Check the DC bus for a possible short circuit.
   b. Check input and Bypass power for proper voltages and phase rotation.
   c. Check all lamp test functions.

4. Initial UPS Startup

   a. Verify that all the alarms are in a “go” condition.
   b. Energize the UPS module and verify the proper DC, walkup, and AC phasing.
   c. Check the DC link holding voltage, AC output voltages, and output waveforms.
   d. Check the final DC link voltage and Inverter AC output. Adjust if required.
   e. Check for the proper synchronization.
   f. Check for the voltage difference between the Inverter output and the Bypass source.
   g. On site full-load, step-load, and battery discharge tests using supplier furnished load bank.
   h. Confirm proper operation of system while operating on both normal and emergency power.
   i. Confirm proper operation of external manual maintenance bypass switch.
   j. Confirm operation of EPO feature.

5. Final UPS adjustments

   a. Confirm correct operation of system while furnishing power to Owner’s equipment.
   b. Recheck operation points under Initial UPS Startup.

D. Operational Training Provide owner training for UPS system. Training shall include theory of operation for the system and hands-on training of the correct operating procedures and general maintenance for the system. Training shall be scheduled separate from startup.

EMERGENCY MANAGEMENT AND 911 COMMUNICATIONS DISPATCH CENTER

END OF SECTION

SECTION 263600 – AUTOMATIC TRANSFER BYPASS/ISOLATION SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the furnishing and installation of combination automatic transfer bypass/isolation switch (ATBIS) at locations shown on the drawings.

1.2 RELATED DOCUMENTS

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

B. All other sections of division 26.

1.3 QUALITY ASSURANCE

A. Source Limitations Obtain automatic transfer switches, bypass/isolation switches and remote annunciator and control panels through one source from a single manufacturer.

B. Automatic transfer switches shall be designed, tested and assembled in strict accordance with all applicable standards of ANSI, UL, IEEE and NEMA.

C. Comply with NEMA ICS10-1993 – AC Automatic Transfer Switches.

D. Comply with NFPA 70 – National Electric Code.

E. Comply with NFPA 110 – Emergency and Standby Power Systems

F. Comply with UL 1008 – Standard for Transfer Switch Equipment

G. Comply with UL 508 – Industrial Control Equipment

1.4 SUBMITTALS

A. Product Data For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings Provide dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Submit a single-line diagram for each ATBIS illustrating the transfer switch, bypass/isolation switch, power sources, and load. Indicate interlocking provisions for each combined transfer switch and bypass/isolation switch.

2. Submit catalog cuts and descriptive literature.
3. Submit Modbus point lists for status and metering functions.

C. Manufacturer Seismic Qualification Certification Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Seismic Support for Electrical Equipment." Include the following

1. Basis for Certification Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the specified seismic forces and the unit is fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Operation and Maintenance Data For each type of product include the following in the operation and maintenance manuals

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. List of settings after final adjustments and testing.
4. As-built shop drawings for installed switches.

1.5 DELIVERY, STORAGE AND HANDLING

A. Automatic transfer switches described herein shall be transported, stored and handled in accordance with the manufacturer’s written recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ATBIS shall be ASCO 7000 Series (Basis of Design).

1. ATBIS by other manufacturers will be considered for prior approval. Provide approval submittal containing documents listed under section 1.4.A of this specification in accordance with the prior approval requirements of division 1 and 26 for review.

a. Submittals must be made by the bidding contractor proposing to utilize the alternate product for consideration.

2.2 GENERAL CONSTRUCTION

A. The combination automatic transfer bypass/isolation switch (ATBIS) shall consist of a transfer switch and bypass/isolation switch constructed in a single, free standing, NEMA 1 enclosure. The ATBIS enclosure shall be sized to exceed minimum wire bending space required by UL 1008. Both units shall be bused together with silver plated copper bus to provide a complete pre-tested assembly.

B. The ATBIS shall have top cable access.

C. Voltage and continuous current ratings as defined in UL 1008 for continuous loading and total system transfer and number of poles shall be as listed on the one-line diagrams.

D. The ATBIS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the terminals with the type of overcurrent protection shown on the plans.

E. The ATBIS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle ratings without series rating with connecting circuit breakers.

F. All bolted bus connections shall have Belleville compression type washers.

G. Control components and wiring shall be front accessible. All control wires shall be multi-conductor 18 gauge 600 volt SIS switchboard type point harness. All control wire terminations shall be identified with tubular sleeve-type markers.

H. Cable termination shall be bolted type utilizing two-hole lugs.

I. Resistance to Damage by Voltage Transients Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. The complete automatic transfer bypass/isolation switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.

2.3 TRANSFER SWITCH

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. The transfer switch shall be an electrically operated and mechanically held mechanism designed specifically to function as a transfer switch. The transfer switch electrical operator shall be a momentarily energized, solenoid mechanism. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

1. Transfer switches that utilize circuit breakers or contactor construction do not meet the requirements of this specification.

C. The transfer switch shall be of the closed transition type.

D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600A and

higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

E. The transfer switch shall be equipped with a safe external manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. The external manual operator shall be safely operated from outside of the transfer switch enclosure while the enclosure door is closed.

2.4 BYPASS/ISOLATION SWITCH

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Bypass/isolation switches shall provide a safe and convenient means for manually bypassing and isolating the transfer switch, regardless of the condition or position of the transfer switch, with the ability to be used as an emergency back-up system in the event the transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate maintenance and repair of the automatic transfer switch.

C. The transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch.

D. Description Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
2. Draw-out Arrangement for Transfer Switch Provide physical separation from live parts and accessibility for testing and maintenance operations.
3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
5. Operability Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
6. Legend Manufacturer’s standard legend for control labels and instruction signs shall describe operating instructions.
7. Maintainability Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

2.5 ATBIS CONTROLS

A. The ATBIS shall be equipped with a microprocessor-based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two

asynchronous serial ports. The controller shall have a real time clock with rechargeable battery back-up.

B. The CPU shall be equipped with self-diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit.

C. The controller shall use industry standard open architecture communication protocol for high speed serial communications via RS422/485 network. The serial communication port shall allow interface to either the manufacturers or the Owner's furnished remote supervisory control.

D. The controller shall have password protection to limit access to qualified and authorized personnel.

E. The controller shall include an LCD display, with keypad, which allows access to the system.

F. The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.

G. The controller shall be capable of storing the following records in memory for access either locally or remotely

1. Number of hours transfer switch is in the emergency position (total since record reset).
2. Number of hours emergency power is available (total since record reset).
3. Total transfer in either direction (total since record reset).
4. Date, time, and description of the last four source failures.

2.6 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources shall be continuously monitored by the ATBIS control system with the following pickup, dropout and trip setting capabilities

1. Under-voltage on all ungrounded conductors for both normal and emergency sources Dropout/trip setting shall be adjustable between 70 to 98% of nominal and the pickup/reset setting shall be adjustable between 85 to 100% of nominal.
2. Over-voltage on all ungrounded conductors for both normal and emergency sources Dropout/trip setting shall be adjustable between 102 to 115% of nominal, pickup/reset shall occur 2% below dropout/trip setting.
3. Under-frequency for both normal and emergency sources Dropout/trip setting shall be adjustable between 85 to 98% of nominal and the pickup/reset setting shall be adjustable between 90 to 100% of nominal.
4. Over-frequency for both normal and emergency sources Dropout/trip setting shall be adjustable between 102 to 110% of nominal, pickup/reset shall occur 2% below dropout/trip setting.
5. Voltage imbalance for both normal and emergency sources Dropout/trip setting shall be adjustable between 5 to 20% imbalance, pickup/reset shall occur 1% below dropout/trip setting.

B. Repetitive accuracy of all settings shall be within +/-0.5%.

C. Voltage and frequency settings shall be field adjustable in 1% increments.

D. The controller shall be capable of sensing the phase rotation of both normal and emergency sources. The source shall be considered unacceptable if the phase rotation does not match ATBIS settings.

E. Voltage, frequency and phase rotation measurements shall be accessible through the ATBIS control system display.

F. The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye – Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the ATBIS control system.

2.7 ATBIS TIME DELAY SETTINGS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24V DC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0-to-5-minute time delay in any of the following modes

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

F. All time delays shall be adjustable in 1 second increments. All time delays shall be adjustable through the ATBIS control system.

2.8 METERING

A. The ATBIS shall be equipped with a digital power meter, similar to ASCO 5200 Series Power Manager XP, displaying the following readings

1. Current, per phase RMS and neutral (if applicable)
2. Current Unbalance %
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage Unbalance %
5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated Energy, (MWH, MVAH, and MVARH)

B. The meter shall be equipped with a serial interface using industry standard open architecture communication protocol (ModBus) for high speed serial communications via RS422/485 network.

C. Provide current and potential transformers as required for operation of the meter.

D. Configuration of the meter measuring and communication parameters shall be made via an operators interface utilizing the meter display and controls accessible from the face of the meter.

E. The meter shall have password protection to limit access to qualified and authorized personnel.

F. The meter shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32VDC.

G. The meter shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

H. The meter shall be listed to UL 3111-1, CSA, CE Mark.

2.9 REMOTE ANNUNCIATION OF TRANSFER SWITCH STATUS

A. Provide an ASCO 5310 ATS Remote Annunciator, or equal from approved ATBIS manufacturer, for each ATBIS, see plans for location of annunciators.

B. The ATBIS shall be equipped with dry contacts for future use. Provide minimum 2 each, NO/NC contacts pairs for each signal. Contacts provided shall include the following status and signals

1. ATBIS connected to normal power.
2. ATBIS connected to emergency power.
3. ATBIS in bypass connected to normal source.
4. ATBIS in bypass connected to emergency source.

5. Pre-signal to transfer between sources.

PART 3 - EXECUTION

3.1 INSTALLATION

A. ATBIS shall be installed per manufacturer’s written instructions and fastened in place utilizing hardware in accordance with division 26 specifications “Seismic Support for Electrical Equipment.”

B. Floor-Mounted Switch Anchor to floor by bolting.

1. Concrete Bases 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Pads shall be doweled into concrete slab.

C. Identify components according to Division 26 Section "Electrical Coordination."

D. Set field-adjustable intervals and delays.

3.2 CONNECTIONS

A. Wiring to Remote Components Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding."

C. Connect wiring according to Division 26 Section "Wire and Cable – Building Wire (600V and Below)."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Verify accessory time delay settings.
c. Verify pickup and dropout voltages by data readout or inspection of control settings.
d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

B. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

END OF SECTION

SECTION 263601 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the furnishing and installation of automatic transfer switches (ATS) at locations shown on the drawings.

1.2 RELATED DOCUMENTS

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

B. Other division 26 sections.

1.3 QUALITY ASSURANCE

A. Source Limitations Obtain automatic transfer switches and accessories through one source from a single manufacturer.

B. Automatic transfer switches shall be designed, tested and assembled in strict accordance with applicable standards of ANSI, UL, IEEE and NEMA.

C. Comply with NEMA ICS10-1993 – AC Automatic Transfer Switches.

D. Comply with NFPA 70 – National Electric Code.

E. Comply with NFPA 110 – Emergency and Standby Power Systems

F. Comply with UL 1008 – Standard for Transfer Switch Equipment

G. Comply with UL 508 – Industrial Control Equipment

1.4 SUBMITTALS

A. Product Data For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings Provide dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Submit catalog cuts and descriptive literature.

C. Manufacturer Seismic Qualification Certification Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Seismic Support for Electrical Equipment." Include the following

1. Basis for Certification Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Operation and Maintenance Data For each type of product include the following in the operation and maintenance manuals

1. Features and operating sequences, both automatic and manual.
2. List of factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. List of settings after final adjustments and testing.
4. As-built shop drawings for installed switches.

1.5 DELIVERY, STORAGE AND HANDLING

A. Automatic transfer switches described herein shall be transported, stored and handled in accordance manufacturer’s written recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ATS shall be ASCO 300 Series (Basis of Design).

1. ATS by other manufacturers will be considered for prior approval. Provide approval submittal containing documents listed under section 1.4.A of this specification in accordance with the prior approval requirements of division 1 and 26 for review.

a. Submittals must be made by the bidding contractor proposing to utilize the alternate product for consideration.

2.2 GENERAL CONSTRUCTION

A. Automatic transfer switches (ATS) shall consist of a transfer switch in a single, wall mounted, NEMA 1 enclosure. The ATS enclosure shall be sized to exceed minimum wire bending

space required by UL 1008. Construction shall be such that the contractor needs to install only the power and control connections.

B. Voltage and continuous current ratings as defined in UL 1008 for continuous loading and total system transfer and number of poles shall be as indicated on plans.

C. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the terminals with the type of overcurrent protection shown on the plans.

D. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle ratings without series rating with connecting circuit breakers.

E. Bolted bus connections shall have Belleville compression type washers.

F. Control components and wiring shall be front accessible.

G. Provide 90 degree C rated copper/aluminum solder-mechanical type lugs for connection of power conductors.

H. Resistance to Damage by Voltage Transients Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. The complete ATS assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.

2.3 TRANSFER SWITCH

A. The transfer switch shall be an electrically operated and mechanically held mechanism designed specifically to function as a transfer switch. The transfer switch electrical operator shall be a momentarily energized, solenoid mechanism. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

1. Transfer switches that utilize circuit breakers or contactor construction do not meet the requirements of this specification.

B. The transfer switch shall be of the programmed transition type.

C. Inspection of contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600A and higher shall have front removable and replaceable contacts. Stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

D. The transfer switch shall be equipped with a manual operator. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.

E. The transfer switch shall utilize a three-wire generator start interface.

F. See plans for transfer switch ampacity ratings and pole configurations.

2.4 ATS CONTROLS

A. The ATS shall be equipped with a microprocessor-based control system, to provide the operational functions of the ATS. The controller shall have a real time clock with rechargeable battery back-up.

B. The CPU shall be equipped with self-diagnostics and a watchdog/power fail circuit.

C. The controller shall have password protection to limit access to qualified and authorized personnel.

D. The controller shall include an LCD display, with keypad, which allows access to the system.

E. The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.

F. The controller shall be capable of storing the following records in memory for access either locally or remotely

1. Number of hours transfer switch is in the emergency position (total since record reset).
2. Number of hours emergency power is available (total since record reset).
3. Total transfer in either direction (total since record reset).
4. Date, time, and description of the last four source failures.

2.5 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources shall be continuously monitored by the ATS control system with the following pickup, dropout and trip setting capabilities

1. Under-voltage on ungrounded conductors for both normal and emergency sources Dropout/trip setting shall be adjustable between 70 to 98% of nominal and the pickup/reset setting shall be adjustable between 85 to 100% of nominal.
2. Over-voltage on ungrounded conductors for both normal and emergency sources Dropout/trip setting shall be adjustable between 102 to 115% of nominal, pickup/reset shall occur 2% below dropout/trip setting.
3. Under-frequency for both normal and emergency sources Dropout/trip setting shall be adjustable between 85 to 98% of nominal and the pickup/reset setting shall be adjustable between 90 to 100% of nominal.
4. Over-frequency for both normal and emergency sources Dropout/trip setting shall be adjustable between 102 to 110% of nominal, pickup/reset shall occur 2% below dropout/trip setting.
5. Voltage imbalance for both normal and emergency sources Dropout/trip setting shall be adjustable between 5 to 20% imbalance, pickup/reset shall occur 1% below dropout/trip setting.

B. Repetitive accuracy of settings shall be within +/-0.5%.

C. Voltage and frequency settings shall be field adjustable in 1% increments.

D. The controller shall be capable of sensing the phase rotation of both normal and emergency sources. The source shall be considered unacceptable if the phase rotation does not match ATS settings.

E. Voltage, frequency and phase rotation measurements shall be accessible through the ATS control system display.

F. The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye – Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the ATS control system.

2.6 ATS TIME DELAY SETTINGS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24V DC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. Transfer conditions or only when both sources are available.

F. Time delay for automatic forced retransfer from either position utilizing an open transition mode due to non-synchronization shall be set to infinity. The transfer switch shall not operate in an open transition mode.

G. Time delays shall be adjustable in 1 second increments through the ATS control system.

2.7 REMOTE ANNUNCIATION OF TRANSFER SWITCH STATUS

A. The ATS shall be equipped with dry contacts to provide the following status and signals

1. Transfer switch connected to normal power.
2. Transfer switch connected to emergency power.
3. Pre-signal to transfer between sources.

PART 3 - EXECUTION

3.1 INSTALLATION

A. ATS shall be installed per manufacturer’s written instructions and fastened in place utilizing hardware in accordance with division 26 specifications “Seismic Support for Electrical Equipment.”

B. Identify components according to Division 26 Section "Electrical Coordination."

C. Set field-adjustable intervals and delays.

3.2 CONNECTIONS

A. Wiring to Remote Components Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer’, size control conduits in accordance with NEC.

B. Ground equipment according to Division 26 Section "Grounding."

C. Connect wiring according to Division 26 Section "Wire and Cable – Building Wire (600V and Below)."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Verify time-delay settings.
c. Verify pickup and dropout voltages by data readout or inspection of control settings.
d. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

B. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

END OF SECTION

SECTION 263602 – STATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY:

A. These specifications describe the requirements for an automatic static transfer switch (STS) which is a solid-state, three-pole, dual-position transfer switch designed to switch automatically and manually between two synchronized three-phase AC power sources.

1.2 STANDARDS:

A. The specified system shall be designed, manufactured, tested and installed in accordance with:

1. American National Standards Institute (ANSI)
2. Canadian Standards Association (CSA)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. ISO 9001
5. National Electrical Code (NEC)
6. National Electrical Manufacturers Association (NEMA)
7. National Fire Protection Association (NFPA 70)
8. Underwriters Laboratories (UL)
9. EN 61000-6-4 & 6-2

B. The STS shall be UL and UL listed per UL Standard 1008 for Automatic Transfer Switches or 1008S for Solid State Transfer Switches.

C. The STS shall comply with the latest FCC Part 15 EMI emission limits for Class A computing devices and the emission limits of EN/IEC61000-6-4 Class A.

D. The STS shall safely withstand without misoperation or damage.

1. Transient voltage surges on either AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities).
2. Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit.
3. Electromagnetic fields from portable transmitters that are not within 3 ft. (1m) of the unit.

E. The STS shall comply with the immunity requirements of EN/IEC61000-6-2 Class A.

1.3 DEFINITIONS:

A. STS - Static Transfer Switch

B. SCR - Silicon Controlled Rectifier

C. MTBF - Mean Time Between Failure is the actual arithmetic average time between failures of the critical AC output bus.

D. MCS - Molded-case Switch - A circuit breaker that has no automatic thermal overload trip element but does have a magnetic trip element for short-circuit/fault protection. Short-circuit and overload protection must be provided by an upstream overcurrent device.

1.4 DOCUMENTATION:

A. Shop Drawing Submittals:

1. Shop drawing submittals shall include:

a. A system one-line diagram.
b. Outline drawing including weights, dimensions, heat dissipation and recommended service clearances.
c. Location and detailed layouts of customer power and control connections.
d. Description of equipment to be furnished, including deviations from these specifications.
e. Installation, operation and maintenance manual with installation, startup, operation and maintenance instructions for the specified system.

B. O&M Manuals:

1. Submittal shall include a complete set of submittal drawings updated with field modifications if any and shall include startup and testing reports.

C. Spare Parts:

1. A list of recommended spare parts shall be furnished upon request.

1.5 QUALITY ASSURANCE:

A. Manufacturer Qualifications:

1. A minimum of five years' experience in the design, manufacture and testing of STS systems is required. The specified system shall be completely factory-tested before shipment. Testing shall include, but shall not be limited to quality control checks, Hi-Pot test (two times rated voltage plus 1000 volts, per UL requirements), transfer tests and metering calibration tests. The system shall be designed, manufactured and tested according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

B. Factory Testing:

1. Before shipment, the manufacturer shall fully and completely test the STS to assure compliance with the specifications.

1.6 WARRANTY:

A. The manufacturer shall provide a warranty against defects in material and workmanship for 12 months after initial system startup or 18 months after ship date, whichever occurs first. (Refer to the Warranty Statement for details.).

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. Basis of Design: The basis of design is a Vertiv Liebert STS2 automatic static transfer switch.

1. Static switches by other manufacturers will be considered for prior approval. Provide approval submittal containing documents listed under section 1.4.A of this specification in accordance with the prior approval requirements of division 1 and 26 for review.

    a. Submittals must be made by the bidding contractor proposing to utilize the alternate product for consideration.

B. The STS shall allow uninterrupted transfer from one source to the other in case of the failure of one source or by manual initiation for test or maintenance. The switching action shall not connect together the two sources of power that would allow backfeeding one source to the other.

C. The STS shall allow for either source to be designated as the preferred source.

D. The switch shall automatically transfer to the preferred source and remain so until manually initiated to transfer or until the selected source fails.

E. The STS shall be furnished with key-interlocked static switch isolation and bypass Molded-Case Switches (MCSs) to each source, which allow uninterrupted manual transfer to and from either source for maintenance.

F. Modes of Operation:

1. The Static Transfer Switch shall be a three-pole, double-throw, solid-state, automatic transfer switch that is fed from two AC power sources. One source shall be designated as the preferred source, while the other is the alternate source. Selection of which input source is preferred shall be user selectable from the operator control panel. All transfers shall be a fast break-before-make with no overlap in conduction from one source to the other.
2. The Static Transfer Switch is fuseless and consists of six pairs of Silicon Controlled Rectifiers (SCRs) connected in an AC switch configuration. The SCRs are continuous rated to carry 100% of the STS rated load while operating within the STS specifications. The use of fuses for protection is not permitted due to possible fuse clearing in an out of phase transfer.
3. The Static Transfer Switch logic power shall automatically power up when connected to the power source. The control panel shall be active as long as one input to the STS is energized. The STS shall be supplied with factory default settings; mechanical trim pots shall not be used for calibration or adjusting settings. All settings must be adjustable; the settings shall be adjusted/configured from the LCD display.

    a. Normal Mode. The unit is fed by two sources with the output connected to the load. In normal operation, the load shall be connected to the preferred source as long as all phases of the preferred source are within the acceptable limits. The transfer voltage limits shall default to ±10% of the nominal input voltage for steady state conditions, with low voltage transfer limits having an inverse time relationship that is within the IEEE Std. 446 computer voltage tolerance envelope. Upon failure of the

preferred source, the load shall be transferred to the alternate source. After the preferred source returns to within the acceptable voltage limits for at least the preset adjustable retransfer time delay (typically 3 seconds) and is in phase with the alternate source, the load shall be retransferred automatically to the preferred source. The automatic retransfer to the preferred source can be disabled if so selected by the user from the operator control panel. Provided the preferred source is qualified, in the event the alternate source fails, the STS will always transfer to the preferred source, regardless of the automatic retransfer setting.

b. Load Current Inhibit (also called Ipeak or Peak Current Overload). The STS shall sense the load current and, if the load current exceeds an adjustable preset level deemed to represent a load inrush or fault condition, the STS shall disable the automatic transfer even if the voltage on the selected source exceeds the transfer limits. The load current transfer inhibit shall be user selectable between [(automatically) (manually)] reset after the current returns to normal to allow for continued protection against a source failure.

c. Manual Transfer (Optimized Transfer Disabled). The STS shall allow manually initiated transfers between the two sources, providing the alternate source has proper phase rotation and is within acceptable voltage and frequency limits and phase tolerances with the preferred source. Allowable phase differences between the sources for manually initiated transfers shall be adjustable from the operator control panel. The STS shall be capable of tolerating transfers up to 30 degrees out of phase for emergency conditions. The user-adjustable phase synchronization window shall be limited to ±30 degrees. If the transfer is manually initiated, the STS shall transfer between the two sources without interruption of power to the load greater than 1/8 cycle or less provided that both sources are available and synchronized within the user-adjustable phase synchronization window. For sources where the two frequencies are not exactly the same (as would be the case between a utility and standby generator source), manually initiated transfers shall be delayed by the STS until the two sources are within the user-adjustable phase synchronization window.

d. Manual Transfer (Optimized Transfer Enabled). The STS shall allow manually initiated transfers between the two sources, providing the alternate source has proper phase rotation and is within acceptable frequency limits, is within acceptable voltage and frequency limits at any phase angle difference. When a manual transfer is initiated, the STS will perform an optimized transfer such that the flux linkage is balanced when transferring between sources. The transfer time is typically less than one line-cycle and the load voltage is maintained within the ITIC voltage classification.

e. Emergency Transfer (Optimized Transfer Disabled). In an effort to maintain power to the load, upon loss of the source that the load is connected to, the STS shall automatically transfer to the other source within ¼ cycle typical, (depending on the load, phase difference between sources, and type of source failure) overriding any retransfer time delays or other inhibits except load overcurrent providing that the other source is available.

f. Emergency Transfer (Optimized Transfer Enabled). The STS shall perform an optimized transfer such that the flux linkage is balanced when transferring between sources, when any source anomaly that exceeds certain voltage thresholds is detected. The transfer time is typically less than one line-cycle and the load voltage is maintained within the ITIC voltage classification. By balancing the flux linkage, the STS minimizes any saturation current should a downstream transformer be connected.

g. SCR Failure. The STS shall continuously monitor the status of the SCR switching devices for proper operation. In the event of a shorted SCR on the source powering the load, the STS shall automatically alarm the condition and trip open the other source isolation MCS. In the event of a shorted SCR on the other source, the STS shall automatically alarm the condition and trip open the other source isolation MCS. In the event of an open SCR, the switch shall automatically alarm the condition and transfer to the other source. All open and shorted SCR alarm conditions shall be latched and require the system to be repaired and reset to restore normal operation.

h. System Bypass. The STS shall be furnished with key-interlocked maintenance bypass MCSs that allow the STS power, controls and monitoring electronics to be bypassed to either input source for maintenance without interruption of power to the load. The packaging of the STS shall have all electronics isolated from the input, output and bypass connections to allow servicing of any components without access to hazardous voltages when the unit is in maintenance bypass.

i. Rotational/Regenerative Loads. When a rotational load, such as a motor, is connected to the output of the unit, the time to detect a source fail and ultimately transfer to the alternate source can extend beyond the previously outlined timeframe. Regardless, the critical bus voltage is always maintained within the ITIC standard. Recommend contacting for guidance if connecting to a rotational/regenerative load to the STS.

4. Performance Requirements:

a. Nominal Input/Output Voltage: 208V three phase, 3-wire with ground
b. Default Voltage Range: +10%, -10% of nominal
c. Nominal Frequency: 60 Hz
d. Maximum Continuous Current: 200A
e. Source Voltage Distortion: Up to 10% THD with notches and ringing transients
f. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category B3
g. Sensing and Transfer Time: Refer to Modes of Operation section (Page 2-3) for details
h. Overload Capability:

1) 125% for 30 minutes
2) 150% for 2 minutes
3) 500% for 0.25 seconds

i. Short Circuit Withstand Capability: 100kA

5. Environmental Conditions:

a. Storage Temperature Range: -20° to +70°C (-4° to 158°F)
b. Operating Temperature Range: 0° to 40°C (32° to 104°F)
c. Relative Humidity: 0 to 95% without condensation
d. Operating Altitude: Up to 4000 ft. (1200m) above sea level without derating. Above 4000 ft. (1200m), output current is derated by 6% per 1000 ft. (18% per 1000m)
e. Storage/Transport Altitude: Up to 40,000 ft. (12,200m) above sea level
f. Audible Noise: Less than 55 dBA at 5 ft. (1.5m) with audible alarm off

6. Reliability:

   a. MTBF:

      1) The STS shall be designed for high reliability and high availability with an MTBF exceeding 1,000,000 hours. To the fullest extent practical, redundant circuits and components shall be used to eliminate single points of failure.

   b. Power Supply:

      1) Redundant power supplies shall be provided to prevent any single-point power supply failure mode. The STS shall have two completely separate power supplies mounted on separate boards so a power supply can be replaced while the load is on bypass. There shall be two separate DC buses, one from each power supply, to provide redundancy throughout the controls.

   c. Logic:

      1) Control logic shall be triple-redundant. Each of the three logic modules shall have its own separate power connection to each power supply bus. Each logic module shall be fused to prevent it from shorting the power supplies if an internal failure occurs. Gating and control logic shall be partitioned so that the failure of one source's gating or sensing logic does not prevent the switch from transferring to the other source.

   d. Components:

      1) All electrical components requiring normal maintenance or repair shall be replaceable without de- energizing the load, assuming that at least one source is available. Solid-state switching devices shall be packaged to allow safe repair of the switching devices without having to de-energize the load. All MCSs shall be of a plug-in or draw-out type to allow replacement without de-energizing the load. All control and logic components shall be mounted separate from the power components.

   e. Fuseless:

      1) No fuses are used to protect the solid-state power switching devices. Access.

   f. Access:

      1) The STS shall be designed for front access only. The STS shall be designed so all installation, repairs and maintenance can be done from the front or top of the unit. The STS shall be designed to minimize the exposure of hazardous voltages to allow safe servicing of the unit while the load is energized. Barriers shall be used on and around customer connections to protect personnel during maintenance.

2.2 FABRICATION:

A. Materials:

1. All materials of the STS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
2. The maximum working voltage, current and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component subassembly shall not be greater than 75% of their ratings.

B. Wiring.

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
2. Provision shall be made for power and control cables to enter or leave from the top or bottom of the STS cabinet.

C. Frame and Enclosure:

1. The STS unit, comprised of solid-state, three-pole, dual-position transfer switch, key-interlocked static switch isolation and bypass MCSs, shall be housed in a single free-standing NEMA type 1 enclosure and meet IP20 requirements. The frame shall be constructed of galvanized steel and pop riveted to provide a strong substructure. The frame shall include four heavy-duty swivel castors for ease of installation and four permanent leveling feet for final installation. Doors and removable exterior panels shall be a minimum of 16GA steel and be powder-painted the manufacturer's standard color textured enamel finish paint. A key-lock, hinged front door shall provide access to the MCSs. A tool shall be required to remove exterior panels that expose hazardous voltages. All removable panels shall be grounded to the frame for safety and EMI/RFI protection. The cabinet shall be structurally designed to handle forklifting from the base.
2. Removable conduit/cable termination plates shall be provided in the top and bottom of the unit for termination of the two source input and/or output conduits, raceways or cables.

D. Cooling:

1. The STS shall utilize convection air cooling for the enclosure with forced air cooling of the heat sinks. All fans shall be redundant so that a single fan failure will not cause temperature to increase beyond acceptable limits. Individual sensor(s) are located on heat sinks for alarm and shutdown. Heat rejection shall be through screened protective openings in the top of the unit. Air filters shall be located in the front door at the point of air inlet.

E. Grounding:

1. The STS chassis shall have an equipment ground terminal.

2.3 COMPONENTS:

A. Molded-Case Switches (MCS):

1. The STS shall be equipped with five MCSs. The MCSs shall be UL listed and IEC rated for use at the system voltage. The plug-in feature of the breaker shall include interlock,

which prevents the breaker from being unplugged without being in the Off (open) position. Three of the MCSs shall provide for total isolation of the solid-state switching devices with an input MCS for each source and a load isolation MCS. Two of the MCSs shall provide for maintenance bypassing of the solid-state switching devices to either input source. Key interlocks shall be provided on the MCSs to prevent improper maintenance bypassing of the solid-state switch. A bypass MCS cannot be closed unless the solid-state switch is connected to the same input source, and only one bypass MCS can be closed at a time. All MCSs shall be equipped with N.O. and N.C. auxiliary switches for monitoring of the breaker positions. The two input MCSs for the solid-state switching devices also shall be equipped with 48 VDC shunt trips to allow for control by the STS logic.

B. Silicon Controlled Rectifiers (SCRs):

1. The STS shall utilize six pairs of SCRs connected in an AC switch configuration. The SCRs shall be brick-type and rated to carry the full 100% rated load. The SCRs shall be rated to prevent hazardous device failure within the specified STS performance requirements.

C. Control Panel:

1. The STS shall be provided with a microprocessor-based Human-Machine Interface (HMI) to configure and monitor the STS. The HMI shall be located on the front of the unit and can be operated without opening the hinged front door. The HMI shall not be mounted to the front door so the door can be easily removed for maintenance. A backlit, menu-driven, full graphics, color touch-screen Liquid Crystal Display (LCD) shall be used to display system information, status information, a one-line diagram of the STS, active alarms, alarm history information, startup and bypass instructions. No mechanical pushbuttons shall be used.
2. The mimic screen shall indicate the power flow, the status of all MCSs, the preferred source and the STS position (connected to source 1 or 2) as well as active alarms.
3. Pop-up boxes selected from the menu bar shall be provided for operator interface to the HMI for menu selection, control of the preferred source, manual transfer initiation, auto/manual retransfer selection and other system setpoints. In addition, an operator can silence and reset the audible alarm by touching the screen. To facilitate STS operation, help text, step-by-step startup, transfer and maintenance bypass procedures shall be displayed on the LCD screen. For manual transfers, a syncscope shall display the leading or lagging real-time phase difference between the two input sources.
4. The HMI shall be equipped with an internal RS232 port and Flash memory to allow the STS software to be upgraded by a factory-trained customer engineer without shutting down the load.
5. To facilitate diagnostics, an event log of the last 512 alarm events shall be stored in non-volatile memory and displayed on the LCD. Two history logs, each having 64 frames of unit status frozen upon an alarm condition designated as a freeze fault, will be stored in non-volatile memory and displayable on the LCD. A frame shall be acquired every 4 milliseconds, with 40 frames before the fault and 23 frames after the fault. Each frame contains metering data, active alarms/faults and unit status. A system calendar and real-time clock shall be included to time-stamp all stored events.

D. CAN bus shall be used to communicate between the logic and the HMI as well as the options.

E. For remote monitoring, a serial RS-232 port shall provide present switch status information, alarm history information and the history of status screens that are triggered upon a major alarm event.

F. Metering:

1. The following metering parameters shall be displayed:

a. Input AC voltage for both sources, line-to-line for each phase
b. Input AC current for both sources for each phase
c. Input frequency for both sources
d. Output Kva
e. Output kW
f. Percent load
g. Number of switch transfers
h. Synchronization phase angle

G. All voltages and currents shall be measured using true-RMS techniques for accurate representation of non-sinusoidal waveforms associated with computers and other electronic loads. The metering parameters shall have a full-scale accuracy of ±2%.

H. Alarm Messages

1. Active alarms shall be monitored and displayed simultaneously as part of the LCD event panel. The following alarm messages shall be displayed

Source 1 Failure	CB1 (Source 1) Open	Power Supply S1 AC Failed
Source 2 Failure	CB2 (Source 2) Open	Power Supply S2 AC Failed
Sources Out of Sync	CB3 (Output) Open	Power Supply DC A Failed
Source 1 Overvoltage	CB3A Open (If used)	Power Supply DC B Failed
S1 Undervoltage (fast)	CB4 (S1 Bypass) Closed	Power Supply Logic Failed
S1 Undervoltage RMS (slow)	CB5 (S2 Bypass) Closed	S1 Voltage sense module failed
Source 2 Overvoltage	CB1 Shunt trip fail	S2 Voltage sense module failed
S2 Undervoltage (fast)	CB2 Shunt trip fail	S1 SCR sense module failed
S2 Undervoltage RMS (slow)	S1 SCR Open	S2 SCR sense module failed
Source 1 Overcurrent	S2 SCR Open	S1 Current sense module failed
Source 2 Overcurrent	S1 SCR Shorted	S2 Current sense module failed

Source 1 Over/Under Frequency	S2 SCR Shorted	S1 Gate drive module failed
Source 2 Over/Under Frequency	Primary fan failure	S2 Gate drive module failed
Source 1 Phase Rotation Error	Control Module Fail	Internal comm failed
Source 2 Phase Rotation Error	S1 I-peak	Option comm failed
Output undervoltage	S2 I-peak	Output voltage sense module failed
STS on alternate source	Auto Retransfer Inhibit	Heatsink Overtemp
Transfer Inhibit		

2. An audible alarm shall be activated when any of the alarms occurs. All alarms shall be displayed in text form

2.4 ACCESSORIES (OPTIONAL COMPONENTS AND SERVICES):

A. Optimized Transfer:

1. The STS shall be furnished with an optimized transfer control algorithm. This algorithm shall optimize the STS transfer timing such that the volt-seconds applied to a downstream transformer(s) primary is balanced, thus sufficiently minimizing peak saturation current drawn by the downstream transformer(s).
2. In addition to controlling the transformer primary current and flux, the optimized transfer control algorithm must maintain the load voltage within the CBME/ITIC Standards during the transfer. To maintain load voltage after the preferred source is turned off, the control algorithm must be able to pulse- fire the alternate source SCRs to minimize load discontinuity and voltage disruption.
3. The STS must maintain the above specification under the following conditions:

    a. Loss of source
    b. Loss of a single phase
    c. Voltage droop
    d. Phase-to-neutral short
    e. Phase-to-phase short
    f. Power factor load range of 0.75 to 1.0 leading or lagging
    g. Out-of-phase conditions from +180 to -180

B. Programmable Relay Board:

1. A Programmable Relay Board with eight sets of isolated Form C contacts shall be provided to indicate a change of status of any alarm condition. Any alarm can be programmed onto any channel or channels. Up to two programmable relay boards can be

installed in the STS. Programming is performed through the touchscreen display. Each contact shall be rated 1A @ 30 VDC or 250mA @ 125 VAC.

C. Input Contact Isolator Board:

1. An input Contact Isolator Board with eight relay inputs (normally open dry contacts) shall be provided for owner alarm messages. The owner, through the touchscreen display, can program the alarm messages.

D. Key Lockout Switch:

1. A key lockout switch shall be provided which activates a software lockout of the touch-screen display to prevent manual transfers and configuration changes. When locked out, the touch screen becomes a read- only display and a key is required to do manual transfers or change settings. The alarm silence button shall not be disabled when in the lockout position. The switch shall be located behind the front door but can be operated without opening the front door.

E. Redundant Output MCS:

1. A redundant output plug-in, MCS shall be provided and connected in parallel with the output plug-in, MCS to provide redundancy in the output power path. The redundant MCS shall be of the same rating and type as the output MCS.

F. Seismic Floor Anchors:

1. The STS shall be provided with seismic floor anchors to fasten the unit to a concrete floor to meet seismic IBC 2018 requirements.

G. Certified Test Report:

1. A certified copy of the factory test report shall be provided for each unit.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL:

A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the STS startup.

1. Visual Inspection:

a. Inspect equipment for signs of damage.
b. Verify installation per drawings.
c. Inspect cabinets for foreign objects.
d. Verify ground conductors are properly sized and configured.
e. Verify all printed circuit boards are configured properly.

2. Mechanical Inspection:

a. Check all control wiring connections for tightness.
b. Check all power wiring connections for tightness.

c. Check all terminal screws, nuts, and spade lugs for tightness.

3. Electrical Inspection:

a. Check all fuses for continuity.
b. Confirm input voltage and phase rotation is correct.
c. Verify control transformer connections are correct for voltages being used.

3.2 MANUFACTURER'S FIELD SERVICE:

A. Service Personnel:

1. The STS manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup, maintenance and repair of UPS and power equipment. The organization shall consist of regional and local offices.
2. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, 365 days/year. If emergency service is required, response time shall be 20 minutes or less.
3. An automated procedure shall be in place to ensure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.

B. Replacement Parts Stocking:

1. Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.
2. Recommended spare parts shall be fully stocked by local field service personnel with backup available from the national parts center and the manufacturing location. The national parts center Customer Support Parts Coordinators shall be on call 24 hours/day, 7 days/week, 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.

C. STS Maintenance Training:

1. Maintenance training courses for customer employees shall be made available by the STS manufacturer. This training is in addition to the basic operator training conducted as a part of the system startup.
2. The training course shall cover STS theory, location of subassemblies, safety and STS operational procedures. The course shall include control, metering and feedback circuits to the Printed Circuit Board (PCB) level. Troubleshooting and fault isolation using alarm information and internal self-diagnostics should be stressed.

END OF SECTION

SECTION 264113 – LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 DOCUMENTS

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

B. All other sections of Division 26.

1.2 SUMMARY

A. This section includes the furnishing and installation of the lightning protection system. The system shall be a complete UL Master Labeled system.

B. The work included under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the lightning protection system shown on the drawings and hereinafter specified.

1.3 CODES AND STANDARDS

A. In addition to those standards listed in other sections of Division 26, the work under this section shall comply with the following

1. NFPA 780
2. UL 96A, Latest Edition

1.4 LABELING

A. The system shall be installed such that it meets all requirements for UL Master Label. System shall be certified for UL Master Label.

1.5 SUBMITTALS

A. Product Data For air terminals and mounting accessories and conductors.

B. Shop Drawings

1. Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
2. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by UL.

3. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
4. Field inspection reports indicating compliance with specified requirements.

C. As-Built Provide three (3) complete sets of “As-Built” drawings to the Architect/Engineer. The drawings shall reflect the UL Master Labeled system configuration.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General The equipment manufacturer shall be a UL listed and approved manufacturer.

B. Available Manufacturers Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

1. Harger Lightning Protection, Inc.
2. Heary Bros. Lightning Protection Co. Inc.
3. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. General All equipment shall be factory inspected, approved and properly labeled in accordance with UL requirements. All equipment shall be new and of a design and construction to suit the application where it is used.

B. Comply with UL 96.

C. Equipment Materials shall be aluminum and of the size, weight, and construction to suit the application where used in accordance with UL and NFPA Code requirements for Class 1 structures. Requirements for bases, splicers, and other fittings shall remain the same.

D. Conductors shall be aluminum.

E. Air terminals shall project 10" minimum above the object to be protected. Locate and space according to UL and NFPA requirements.

F. Air terminal bases shall be of cast aluminum with bolt pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Crimp type connectors are not

acceptable. Bases on built up tar and gravel roofs shall be secured with a proper adhesive and shall have a minimum surface contact area of 18.5 sq. inches.

G. Ground rods shall be a minimum 5/8" in diameter and 10'-0" long. They shall be connected to the system with a two bolt cast bronze clamp having a minimum length of 1-1/2" and employing stainless steel cap screws.

H. Bonding devices, cable splicers, and miscellaneous connectors shall be of cast bronze with bolt pressure connections to cable. Cast or stamped crimp fittings are not acceptable.

I. Equipment on stacks and chimneys shall be protected from corrosion in accordance with UL and NFPA requirements.

J. Connections to structural steel shall be made with bonding plates of cast bronze with bolt tension cable clamps.

K. All miscellaneous bolts, nuts, and screws shall be brass, bronze, or stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

1. Install conductors as inconspicuously as practical with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
2. Lightning conductors exposed to mechanical damage shall be covered with molding or tubing. Ferrous metal pipe or tubing used around a conductor shall be bonded to the conductor at both ends of the pipe or tubing.
3. The following conductors shall be concealed

    a. System conductors.
    b. Down conductors.
    c. Interior conductors.
    d. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.

4. Make connections of dissimilar metal with suitable bimetallic type fittings to prevent electrolytic action.
5. Connections in the main vertical and horizontal conductors, and any connections which will not remain exposed, shall be the exothermic welding type which form solid metal joints.
6. For the conductors located outside of the building or stack, install the conductors not less than two feet below the finished grade.
7. Connect exterior metal surfaces to the lightning protection system conductors to prevent flashovers.
8. Components shall be protected against deterioration due to local conditions.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 AIR TERMINALS

A. Unless otherwise indicated in this standard, an air terminal shall be provided for each part of a structure that is likely to be damaged by lightning.

B. Air terminals shall be placed around the perimeter of a flat or gently sloping roof.

C. Flat or gently sloping roofs exceeding 50 feet (15 m) in width shall have air terminals located at intervals not exceeding 50 feet on the flat or gently sloping areas.

D. An air terminal shall be placed not more than 2 feet (610 mm) from the ends of each ridge, edge, or outside corner of roofs.

E. The tip of an air terminal shall be at least 10 inches (254 mm) above the object to be protected if the interval between air terminals is not more than 20 feet (6 m) and at least 24 inches (610 mm) above the object to be protected if the interval between air terminals is more than 20 feet but not more than 25 feet (7.6 m).

F. Each air terminal shall be secured against overturning either by attachment to the object to be protected or by means of braces that are permanently and rigidly attached to the building. Each terminal that is more than 24 inches (610 mm) high shall be supported at a point not less than one-half its height.

3.4 CONNECTION OF AIR TERMINALS

A. Conductors shall interconnect all air terminals and shall form a two-way path from each air terminal horizontally or downward to connections with ground terminals.

B. Conductors shall maintain a horizontal or downward course, free from "U" or "V" (down and up) pockets. Such pockets, often formed at low-positioned chimneys, dormers, or other similar elevations on the slope of a roof and at coping walls, shall be provided with a down conductor from the base of the pocket to ground, or to a convenient down lead of the main conductor.

C. Roof conductors shall be coursed along ridges of gable, gambrel and hip roofs and around the perimeter of flat and gently sloping roofs. Conductors shall be coursed through or around obstructions, such as cupolas, ventilators, and the like, in a horizontal plane with the main conductor. On a flat or gently sloping roof the conductor shall form a closed loop.

D. Cross run conductors shall be provided to interconnect the air terminals on flat or gently sloping roofs.

3.5 METAL BODIES

A. If a lightning conductor is bonded to a metal water pipe system, a metal body as described in this paragraph shall be connected either to the metal water pipe system, the nearest lightning conductor, or to another metal body already connected to the system. A metal body that is bonded through structural connection to the metal water pipe system requires no additional bonding.

B. Each metal body of conductance having an area of 400 square inches or more, a volume of 1000 cubic inches or more and each metal object that is as high as or higher than adjacent air terminals shall be bonded to the lightning-protection system unless located entirely within a zone of protection.

C. Main-sized conductors and a bonding plate having a surface contact area of not less than three (3) square inches shall be used to bond a metal body of conductance to the system. Provisions shall be made to guard against the corrosive effect introduced by dissimilar metals at points on bonding.

D. Metal bodies of inductance that are within six (6) feet (1.8 m) of the main conductor or other bonded metal body shall be connected to the system.

E. A metal body of inductance shall be bonded at the closest point to the system using secondary bonding conductors and fittings.

3.6 MARKING

A. A nameplate that includes the name and address of the installer of the lightning-protection system shall be affixed to the building structure at the roof level. Coordinate with Architect for location.

3.7 FIELD QUALITY CONTROL

A. UL Inspection Provide inspections as required to obtain a UL Master Label for system.

END OF SECTION

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 SCOPE

A. This section included the furnishing, installation, and connection of light fixtures, conduit, lamps, fittings, and boxes to form complete, coordinated, grounded interior lighting systems.

1.2 RELATED WORK/SECTIONS:

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included. This shall include, but not be limited to, the following:

1. Division 1
2. All other Division 26000 sections

1.3 QUALITY ASSURANCE

A. NEC Compliance Comply with NEC as applicable to installation and construction of lighting fixtures.

B. UL Compliance Provide lighting fixtures which have been UL listed and labeled.

C. CBM Labels Provide fluorescent lamp ballasts which comply with certified Ballast Manufacturers Association standards and carry the CBM label.

1.4 SUBMITTALS

A. Submit catalog cuts and descriptive literature for approval in accordance with Section 260500, ELECTRICAL GENERAL REQUIREMENTS.

1.5 COORDINATION OF CEILING TYPE

A. Determine the exact ceiling to be furnished in each area and obtain fixtures to suit. Deviate from specifications only where necessary and to the extent necessary to ensure fixture-ceiling compatibility.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES - GENERAL

A. Shall conform to the drawings and fixture schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, and as shown on the drawings.

B. Align, mount, and level the lighting fixtures uniformly.

C. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as shown on the drawings.

D. Support fixtures securely from building structure. Grid ceiling framing members shall not be used to support fixtures.

3.2 CLEAN-UP

A. Before final acceptance of the electrical work in all or any part of the building, the Contractor shall clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, reflector cones and lamps of all lighting fixtures.

B. Mask the trim and bottoms of all lighting fixtures if necessary to protect the fixture during construction.

C. Replace burned out or inoperative lamps, modules, ballasts and drivers in fixtures so that lighting fixtures will be in first class operating condition upon acceptance.

END OF SECTION

SECTION 270010 - TECHNOLOGY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS AND DEFINITIONS

A. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections except for Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as “technology systems”.

B. Drawings and specifications: The words “drawings” and “specifications” used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.

C. Installer and Contractor: The word “installer” where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word “contractor” where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.

D. Provide and Install: The word, "provide" where used on the drawings or specifications shall mean, "furnish, install, mount, connect, test, complete, document and make ready for operation". The word "install" where used on the drawings or specifications shall mean, "mount, connect, test, complete, and make ready for operation".

E. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.

F. Complete systems: All technology systems are intended to be complete systems, including all materials, labor and programming to make it an operation system. A Responsibility matrix has been included with the contract documents to clarify the scope of all system.

G. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications

are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.

B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant to the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.

C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two-dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable distances and materials.

D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.

E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advise the Engineer of discrepancies prior to bid.

F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installers for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

1.3 ABBREVIATIONS

A. Abbreviations: The following abbreviations or initials may be used:
   1. ABV CLG - Above Ceiling
   2. AC - Alternating Current
   3. ADA - American Disabilities Act
   4. AFF - Above Finished Floor
   5. AFG - Above Finished Grade
   6. AMP - Ampere
   7. ANSI - American National Standards Institute
   8. AWG - American Wire Gauge
   9. BC - Bare Copper

10. CCTV - Closed Circuit Television
11. CATV - Community antenna television
12. CLG - Ceiling
13. COAX - Coaxial Cable
14. CPU - Central Processing Unit
15. DC - Direct Current
16. DEG - Degree
17. EMT – Electrical Metallic Tubing
18. GND - Ground
19. IDF - Intermediate Distribution Frame (Telecom Room)
20. IMC - Intermediate Metallic Conduit
21. IN - Inches
22. IP - Internet Protocol
23. JB - Junction Box
24. KVA - Kilo-Volt-Amps
25. KW - Kilowatts
26. LBS - Pounds
27. LED - Light Emitting Diode
28. MAX - Maximum
29. MDF - Main Distribution Frame (Main Telecom Room)
30. MIC - Microphone
31. MIN - Minimum
32. MTD - Mounted
33. MTG - Mounting
34. NEC - National Electrical Code
35. NECA - National Electrical Contractors Association
36. NEMA - National Electrical Manufacturers Association
37. NFPA - National Fire Protection Association
38. NIC - Not in Contract
39. OFE - Owner furnished equipment
40. OSHA - Occupational Safety and Health Administration
41. PB - Pullbox
42. PWR - Power
43. PVC - Polyvinylchloride
44. EF - Telecommunications Entrance Facility
45. TR - Telecommunications Room
46. TTB - Telephone Terminal Board
47. V - Volt
48. WP - Weatherproof

1.4 CODES AND STANDARDS

A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.

B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced

documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.

C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it follows all codes.

D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:
   1. Building Code: South Carolina Building Code, current version
   2. South Carolina Accessibility Code

E. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. Definitions:
   1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
   2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
   3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
   4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
   5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.
   6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar result as the system/products basis of design.

B. Use of Prototype. Prototypes are not allowed in any technology system.

C. Use of alternates. Alternates are allowed and installer shall follow these requirements:
   1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is

specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.

2. The use of alternate products does not allow the change of system architecture with such products.

D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:

1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Attachment 1 of this specification.
3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
4. Substitutions of unnamed manufacturers will not be acceptable.
5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
6. Substitutions that create a change in system architecture are not allowed.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system.

B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal.

C. Electronic submittals. Submittals in electronic format (PDF) are accepted.

D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.

E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of those changes. The contract documents and any

changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.

F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 month before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers

G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer's expense.

H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
   1. Detailed course syllabus for each type of training required in the specifications
   2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
   3. A copy of all training material to be used during each session.
   4. Test result sheets for all testing done by the installer prior to the system acceptance test.

PART 2 - PRODUCTS

2.1 IDENTIFICATION AND LABELING TAGS

A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed labels or tags.

B. The only approved types of labels for inside premise environments for any technology systems are:
   1. Non-laminated thermal transfer labels, printed with a high-quality thermal transfer printer.
   2. Laminated thermal transfer labels printed with a high-quality thermal transfer printer.
   3. Thermal transfer polyolefin tape printed with a high-quality thermal transfer printer.
   4. Self laminated dot-matrix labels, printed with a high-quality dot-matrix printer.
   5. Non-laminated dot-matrix labels, printed with a high-quality dot-matrix printer.

C. For labeling cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.

D. Any type of write-on labels (except for outdoor marker plates), handwriting on cable jackets or directly on equipment, labels made with masking tape or any other type of

tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.

E. Approved manufacturer:
   1. Rhino,
   2. Brady,
   3. Panduit or
   4. approved equal

2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.

B. Installation Requirements: Each item of equipment or material shall be installed in accordance with the instructions and recommendations of the manufacturer and the contract documents.

C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically, these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.

B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.

C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall always be adequately protected against mechanical/chemical damage by the elements or work perform by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:

1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
2. Equipment with visible indication of rust or water intrusion.
3. Equipment that has dents on the metal enclosures and is clearly visible to the end user.
4. Equipment that has been sprayed with paint, fireproofing materials, or other types of chemicals, when the equipment was not intended to have this type of materials applied to it, according to the contract documents.
5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.
7. Cables that have visible damage to the jackets even if cables are not broken and still provide electrical continuity.
8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
9. Equipment with screws with stripped heads.

D. CLEAN EQUIPMENT: All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time when the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. Clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans.

E. IDENTIFICATION AND TAGGING: All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to the Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.

3.2 COORDINATION

A. General: The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.

B. Adjustments: Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.

C. Replacement: All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

3.3 REQUEST OF IP ADDRESSES

A. General: The installer of any of the technology systems shall be required to submit request for IP addresses for the configuration of network connected system. The requests shall be separated by each trade that requires IP addresses. Contractor shall indicate all the different device types for a system (i.e. cameras, workstation, servers, controllers, VoIP phones, etc) and provide a list of all devices required classified by their type and properly indicating location where the device will be used.

B. Reprogramming cost of any technology systems due to un-approved addresses used by the installer shall be at the installer's expense

3.4 TELECOM ROOM/EQUIPMENT ROOM READINESS

A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be meet at all rooms in order for the owner to install the equipment:
   1. All power outlets in the telecom rooms shall be fed from the permanent source of power. Temporary power shall not be provided.
   2. Backup power (generator and/or UPS) shall be already operation, tested and connected to the final power distribution system.
   3. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.
   4. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
   5. All light fixtures in the telecom rooms shall be fully operational.
   6. All walls to the telecom rooms shall be completed and including the last coat of paint.
   7. The ceiling and flooring of the telecom rooms shall be finished.
   8. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
   9. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
   10. Telecom rooms shall be cleared of any materials being stored inside the room.
   11. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.
   12. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
   13. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people's shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day.

Sticky mats shall be provided until the project receives the final Certificate of Occupancy.

B. In projects where the network equipment is part of the contract documents, the contractor is required to provide all equipment functioning and clean at the end of the project. The contractor is responsible to determine at what point this delicate equipment can be installed in the telecom room. The contractor shall make sure the recommended manufacturer guidelines are applied to the installation of the equipment when it comes to cleanness. It is highly recommended that all steps indicated above are followed even for this type of project.

3.5 SYSTEMS WARRANTY AND SERVICE

A. General: At a minimum all technology system shall include a warranty from the manufacturer and installer of the system for no less than one (1) year with the following exceptions:
   1. Structured Cabling system shall have a warranty longer than one year as indicated in that specification section.
   2. When specific equipment or software manufacturers include a warranty longer than one year, the manufacturer's warranty shall be transferred to the owner in the same terms as indicated by the manufacturer.

B. Warranty coverage. The warranty for the technology system shall cover the following elements:
   1. All equipment parts, cabling and materials.
   2. Any software updates/patches issued during the warranty period by the manufacturer.
   3. The labor to replace those parts and programming time to re-configure equipment.
   4. Shipping and freight charges to send equipment back and forth from the manufacturer and/or site.
   5. Tool rentals such as scaffold or lifts to access equipment.
   6. The troubleshooting time to detect the faults in the system.
   7. All travel time and expenses associated with the service.

C. Start of warranty. The warranty period for the technology systems starts the day the project gets the Certificate of Occupancy (CO), for new construction projects. For retrofit jobs of a particular system, the warranty starts when the project is accepted by A&E. For most equipment/software manufacturer's the warranty period starts when the equipment is shipped from the factory, so it is the responsibility of the installer of each system to provide additional warranty coverage from the manufacturer to cover the additional time of warranty up to the CO date plus one year.

D. Service calls. During the warranty period the installer shall support the system when called by owner/contractor for service. All equipment/software service shall be done by personnel with the same qualifications as the personnel who installed the system and as indicated in each technology system specification section. Service calls shall be taken during business hours (same time zone as the project) for normal service and twenty (24) hours three hundred and sixty-five (365) days in the year for emergency service. Emergency Service shall be defined as the loss or failure of any critical

component necessary to maintain the overall integrity and operation of the system. Normal service shall be defined as the loss or failure of a system component that does not compromise the complete operation of the system and allows the owner to operate the system at a minimum of 90% of its capacity. See individual specification sections for delineation on critical components and normal service.

E. Response time for service. The maximum allowed response time after a service call for emergency service shall be four (4) hours and for normal service twenty four (24) hours.

F. Equipment registration. All equipment/software part of the technology system shall be registered to the owner with the manufacturer of the equipment/software for warranty and support. Equipment/software registered with the manufacturer to the name of the Contractor or installer shall be removed from the project and replaced with equal equipment registered to the owner at no additional cost to the owner.

G. Periodic preventive maintenance visits. During the warranty period the installer of the system shall provide no less than two (2) preventive maintenance services. These services shall be provided at 6 months from start of the warranty period and a few weeks before the end of the warranty period. The installer of the system shall coordinate with the owner the precise dates for this type of service. During these visits the following task shall be perform:
   1. Clean up of any active equipment that shows visible accumulation of dirt, dust of debris of any kind.
   2. Replacement of any consumable parts in the system that require replacement per manufacturer's instructions during the warranty period, such as filters.
   3. Oiling/greasing of any mechanical parts that require period maintenance as per manufacturer's instructions during the warranty period.
   4. Run manufacturer's recommended test for each piece of equipment installed. The installer shall provide at the end of the service a report of such test.
   5. Visual observation of all devices in the system to spot any anomalies.
   6. Review of error logs from any system components and analysis of such logs with explanation to owner on the cause of those errors.

H. Extended service agreement. Prior to final acceptance testing, and within thirty 30-days of project completion, the installer of each technology system shall submit to the Owner an option to purchase extended service coverage. This proposal shall provide for the purchase option of 1, 3, or 5, year coverage. Coverage shall include, at a minimum, the same provisions as during the warranty period.

3.6 ENGINEER'S FINAL ACCEPTANCE TEST

A. The technology systems shall be tested during installation by the installer as frequently as required to solve any installation issues and non compliance of system specifications. Technology systems will not be considered delivered to the owner until final acceptance test is passed. The final acceptance test shall be done in presence of the A&E and/or the owner. The installer shall request in writing with 2 weeks in advance the presence of the A&E and/or owner for the final acceptance test.

B. In order for the installer of the system to request final acceptance the following task shall be completed:
   1. All components shall be inspected to ensure they have been properly installed by the installer, securely attached, and remain clean and unmarred
   2. All equipment shall be properly adjusted, clearly labeled, and fully operational.
   3. The installer shall have tested the system previously to ensure the final acceptance test will be successful. Detailed proof of test shall be sent to the A&E with the request for final acceptance
   4. All permanent and final labels as requested in the identification and tagging section of this specification are completed.
   5. No temporary conditions shall be present in the system.
   6. All batteries on all system components shall be connected.
   7. All system programming shall be completed as indicated in the specification for each technology system.

C. All test equipment required for the Final acceptance shall be provided by the installer of the system unless specifically indicated by the A&E.

D. The A&E shall define the scope of the testing but the installer shall be prepared for testing every single component of the system. During the day of the test the A&E will indicate the testing process and procedures for each system. Test could include operation of the system during power outages. The installer of the system shall be available during the complete testing process to answer questions from the Engineer and to demonstrate specific parts of the system. If personnel form the installer or test equipment is not available, the test will be considered and marked as a failure.

E. A punch list of the items to be corrected will be prepared by the A&E during the final acceptance test. The installer shall correct all items and request a second day for verification of all punch-list items by the A&E and Owner. During the second test, no additional punch list items shall be expected, and only the items in the punch list will be tested.

F. If during the testing process the A&E and/or Owner consider that the rate of failure of the test is too high (more than 5 failures or non-compliance with specifications in one hour of test), the test will be cancelled unilaterally by the A&E and/or owner. The installer shall correct all items and re-schedule the final acceptance test again. The new test will start over from the beginning and nothing previously tested will be accepted. The installer shall not be entitled to additional compensation for the additional effort to test the system during this condition.

G. Upon successful completion of the final acceptance test the installer of the system will receive written notice by the A&E and/or Owner acknowledging the acceptance of the test

H. See individual specification sections for system specific requirements for testing.

3.7 TRAINING AND INSTRUCTION

A. Training for each technology system shall be provided as indicated in this specification and in the individual specification section for each system.

B. The following training guidelines shall be followed for all technology system
   1. Training shall not be scheduled in a way that no attendee or presenter shall be required to attend more than 6 hours of training per day.
   2. Prior to starting all training, the training submittal shall be approved. See section one of this specification for details on the training submittal
   3. No training shall be scheduled prior to the system being completed and accepted by A&E.
   4. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the Owner and installer. All training sessions need to be scheduled by the installer at least 2 weeks in advance. The Owner shall be notified in writing by the installer on when are the possible dates for each session.
   5. All different types of training shall be recorded and delivered to the owner as part of the close out information in digital copy.
   6. The installer is responsible for completing list of attendants for each session of training. All these sheets shall be submitted as part of the close out information

3.8 AS BUILT DOCUMENTS

A. Production: During the course of this project the contractor shall maintain record "as-built drawings". One set shall be maintained at the site and at all times and it shall be accurate, clear, and complete, showing the actual location of all equipment as installed. The "As-Built" drawings shall show all technology systems work installed complete to the present stage of progress. These drawings shall be available for review by the A&E's field representatives at all times.

B. Completion: At the completion of the Work, transfer onto the second set of drawings all changes marked in colored and submit to the A&E.

C. Final: Upon installer’s completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings. Submit full size drawings and one (1) set of CAD/Autodesk Revit© disks for review and acceptance.

D. Additional documents. At project completion, the installer of the technology system shall provide, as part of the as-built documents, updated tables, equipment schedules, configuration worksheets and labeling system used. See individual system specification section for more details on these documents.

E. See individual specification sections for each system for additional requirements for As-Built documents.

3.9 CLOSE OUT DOCUMENTS

A. Closeout information shall be provided to the owner in electronic format at the end of the project. The file shall be organized by each system and shall follow this organization:
   1. PART 1 – OPERATION AND MAINTENANCE MANUALS. Operation and Maintenance manuals as issued by the manufacturer of each system’s

component. Such manuals shall include all maintenance procedures required to be done by the owner. Also, when required by each individual specification section, a short form operation guide, prepared by installer) for the system.

2. PART 2 – INVENTORY OF EQUIPMENT INSTALLED. A detailed list of all relevant active equipment (equipment with electronic components with a market value over $200) installed in the project including the following information and presented in electronic format (Microsoft Excel):
    a. Make
    b. Model
    c. Serial number
    d. Room location
    e. Warranty period, including manufacturer's extended warranties.
3. PART 3 – PROOF OWNERSHIP, DELIVERY AND ACCEPTANCE. The following letters/documents shall be attached in this part:
    a. Acceptance letter signed by A&E for each of the technology systems installed.
    b. Proof of training by submitting sign in sheets for each training session done
    c. Signed transmittal for all training videos and training material.
    d. Signed transmittal for all spare parts and consumables delivered to the owner.
    e. A list of all the user names and passwords for all the different software programs used by the technology systems and any equipment with password codes. All levels of passwords shall be provided, from the lowest hierarchy to the highest.
    f. At least four (4) copies of all physical keys to different devices part of the technology systems. Each key shall be individually tagged in a key ring. All keys shall be included and organized inside a key ring management enclosure.
    g. A list of all software modules and licenses delivered to the owner. The list shall include part numbers, serial numbers, license certificate of authenticity, hardware key (dongles) numbers and software version. This list shall have a clear signature, name and date on person that received this software by the Owner.
    h. A copy of all official equipment and software registrations with manufacturer.
4. PART 4 – AS BUILT DOCUMENTS. All as-built documents as indicated in this specification section

END OF SECTION 270010

ATTACHMENT 1 – SUBSTITUTION REQUEST FORM

Substitution Request Number: _____

PROJECT:_____ DATE: _____

SPECIFICATION SECTION: _____ITEM(S):_____

SPECIFIED MANUFACTURER:_____

SPECIFIED MODEL NO: _____

PROPOSED MANUFACTURER:_____

PROPOSED MODEL NO:_____

REASON(S) FOR NOT PROVIDING SPECIFIED ITEM:_____

_____

Attach product description, drawings, photographs, performance and test data, samples and other information necessary for side-by-side evaluation. Fill in all blanks.

A. Provide substantiated reason for requested substitution.

B. Does the requested substitution affect dimensions, locations or configurations?
No:_____Yes:_____
Explain (attach drawings if necessary):_____
_____
_____

C. What are the differences between the specified item and the requested item:
_____
_____

D. Will the Contractor pay for any changes to the building design, including engineering and detailing costs caused by the approval?
No:_____Yes:_____
Explain (if no, and describe modifications required to install or accommodate the requested change):_____
_____
_____

E. Will approval affect the work of other trades, including the Construction schedule?
No:_____Yes:_____
Explain (if yes):_____
_____
_____

F. Manufacturer's guarantees of the proposed and specified items are:

Same:_____Different:_____
Explain (if different):_____
_____
_____

G. Does the proposed item meet all applicable codes, ordinances and regulations for this specific application?
No:_____Yes:_____
Explain (if no):_____
_____
_____

H. Has proposed item been used locally in similar applications?
No:_____Yes:_____
Explain (give nearest location):_____
_____
_____

I. Will maintenance and service parts be locally available for the requested item?
No:_____Yes:_____
Explain (if no, give nearest location):_____
_____
_____

J. Will the requested item require waiving of any qualifications or other requirements?
No:_____Yes:_____
Explain (if yes):_____
_____
_____

K. Are there any license fees or royalties associated with the requested substitution?
No:_____Yes:_____
Explain (if yes):_____
_____
_____

L. If approved, will the Owner receive a credit for the proposed alternate material?
No:_____Yes:_____
Explain (if no):_____
_____
_____

M. Does the proposed alternate material meet the same applicable standards (ASTM, ANSI, UL, FS) as the specified item?
No:_____Yes:_____
Explain (if no, attach drawings if necessary):_____
_____
_____

N. Identify the recycled materials or components or features that lead to the claims to being "Green": _____
_____
_____

O. Has the required line-by-line comparison been included?
No:_____Yes:_____
Explain (if no):_____
_____
_____

The undersigned agrees to pay for the Designer's review time and for changes to the building design, including review, re-design, engineering, drawings and other costs caused by the requested substitution.

_____
Signature

_____
Print

The following Purchase Order or billing number is to be used for billing the Contractor for costs incurred in evaluating and if applicable accommodating the requested substitution.

_____

The Engineer will not be required to approve any product that is not equal or suitable for the specific application and functionality of this project.

SECTION 270526 – GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

B. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.

C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 270010 Technology General Provisions
   2. 270528 Raceways for Technology
   3. 260526 Grounding and Bonding for Electrical Systems

D. General. For a bonding diagram for telecommunications refer to T Drawings.

E. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.

F. Reference Standards:
   1. TIA-607-D
   2. TIA-568.0-D
   3. TIA-606-C
   4. UL 1863 Communication Circuit Accessories
   5. UL-50 & UL-514
   6. NFPA 70 – NATIONAL ELECTRIC CODE
   7. IEEE Std. 1100-1992, Powering and Grounding Sensitive Electronic Equipment.
   8. BICSI TDMM, Telecommunications Distribution Method Manual.
   9. UL 1449
   10. R56 “Standard and Guidelines for Communications Sites” Motorola Inc. 2017.

G. Standard compliance: This project requires compliance with R56 grounding standards. The requirements of R56 grounding standards are more stringent and supersede the requirements indicated in this specification section.

1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.3 SHOP DRAWINGS AND SUBMITTALS

A. See additional requirements for shop drawings and submittals in specification section 270010.

B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
   1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
   2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
      a. Room Name or number
      b. Quantity of ground bars
      c. Height of each ground bar
      d. Length of each ground bar
      e. Number of holes in each ground bar
      f. Label for each ground bar
   3. A drawing indicating the following information:
      a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
      b. Wire size charts for all telecommunications grounding backbones in the project.
      c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.

1.4 ABBREVIATONS

A. General: The following abbreviations are used in this specification section:
   1. TBB - Telecommunications Bonding Backbone
   2. BC - Bonding Conductor
   3. EMT - Electrical Metallic Tubing
   4. RMC - Rigid Metal Conduit

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).

B. The TMGB shall have the following specifications:
   1. Material: Copper with a thin plated finish.

2. Thickness: ¼" thick
3. Width: No less than 4"
4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
    a. Two holes required for each TBB termination.
    b. Two holes for each cabinet or rack row in the room
    c. Two holes for each protector block in the room
    d. Two holes for each layer of ladder tray above the rack.
    e. Two holes for each set of conduit sleeves entering the room
    f. 20% of spare capacity shall be available after all terminations are done.
    g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:
1. Panduit,
2. Erico or
3. approved equal.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE

A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).

B. The TMGB shall have the following specifications:
1. Material: Copper with a thin platted finish.
2. Thickness: ¼" thick
3. Width: No less than 4"
4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
    a. Two holes required for each TBB termination.
    b. Two holes for each cabinet or rack row in the room
    c. Two holes for each protector block in the room
    d. Two holes for each layer of ladder tray above the rack.
    e. Two holes for each set of conduit sleeves entering the room
    f. 20% of spare capacity shall be available after all terminations are done.
    g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.

5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16”
6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with standoffs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:
1. Panduit,
2. Erico or
3. approved equal.

2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR OUTDOOR USE

A. When TGB are located outdoors, all specs for indoor used TGB shall be followed with the exception of the construction material. The TGB for outdoor use shall be made of galvanized steel.

2.4 FLEX CONDUCTOR, ONE-HOLE, LONG BARREL WITH WINDOW LUG

A. All BCs (different from TBB) shall be terminated in a flex conductor, one hole, long barrel with window lug when a two hole connector is not possible to be used because receiving equipment does not support the two holes. All lugs shall be selected to match the size of the conductor being used. Other types of terminations such as screw type connectors are not accepted

B. The flex conductor, one hole, long barrel with window lug shall have the following specification:
1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Stud hole size: ¼”
4. Barrel type: Long barrel > 1”
5. Termination type: crimp type
6. Angle: straight or angled if installation space is limited.
7. Listing: UL listed and tested to 35 KV and 90ºC

C. Approved manufacturers: Panduit, Thomas & Betts or approved equal.

2.5 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG

A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of termination are not accepted.

B. The flex conductor, two hole, long barrel with window lug shall have the following specification:
1. Finish: Thin platted

2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Stud hole size: ¼”
4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
5. Barrel length: long barrel > 1”
6. Termination type: crimp type
7. Angle: straight or angled if installation space is limited.
8. Listing: UL listed and tested to 35 KV and 90ºC

C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:
1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
2. Bonding a BC or a TBB to a TGB or TMGB
3. Bonding to equipment that requires two holes for bonding.

D. Approved manufacturers:
1. Panduit,
2. Thomas & Betts or
3. approved equal.

2.6 HTAP CONNECTOR

A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:
1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.
4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
5. Termination type: crimp type
6. Listing: UL listed and tested to 600V

B. Approved manufacturers:
1. Panduit,
2. Thomas & Betts or
3. approved equal.

2.7 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be insulated copper stranded conductors with a wire gauge dictated by the length of the cable. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum of 3/0 AWG. The following table shall be used to estimate the size of the TBBs:

TBB LENGTH LINEAR M (FT)	TBB SIZE (AWG)
Less than 4 (13)	6
5- 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8– 10 (27 – 33)	2
10– 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 - 46 (126 – 150)	300 kcmil
46– 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

B. Once a TBB has been sized with a particular gauge, any extensions of such backbone shall not be done with a wire gauge smaller than the previous run regardless of distance.

2.8 BONDING CONDUCTOR (BC)

A. Boding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
   1. Conductor Size: use the chart above for TBB to estimate the size of the bonding conductor. BC shall be no smaller than an AWG-2.
   2. Material: copper stranded conductors.
   3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.

B. Pre-fabricated BCs or field made BCs are acceptable.

C. Both ends of a BC shall be terminated in long barrel lugs.

2.9 RAISED FLOOR BONDING CLAMP

A. Raised floor bonding clamps shall be used to bond BCs under the raised floor to raise floor pedestals. The specifications of the raised floor bonding clamp shall be:
   1. Construction: solid metal device
   2. Bonding of BCs: The device used to bond the BCs shall be a split screw copper bolt sized to match the size of the BCs being bonded

3. Bonding of raised floor pedestals: The device shall include an adjustable clamp to bond the pedestal. The installer of this system is responsible for selecting the size of the clamp to match the size and shape of the pedestal provided for this project.
4. Listing: UL listed

B. Approved manufacturers:
1. Panduit,
2. Thomas & Betts or
3. approved equal.

2.10 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE

A. Installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.

B. General: All installation requirements indicated in specification section 270010 shall be followed.

C. PROTECTION. The TBBs and BCs shall be installed and protected from physical and mechanical damage.

D. GALVANIC CONTINUITY. The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.

E. CRIMPING. All lugs shall be crimped with the proper die for the size of lug being used.

F. PAINT REMOVAL. Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as ladder trays and racks, if no ground lug is available in the equipment.

G. SPLICING. The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

H. BONDING TO ELECTRICAL PANELS. The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.

I. BONDING TO BUILDING STEEL. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.

J. LUG SCREWS. All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.

K. BONDING PROTECTOR BLOCKS. All primary or secondary building entrance protectors' blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.

L. BONDING OUTSIDE PLANT CABLES. When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack's vertical ground bar (if available).

M. BONDING BACKBONE CABLES. Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack's vertical ground bar (if available).

N. BONDING HORIZONTAL CABLES. When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack's vertical ground bar (if available).

O. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.

P. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.

Q. INSTALLATION OF TBBs OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.

R. HALO GROUND SYSTEM. For room with R56 grounding requirements, a halo ground shall be provided around the room. This halo ground is composed of a AWG-0 uninsulated stranded copper conductor, installed 6" below the ceiling, going around the complete perimeter of the room and one end bonded to the TGB in that room. This conductor shall be separated from the wall with 6" plastic stand offs. All metal structures or parts around the room, such as door frames and windows, mechanical

cooling equipment, conduit sleeves, etc. shall be bonded to this conductor with a compression connector.

S. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-2) shall be provided and terminated to the rack manufacturer's recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. Provide a vertical ground bar in each rack/cabinet in compliance with Motorola R56 standard. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer's approved grounding lug in the rack/cabinet to the ground bar.

T. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.

U. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA/EIA-606-C standard. At a minimum, the following elements shall be labeled in the telecommunications grounding system:
1. All TMGB or TGB, with a unique identifier located in the wall near the unit, not on the ground bar.
2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.
3. BC for rows of racks with a unique identifier at both ends of the cable
4. BC for surge protectors with a unique identifier at both ends of the cable

V. ADDITIONAL LABELING. All BCs boding rows of racks/cabinets and TBBs shall have additional to the identification marker a yellow printed wrap around tag installed close to the bonding point strap to the cable jacket with a flame retardant cable tie. This tag shall have the following wording in green letters: "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".

3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 270010 for as built and close out information requirements.

END OF SECTION 270526

SECTION 270528 - RACEWAYS FOR TECHNOLOGY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Section 260533 - Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 260533.

C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 270010 Technology General Provisions
   2. 270526 Grounding and Bonding for Telecommunications Systems

1.2 DESCRIPTION

A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein.

B. General: For pathways the system shall utilize a combination of conduit, cable tray and support for vertical and horizontal cabling support. Pathways shall be provided and located as shown and, in the quantities, indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.

C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-E requirements at a minimum.

D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturers' installation guidelines.

E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as support. Boxes and conduits shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.

F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.

G. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.

H. Directional boring might be required in the drawings or the installer might choose this method as the way to install underground conduit on this project. In either case, the installer shall comply with the requirements indicated here for directional boring.

I. If at the time of bid and underground locate survey is not available, the installer shall include in the pricing the cost of this survey. No directional boring will be allowed without such survey being completed.

1.3 INSTALLER QUALIFICATIONS

A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.

B. General: The Installer directly responsible for this work shall be a " Pathways and Spaces for Structured Cabling System Installer (PS-SCS) " who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.

C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.

D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. See additional requirements for shop drawings and submittals in specification section 270010.

B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:
   1. Proof of Installer's qualifications per paragraph 1.03.
   2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
      a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
      b. Cable tray system with accessories
      c. Runway cable tray system with accessories.
      d. Plywood
      e. Trough wall/floor firestop system
      f. Innerduct
      g. Detectable tape
      h. Communications vaults
      i. Conduit waterfalls
      j. Fire stop system (for small penetrations)
   3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
   4. For all communication vaults, drawings shall be prepared indicating conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
   5. Pre-cast communications vaults shall be submitted with load calculations signed and sealed by a professional engineer.
   6. For any directional boring runs, the installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as proposed depth.

1.6 WORK EXTERNAL TO THE BUILDING

A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduits as indicated in Section 26.

2.2 TELECOMMUNICATIONS OUTLET BOX

A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
   1. Material: Steel, 0.6858mm. thickness (minimum) with galvanized zinc coating, 0.013mm. (minimum) thickness on both sides of bracket
   2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges).
   3. Size (HXW): 4-11/16” X 4-11/16”
   4. Depth 2-7/8”
   5. Knock outs: At least one of this dimension: 1-1/4”
   6. Listing: UL or ETL

B. Telecommunications outlet electrical boxes shall be provided with the appropriate 1 gang or 2 gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use 1 gang ring, but design documents might indicate the use of 2 gang rings in selected areas.

C. Knockouts in telecommunications outlet boxes shall not be field punched.

D. Basis of design: Raco, Steel City, Randal Industries Inc,

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. HDPE pipe shall be used for all directional boring applications, or it can also be used for open trench applications. HDPE pipe shall comply with the following manufacturing standards:
   1. ASTM D 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
   2. ASTM D 2239 Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
   3. ASTM F 2160 Solid wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (O.D.)
   4. NEMA TC-7 Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.

B. HDPE pipe shall be manufactured from a suitable thermoplastic polymer conforming to the minimum standard of PE334420E/C as defined in ASTM D3350. The resin properties shall meet or exceed the values listed below for HDPE pipe:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	0.941 - 0.955
D-1238	Melt Index, g/10 min Condition E	0.05 - 0.50
D- 638	Tensile strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B,F 20	96 min.

D-790	Flexural Modulus, MPa (PSI)	80,000 min.
D-746	Brittleness Temperature	-75°C

C. Design selection: The HDPE pipe used in this project shall be Rib/Smooth – Ribbed Interior and Smooth Exterior wall. Pipe shall be available in multiple colors, non lubricated and shall include a factory installed 1,800 lbs polyester pull tape. HDPE pipe walls shall be in compliance with SDR 7 - ASTM D3035 specifications and shall have footage markings.

D. Approved manufacturers: Carlon Industries or approved equal.

2.4 WIREWAYS

A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knockouts unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinging type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16-gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

2.5 SUPPORTING DEVICES

A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing or approved suitable preservative methods.

B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.

C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

D. Non-continuous cable supports 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.

E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.

F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel

members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.

H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.

I. Accepted manufactures; Erico or Panduit.

2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)

A. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. Provide mesh system permitting for continuous ventilation of cables and maximum heat dissipation.

B. Materials: Carbon Steel: Cable management system to be manufactured from high strength minimum 6 gauge steel wires. Wire to be welded and bent prior to surface treatment.

C. Finishes: Electro-plated zinc Galvanizing: Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils.

D. Cable tray dimensions as shown on the drawings.

E. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by Manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.

F. Installation: Cable tray system to be installed using splice connectors, and support components as recommended by the Manufacturer.

G. Loading Cable tray system to be installed and supported per NEMA VE-2 and Manufacturer’s suggested span load criteria.

H. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm.

I. Approved Manufacturers: Wiremold, Cablofil, Snake Tray, B-line, WBT or Chatsworth.

2.7 CABLE TRAY AND FITTINGS (LADDER TRAY TYPE)

A. CABLE TRAY SECTIONS AND COMPONENTS

1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in

compliance with applicable standards; and with the following additional construction features.

2. Materials and Finish: Material and finish specifications for each cable tray type are as follows:
   a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
   b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
   c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers.
   d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

B. TYPE OF TRAY SYSTEM
   1. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200-pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
   2. Tray Sizes shall have 3 inch minimum usable load depth, or as noted on the drawing.
   3. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
   4. Tray widths shall be as shown on drawings.
   5. All fittings must have a minimum radius as the width of the tray.
   6. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
      a. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum

cable tray is to be used outdoors then hardware shall be Type 316 stainless.

b. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

7. Splice plates shall be furnished with straight sections and fittings.
8. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. All types of supports shall be factory made supports supplied by the same manufacturer of the cable tray system as recommended for the type of cable tray selected.
9. Trapeze hangers supports shall be supported by 3/8 inch (minimum) diameter rods.
10. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
11. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

C. LOADING CAPACITIES

1. Cable tray shall be capable of carrying a uniformly distributed load of 109 lbs. /ft. on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2. In addition to the uniformly distributed load the cable tray shall support a 200 lb. concentrated load at mid-point of span and centerline of tray. Load and safety factors specified are applicable to both side rails and rung capacities.

D. Approved Manufacturers: B-line, Chatsworth or approved equal.

2.8 TUBULAR RUNWAY CABLE TRAY AND FITTINGS

A. Materials: ASIM A36 steel bar.

B. Finish: Baked Powder painted surface treatment using Polyester coating.

C. Finish color: to match equipment cabinet finish color. See specification section 271000.

D. Cable management tray width: as shown on the drawings.

E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.

F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.

G. Loading: Cable management system to be installed and supported per Manufacturer's suggested span load criteria.

H. Approved Manufacturers: B-line, GS Metals, Chatsworth.

2.9 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS

A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8' AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings

B. Acceptable options for plywood boards are:
1. ¾" AC Grade fire rated plywood painted with two coats of fire-retardant paint in both sides and on the edges.
2. Pre-manufactured plywood system for telecommunications such as Ready Spec by Pathways and Spaces Inc.

C. Other specifications:
1. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted.
2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."
3. The paint shall be grey, white or blue.
4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire-Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
5. Plywood shall be installed with best side out.

2.10 THROUGH WALL FITTING FIRE STOP SYSTEM

A. General. These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.

B. Classification and use: 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. 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 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m3). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.

C. Materials:
   1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
   2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375º 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.
   3. Adjustable doors: the fire stop device shall have doors or other system 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.
   4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield
   5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.

D. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size emt conduit.

E. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.

F. Design selection: Wiremold FlameStopper, STI EZpath or approved equal

2.11 INNERDUCT (REGULAR)

A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.

B. For plenum rated applications, the specifications of the innerduct shall be:
   1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
   2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
   3. Marking: Footage shall be sequentially marked.
   4. Configuration: corrugated type.
   5. Pull line: built in 900 lb rated tape.
   6. Size: Shall be available in ¾” through 2” diameters.

C. For riser rated applications, the specifications of the innerduct shall be:
   1. Material: Orange polyvinyl chloride (PVC).
   2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
   3. Marking: Footage shall be sequentially marked.

4. Configuration: corrugated type.
5. Pull line: built in 900 lb rated tape.
6. Size: Shall be available in ¾" through 2" diameters.

D. For outdoor applications, the specifications of the innerduct shall be:
1. Material: High Density Polyethylene (HDPE).
2. Listing: None.
3. Marking: Footage shall be sequentially marked.
4. Configuration: corrugated type.
5. Pull line: built in 1,800 lb rated tape.
6. Size: Shall be available in ¾" through 2" diameters.

E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.

F. Design selection: products by Carlon or approved equal.

2.12 INNERDUCT (FABRIC TYPE)

A. When indicated in the design drawings, high capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type Innerduct (also referenced as textile innerduct) shall have the following specifications:
1. Material: White Polyester and Nylon resin polymer
2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
4. Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.

B. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.

C. Design selection: Products manufacturer by The Maxcell Group or approved equal. Approved equal shall be only of the fabric type innerduct.

2.13 DETECTABLE TAPE

A. A detectable tape shall be installed above all underground conduit at a minimum depth of 18" or as shown on the drawings. The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and 3" wide. The detectable warning shall have printed diagonal warning stripes conform to APWA color

recommendations and bold, black legends identify what type of utility line is buried below. All detectable tapes used for this shall be labeled “fiber optics buried below”.

B. Design selection: Detectable tape from Carlon, Stranco, Ind., Terra Tape or approved equal.

2.14 COMMUNICATIONS VAULT (POLYMER CONCRETE)

A. In ground communication boxes also referenced in this document as communications vaults (polymer concrete) shall have the following specifications:
   1. Construction Material: Precast Polymer Concrete.
   2. Listing: UL listed enclosure, tested to ANSI/SCTE 77
   3. Box vertical design load: 22,500 lbs.
   4. Box vertical test load: 33,750 lbs.
   5. Box lateral design load: 800 lbs/sq. ft.
   6. Box lateral test load: 1,200 lbs/sq. ft.
   7. Box dimensions: as indicated in design drawings.
   8. Box bottom: open bottom
   9. Holes for conduit: holes for conduit shall be cut at the factory and shall not cover more than 25% of the side of the enclosure. All sides of the box shall have holes for conduits, even though conduits might not be shown for all sides in the floor plans. No less than two holes for standard 4” conduit shall be at all sides. All unused holes shall be plug with plastic caps.
   10. Cover ANSI TIER: 22
   11. Cover logo: “Communications”
   12. Cover screws: two (2) tamper resistant penta head screws
   13. Cover accessories: two (2) 7” long cover hooks made of electroplated steel.

B. Design selection: Hubell Quazite PG style box with HH series cover and accessories or approved equal. Approved equals shall comply with all specifications listed above including construction material.

2.15 CONDUIT WATERFALLS

A. All 4" EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7” shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4" radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.

B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4” conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.

C. Basis of design: Panduit CWF 400 or approved equal.

2.16 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)

A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
   1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include wall/slab type (masonary, drywall, etc), hour rating, and accessibility type.

B. Acceptable systems: caulk-based products or firestop grommets by STI or equal.

2.17 EXPANSION FITTINGS

A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.

B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.

C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. See additional requirements indicated in part 3 of specification section 270010.

3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE

A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90-degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit

B. MAXIMUM DISTANCE BETWEEN JBOXES. For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90-degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer than six hundred (600) ft. or contain more than two 90-degree bends between pull points or pull boxes are required.

C. LABELING. All indoor conduits 2” or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2” or larger penetrating just one wall is not required to be labeled.

D. PULL STRINGS; All conduits for technology systems shall be installed with pull strings.

3.3 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

A. Description: Underground duct lines shall be of individual conduits. Conduits shall be encased in concrete where indicated on the plan drawings and duct bank sections. The conduit shall be of plastic, PVC Schedule 40, unless indicated or specified otherwise. The conduit used shall not be smaller than four (4) inches in diameter, inside, unless otherwise noted on the drawings.

B. Duct lines shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per foot. Changes in direction of runs exceeding a total of ten (10) degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty five (25) feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of forty eight (48) inches.

C. Conduits. Conduits shall terminate in end-bells where duct lines enter manholes or communications vaults. Provide four (4) to six (6) inch reducers as required. Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.

D. Conduit. Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6 1972.

E. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.

F. Excavation: Backfilling shall be in layers not more than eight (8) inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a four (4) inch ring. The

backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.

G. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.

H. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.

I. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.

J. Spacers: All conduit run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.

K. Minimum burial depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300 5 of the NEC except that the minimum cover for any conduit or duct bank shall be two (2) feet, unless otherwise indicated.

L. Directional boring. For all applications requiring directional boring the following installation practices shall be followed.
   1. The installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size and pipe quantities.
   2. When multiple pipes are run, each pipe shall be a different color.
   3. Any pipe run less than 1,500 ft, shall be run as a single pull without splices.
   4. Any splices done to HDPE pipes shall be done with manufacturer's approved methods.

3.4 INSTALLATION OF COMMUNICATIONS VAULTS

A. Excavating and backfilling for vaults. Perform earthwork as specified in Division 2. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.

B. Installing vaults and risers. Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

C. Waterproofing. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.5 CUTTING AND PATCHING

A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.

B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.

C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.

D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

3.6 IDENTIFICATION OF BOXES

A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

3.7 BLANK PLATES

A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

3.8 RACEWAY INSTALLATION

A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduits and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. HANGER INSTALLATION. Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one-hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

C. NON-CONTINUOUS CABLE SUPPORTS INSTALLATION. When j-hooks are allowed in the project by this specification (See USE OF CONDUIT FOR DIFFERENT SYSTEMS) non-continuous cable supports (j-hooks) shall be installed only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no longer than 4'. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.

D. FIRE STOPPING: For 4" sleeves, the PS-SCS installer shall provide through wall fittings firestop system and for other smaller sleeves or wall penetrations through fire rated partitions the PS-SCS installer can use the same type of firestop system, or a fire stop system for small penetrations in compliance with products described in part 2 of this specification.

E. PENETRATIONS IN FIRE RATED PARTITIONS. Installation of electrical boxes or equipment backboxes in fire-rate walls and smoke barriers shall follow the following requirements:
   1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls if all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
   2. As a summary, some of the requirements indicated by the codes listed above are:
      a. Boxes shall be metallic or listed for that purpose
      b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
      c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
      d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
   3. Electrical boxes or technology systems backboxes shall not be installed in a 3- or 4-hour fire rated walls.

F. ROUTING: Conduits shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.

G. PROTECTION DURING CONSTRUCTION. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in

and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.

H. PROTECTIVE BUSHINGS: All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.

I. AVOIDING EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; one (1) foot (0.3 meter) from conduit and cables used for electrical-power distribution; and five (5) inches (12 centimeters) from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The Installer shall not place any raceway alongside power lines

J. COORDINATION. All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

K. MASONARY INSTALLATION. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

L. USE OF CONDUIT IN DIFFERENT AREAS. When low voltage cables (any technology system) have to be run above ground in a space with no type of accessible ceiling (interior or exterior), all cable runs shall be in conduit completely, continuing the raceways all the way to the nearest accessible ceiling (in the direction of the telecom closet) or grouping the raceways into a single larger diameter conduit with the same or larger cross sectional area than the sum of all the conduits coming into it. The use of j-hooks to support low voltage cables in areas with no ceiling or inaccessible ceiling (e.g. hard ceilings) shall not be allowed. This type of condition is usually not indicated in the drawings because design drawings don’t show conduits smaller than 2”, nevertheless it shall be provided as indicated herein.

M. USE OF CONDUIT FOR DIFFERENT SYSTEMS: The following paragraphs indicate the design intent for raceways system for all technology systems.
   1. For all systems under division 27: Conduit stub up from the outlet to the nearest cable tray or telecommunications room.
   2. For all systems under Division 28 with the exception of Fire Alarm and Security Voice Communication system: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to to the telecommunications room.
   3. Non-continuous support systems (J-hooks) are not allowed in this project as a horizontal support system for cables above ceilings. J-hooks shall not replace the cable tray system shown in the drawings.

3.9 CABLE TRAY INSTALLATION

A. Inspection: Examine area for clearances, to allow proper installation of the tray according to the routing indicated on the drawings. Check building steel and other

supporting structures to establish the type of tray hangers to be used and at the proper spans.

B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines

C. Support: Cable tray support shall be by means of welded angle brackets to structural components, brackets shall be manufactured by the Cable tray manufacturer. Complete straight section of cable tray shall have at least 1 support at a ¼ of the length of the section. Additional supports are required at tray ends, offsets, bends and changes of elevation.

D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a grounded in accordance with the National Electric Code.

E. Coordination: Wherever possible, install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of 150 mm (6 in) access headroom shall be provided and maintained at both sides (one side if tray is supported at the wall. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least 75mm (3 in) of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

3.10 RUNWAY CABLE TRAY SYSTEM INSTALLATION

A. General. Runway cable tray system shall be installed following manufacturer’s recommendations for installation.

B. Support locations: supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:
1. Before each 90 deg turn.
2. No continuous section shall have more than 3ft of span without a support.
3. At each 2-post rack or 4-post rack
4. At each change in elevation

C. Support type. When runway cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze-style support brackets shall only be used when no other method of support is possible. Center hung support systems shall never be used.

D. Vertical runways. Runway cable tray system shall be installed continuously vertically in all telecommunications rooms in the project from sleeves coming from the ground (or floor below) to the sleeves going to the floor above, whether or not indicated in the

drawings. The runway installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above don't line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway cable trays installed vertically shall have supports to the floor, wall and slab above.

E. Cable dropout. At each rack or cabinet that has runway cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than 4".

F. Bonding. Any two continuous sections of runway cable tray system shall be bonded together with a #1 bonding jumper (600A) 15" long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish

G. Protective end caps. All end sections of runway cable tray sections shall be protected with plastic protective end caps.

3.11 INSTALLATION OF INNERDUCT

A. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.

B. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than 4 ft.

C. When multiple inner duct are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical taped wrapped on the ends to identify them at the end of each conduit.

3.12 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 270010 for as built documents and close out information these requirements.

END OF SECTION 270528

271000 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.

B. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568D SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.

C. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc.) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.

D. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.

E. WAP installation. The scope of work includes the installation of the Wireless Access Points (WAPs) provided by the owner. The scope includes the labor and installation materials (supports, anchors, etc.) to properly fasten the WAPs to the structure.

1.2 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

SECTION	TITLE
270010	TECHNOLOGY GENERAL PROVISIONS
270528	RACEWAYS FOR TECHNOLOGY

270526	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

C. Owner standards: Comply with the document “Requirements for all Communication Cabling at Clients name” prepared by the Clients applicable office.

D. Standards: All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
   1. ANSI/TIA-568.0-D “Generic Telecommunications Cabling for Customer Premises” with addendums and errata.
   2. ANSI/TIA-568.1-D, “Commercial Building Telecommunications Cabling Standard” with addendums and errata.
   3. ANSI/TIA-568.2 - D, “Balanced Twisted- Pair Cabling Components Standard” with addendums and errata.
   4. ANSI/TIA-568.3-D, “Optical Fiber Cabling Component Standard” with addendums and errata.
   5. ANSI/TIA-569-D, “Telecommunications Pathways and Spaces” with addendums and errata.
   6. ANSI/TIA-606-C, “Administration Standard for Telecommunications Infrastructure” with addendum and errata.
   7. ANSI/TIA-607-D, “Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises” with addendum and errata.
   8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
   9. ANSI/TIA 758-B, “ Customer-Owned Outside Plant Telecommunications Infrastructure Standard” with addendum and errata
   10. ANSI/TIA 862-B, “Structured Cabling Infrastructure Standard for Intelligent Building Systems” with addendum and errata.
   11. ANSI/TIA-1152-A, “Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling” with addendum and errata.
   12. ANSI/TIA-526-7-A, “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
   13. ANSI/TIA-526-14-C, “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
   14. TIA-598-D, Optical Fiber Cable color coding.
   15. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments. “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”
   16. ANSI/TIA-942-B , “Telecommunications Infrastructure Standard for Data Centers” with addendum and errata
   17. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
   18. ANSI/NFPA 70 “National Electrical Code”, CSA C22.1.
   19. BICSI Telecommunications Distribution Methods Manual (TDMM)
   20. BICSI Telecommunications Cabling Installation Manual (TCIM)
   21. BICSI Customer Owned Outside Plant Manual (COOPM)
   22. Local County/City Codes, Ordinances and Regulations.
   23. Underwriters Laboratories (UL)
   24. FCC -Federal Communications Commission
   25. ADA Requirements
   26. Occupational Safety and Health Regulations (OSHA)
   27. National Fire Protection Association (NFPA)
   28. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards

29. Manufacturers Product Cabling Catalogs
30. Manufacturers Training Manuals (Design and Installation).

E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.

B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.

C. Certification: The SCS installer's Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.

D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD's shall not be acceptable.

E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.

F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 270010.

B. Substitutions are only allowed for the SCS when the substitutions do not change the warranty of the SCS system as indicated in this specification section.

1.5 SHOP DRAWINGS AND SUBMITTALS.

A. See additional requirements for shop drawings and submittals in specification section 270010.

B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
   1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
   2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes cable certifiers, OTDRs, fiber splicers, etc.
   3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
   4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
   5. A copy of a current and valid Low voltage License for the State of Florida.
   6. Location of office from which installation and warranty work will be performed.

C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
   1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
   2. Faceplate color selection.
   3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
   4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
      a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
      b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
      c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
      d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length and connector termination on each side.

D. Construction submittals received before proposal submittals are received or approved will be rejected.

1.6 ABBREVIATIONS

A. General: The following abbreviations are used in this specification section:
1. A&E - Architect and Engineer. The Architect is the legal entity that holds a contract for the design of the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
2. APC - Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
3. Array connector - a multi-strand fiber connector user for high density applications, such as the MPO connector
4. BICSI - Building Industry Consultant Services International
5. CCTV - Close circuit television system (surveillance video system)
6. FCC - Federal Communications Commission.
7. FTP - Foiled Twisted pair. One foiled screen around each cable pair.
8. IDC - Insulation Displacement Connector
9. NEC - National Electrical Code.®
10. NEMA - National Electrical Manufacturers Association.
11. OS1 - ISO 11801 designation for single mode 9/125µm glass fiber optics.
12. OS2 - ISO 11801 designation for single mode 9/125µm glass fiber optic with performance criteria identical to ITU-T G652.
13. OTDR - Optical Time Domain Reflectometer.
14. RU - Rack units. Height dimensions for rack mounted equipment. 1 RU equivalent to 1.75”.
15. SCS - Structured Cabling System
16. TIA - Telecommunications Industry Association.
17. TR - Telecommunications Room.
18. UPC - Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
19. UTP - Unshielded twisted Pair
20. UV - Ultraviolet
21. VAC - Volts alternating current.

PART 2 - PRODUCTS

2.1 MODULAR SCS JACKS

A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
1. Electrical Specifications:
a. Insulation resistance: 500 MΩ minimum.
b. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.

c. Contact resistance: 20 M Ω maximum.
d. Current rating: 1.5 A at 68 º F (20 º C) per IEC publication 512-3, Test 5b
e. ISO 9001 Certified Manufacturer
f. UL verified for EIA/TIA electrical performance
g. Comply with FCC Part 68
h. Cable termination: IDC type universal T568A or T568B.

2. Mechanical Performance:
a. Plug Insertion Life: 750 insertions
b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
d. Temperature Range: -40º to 150ºF (-40 º to 66 º C)

B. Design selection: modular SCS jacks shall be selected according to the following criteria:
1. Performance requirement: CAT6
2. Style: Rear loading
3. Mounting orientation: straight mounting
4. Color: To match faceplate
5. Dust cover required: No

C. Approved manufacturer: Ortronics, Panduit, Siemon, CommScope, Belden, Leviton or Hubbell.

2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminatable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:
1. General Specifications:
a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
b. Shall support cable gauges from 22 to 26 AWG
c. Shall include a rubber boot

2. Electrical Specifications:
a. ISO 9001 Certified Manufacturer
b. UL verified for ANSI/TIA electrical performance
c. Comply with FCC Part 68
d. Cable termination: IDC type universal T568B.

B. Design selection: modular SCS jacks shall be selected according to the following criteria:
1. Performance requirement: Match performance of Modular SCS jacks

C. Approved manufacturer: Match selection for modular SCS jacks.

2.3 OTHER MODULAR JACKS

A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are identified in the drawings, the following specifications shall be meet for modular jacks mounted in SCS outlets:
   1. Style, mounting orientation and color: match design selection for modular SCS jacks.
   2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω.
   3. Fiber optic connectors: use modular jack with adapter plate for LC
   4. For line level audio signals: use modular jack with RCA connector bulkhead. Use different color coded insulators for different audio channels.

B. Approved manufacturer: Match selection for modular SCS jacks.

2.4 FACEPLATES

A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:
   1. Construction material: High impact thermo Plastic
   2. Size: use single gang faceplates only unless specifically noted in the design drawings.
   3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
   4. Color: submit color to A&E for approval.
   5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
   6. Faceplate style: Direct modular plug rear loading style.

B. All faceplates shall have a tamper resistant cover to access the modular jacks

C. Approved manufacturer: Match selection for modular SCS jacks.

2.5 FACEPLATES WITH SUPPORT STUDS

A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:
   1. Construction material: Stainless Steel.
   2. Size: use single gang faceplate with two support studs.
   3. Capacity of modular jacks per faceplate: One.
   4. Faceplate style: Direct modular plug rear loading style.

B. Approved manufacturer: Match selection for modular SCS jacks.

2.6 SURFACE MOUNTED BOXES

A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:
   1. Construction material: High impact thermo Plastic.
   2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
   3. Color: White.
   4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers

B. Approved manufacturer: Match selection for modular SCS jacks.

2.7 MOUNTING FRAMES

A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.

B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.

C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture system, SCS installer shall provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.

D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.

E. All un-used ports in mounting frames shall be covered with blank inserts.

F. Approved manufacturer: Match selection for modular SCS jacks.

2.8 HORIZONTAL 4-PAIR CABLE

A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
   1. Cable Gauge: minimum 23 AWG

2. Performance standard: CAT6
3. Cable type: UTP
4. Performance characterized to: 600 MHz
5. Time delay skew: Maximum 45 ns/100m
6. Input impedance (1-100MHz): 100Ω
7. Cable diameter: ≤ 0.295 inch

B. Cable jacket colors for 4-pair horizontal cables shall be selected according to the following criteria:
1. Data cables: Blue
2. Wireless access points: Green
3. Surveillance cameras: Yellow

C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for EIA/TIA electrical performance and comply with FCC Part 68.

D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.

E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.

F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.

G. Approved manufacturer: Corning, Superior Essex, Belden, Panduit, Siemon, CommScope General Cable, or Berk-Tek.

2.9 PATCH PANELS FOR HORIZONTAL CABLING

A. All 4-pair horizontal cables shall be terminated in rack mounted path panel located in the telecommunication rooms rack. These patch panels shall have the following specifications.
1. Connector type: 8-position modular plug (RJ-45)
2. Cable termination: IDC type universal T568A or T568B.
3. Performance requirement: CAT6
4. Maximum connectors per path panel allowed: 48
5. Patch panel type: factory preloaded panels rear loaded panels
6. Patch panel shape: straight (flat)
7. Permanent marking: All connectors shall be labeled in sequential numbers
8. Field labels: patch panels shall have a space for field labels covered with transparent protectors.

B. Approved manufacturers. Match selection for modular SCS jacks

2.10 HORIZONTAL WIRE MANAGERS

A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specifications:
   1. Style: Finger duct style with hinged cover
   2. Sides: front of rack
   3. Minimum height: two RU

B. Approved manufacturers. Match selection for modular SCS jacks

2.11 FOUR (4) PAIR PATCH CORDS

A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:
   1. Connectors: 8-pin modular plugs at both ends
   2. Conductors: 4-pair stranded conductors.
   3. Wire gauge: 23AWG for patch cords in the field site and 28 AWG for patch cords in the telecom room side
   4. Wiring map: See section 3 of this specification
   5. Performance requirement: To match horizontal 4-pair cable performance
   6. Cable type: match horizontal cable selection

B. Approved manufacturers. Match selection for modular SCS jacks

2.12 SINGLE STRAND FIBER OPTICS CONNECTORS

A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA 604 series. Single strand fiber optic connectors shall have the following specification:
   1. Physical contact type: use UPC type connector for all application with the exception of applications of Broadband TV distribution systems or DAS systems. For those applications use APC type connectors.
   2. Connector type: LC
   3. Security level: non-keyed connector keyed connector
   4. Pairing style: duplex
   5. Acceptable connector attachment types:
      a. Epoxy type connectors, field polished
      b. Epoxyless (Crimp) type connector, field polished.
      c. Splice on connectors. Fusion spliced connectors with factory polished finish.
      d. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.

6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.
8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.

B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.

C. Single strand multimode fiber optic connectors shall have the following performance requirements:
1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer's recommended procedure.
3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90º angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.

D. Single strand single mode fiber optic connectors shall have the following performance requirements:
1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90º angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
5. Connectors shall meet the following performance criteria:

Test	Procedure	Maximum Attenuation Change (dB)
Cable Retention	FOTP-6	0.2 dB
Durability	FOTP-21	0.2 dB
Impact	FOTP-2	0.2 dB
Thermal Shock	FOTP-3	0.2 dB
Humidity	FOTP-5	0.2 dB

E. Approved manufacturers. Ortronics, Corning, Belden, Panduit, Siemon, Leviton, CommScope or 3M

2.13 FIBER OPTICS SPLICES

A. When fiber splicing is required in the project because of the use of pigtails or field splicing, only fusion splicing will be acceptable. Mechanical splices shall not be used unless specifically indicated in the contract documents.

B. All fiber splices shall be terminated with heat shrink sleeves and organized in splice trays. Splice trays sizes shall be selected to match the quantity of fiber strands in the cable bundles. Splice trays shall be organized in Fiber Optics Distribution Centers when inside a telecom room or in outdoor rated splice closures when done outdoors.

C. Fusion splice equipment to be used in this project shall have the following specifications:
   1. Alignment system: Automatic Core Detection system (ACD). V-groove splicers are not allowed.
   2. Typical splice loss for single mode fibers: 0.02 dB
   3. Splice loss result: Estimated (ACD)
   4. Unit shall have a fast heat shrink oven, maintenance free electrodes, built in cleaver and graphical user interface to display alignment condition.
   5. Cleaver blade type: diamond.

2.14 INSIDE PREMISE FIBER OPTICS HORIZONTAL CABLES

A. Telecommunications outlets could have fiber optic terminations. Whenever design drawings indicate fiber optic terminations, inside premise fiber optic horizontal cables shall be used. The following are the specifications for fiber optic horizontal cables:
   1. Strand Count: as indicated in design drawings
   2. Fiber type: OS1/OS2 as indicated in design drawings
   3. Fiber coating: 900µm coating color coded
   4. Fiber protection: aramid yarn
   5. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
   6. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated. Rating shall be printed in the cable jacket.

C. OSP Jackets: All fiber optic horizontal cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable with this application.

D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.15 INSIDE PREMISE FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate fiber optics backbone cables to be run inside premises, the following specification shall be followed for those cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable.
   4. Fiber protection: aramid yarn around all strands for cables under 24 strands, and aramid yarn and jacket around each subunit (6 or 12 strands) for cables above 24 strands.
   5. Interlock requirement: Interlock aluminum armor is required is not required
   6. Jacket type: Flame-retardant PVC jacket or materials with superior performance.
   7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
   8. Fiber termination: fibers shall be field terminated.
   9. Buffer type: tight buffer required.
   10. Center strength member material: dielectric material

B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

C. Approved manufacturers: Match selection for horizontal 4-pair cable

2.16 OUTSIDE PLANT FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate fiber optics backbone cables to be run between building or outside premises, the following specification shall be followed for those cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 250µm coating protected with break-out kits with color coded 900µm buffers at both ends of the cable when cables are terminated in conditioned spaces. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
   4. Rodent protection requirement: required
   5. Buffer type: Loose tube.
   6. Center strength member material: dielectric material

B. Jacket: All outside plant fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
   1. ANSI/TIA-568-C

2. Telcordia GR-20
3. ANSI/ICEA S-87-640

C. Approved manufacturers. Match selection for horizontal 4-pair cable.

2.17 INDOOR/OUTDOOR FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate indoor/outdoor fiber optics backbone cables to be run between buildings or outside premises, the following specification shall be followed for those cables:
1. Strand Count: As indicated in design drawings
2. Fiber type: As indicated in design drawings
3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
4. Rodent protection requirement: required
5. Buffer type: tight buffer required loose buffer acceptable.
6. Center strength member material: dielectric material

B. Jacket: All indoor/outdoor fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
1. ANSI/TIA-568-C
2. Telcordia GR-409
3. ANSI/ICEA S-104-696

C. Jacket: Cable jackets for indoor/outdoor fiber optic cables shall also comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.18 FIBER OPTIC DISTRIBUTION CENTERS

A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:
1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only

when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.

2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
3. Front locking doors are required.
4. Locking door shall be transparent doors and shall have labeling cards.
5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.

B. These are the specifications of the snap-on adapters for the FODC:
1. Style: plate style
2. Connector type: LC to match fiber types of fiber optic cables
3. Maximum fiber strands allowed per adapter: 24
4. Security level: non-keyed connector keyed connector
5. Pairing style: duplex

C. Approved manufacturers. Match selection for fiber optic connectors

2.19 FIBER OPTICS PATCH CORDS

A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.

B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:
1. Strand Count: 2 strands
2. Fiber type: Match fiber type of backbone cable or horizontal cable.
3. Fiber connector in FODC or outlet side: match connector for each adapter
4. Fiber connector in active equipment side: the SCS installer shall coordinate with supplier of equipment the type of connector required in this side.
5. Fiber protection: aramid yarn
6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

C. Approved manufacturers. Match selection for fiber optic connectors

2.20 EQUIPMENT CABINETS

A. Whenever indicated in the design drawings equipment cabinets shall be provided as shown. Equipment cabinets shall be made of all welded steel frames and shall have a powder coat finish. Equipment cabinets shall have the following specifications:
1. Cabinet construction material: Welded and bolted steel frame.
2. Footprint: As indicated in design drawings

3. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
4. Rack rails type: standards EIA 19” square holes with cage nut rail located in the front and back of cabinet. Rack rails shall be adjustable for depth and shall have RU marked and labeled.
5. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
6. Side panels (end of row cabinet sides): solid steel, removable and lockable side panels.
7. Side panels (between adjacent cabinets): solid steel, removable panels with openings for passing cables, covered with plastic removable caps, rubber caps or brush openings. No less than Eight (8) openings in total area of the side of the cabinet. Each opening shall be no less than 34 sq inches.
8. Top panel: solid steel with no less than four (4) brush protected openings for cables. Each opening shall be no less than 34 sq inches.
9. Bottom panel: solid steel with no less than two (2) brush protected openings for cables. Each opening shall be no less than 34 sq inches. For cabinets with top exhaust duct, a bottom air director shall be provided in the back side of the cabinets to force air up towards the exhaust duct.
10. Door hinge supports shall be provided at both sides of the racks and front and back to be able to reverse doors.
11. Grounding: Prepared location for ground lug at the top and bottom of the cabinet frame. Door shall include bonding jumper to cabinet.
12. Weight capacity: UL listed for 2500 lb
13. Finish: Epoxy-polyester hybrid powder coat paint on frame, rails, panels and metal accessories:
14. Finish color: Black for all parts of the cabinet

B. Equipment cabinets shall be provided with the following accessories:
   1. Front 78% perforated panel hinged door with key lock.
   2. Rear 78% perforated panel solid split hinged doors with lock.
   3. Locking system: locks for front and rear doors shall be two point latching locks and shall be keyed identically for front and rear lock. All locks for cabinets for each user ground shall be keyed alike but different between user groups.
   4. Leveling feet and any accessories required to be able to bolt the cabinet to the floor with ½” screws or rods. Four (4) casters are required.
   5. Vertical wire managers covering the full height of the rack rails. Two in the front. Vertical wire managers shall be selected as recommended by equipment cabinet manufacturer to avoid obstructions to rack rails or doors. Vertical wire managers shall have brush openings to run cables between front and back of cabinet and shall have all openings sealed to avoid air leakage between front and back.
   6. Steel top exhaust duct, made of two separate sections to allow adjusting the height. Installer shall confirm final ceiling height in the room and order these ducts in a length as to provide adjustment for no less than 2” above and below of the final ceiling height. Top exhaust section shall have a rubber gasket to allow for good seal in ceiling imperfections.
   7. Filler panels: For all racks with SCS installer provided equipment, all un-used rack spaces shall be covered with filler panels to avoid any air flow between front and back of cabinet. For all racks with owner provided equipment, the installer shall provide no less than 50% of all rack spaces in all racks with filler panels to prevent air flow between front and back of cabinet. All cabinets with no

equipment installed at the end of the project shall have the front door wrapped with plastic wrap to prevent any air flow through the cabinet.

8. Air dam: The cabinet shall be provided with an air dam blocks airflow around the sides and top of the equipment mounting space, so cold air passes through equipment and hot air does not re-circulate around equipment. Any other additional type of seal required to prevent air flow from the front of the cabinet to the back shall be provided.
9. PDU bracket: PDU brackets shall be provided in each cabinet according to the number of vertical PDUs programmed to be installed in each cabinet. See drawings for quantities. These brackets shall be selected by the SCS installer as to match the support holes of the PDU selection for each cabinet.
10. All cabinets with equipment installed with substantial amount of cables terminating in the rear of the equipment, such as audio/visual systems and security systems shall be provided with enough cable lashing metal brackets to strap all cables to the frame for proper organization and support.
11. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8” thick and 1” wide with threated holes 1032 mounted to the cabinet using nylon insulation washers

C. Required equipment cabinet certifications: Complaint with EIA 310-E and UL 2416 listed

D. Airflow re-director: The manufacturer of the equipment cabinet shall offer an air flow re-director kit for the type of cabinet selected for this project to allow for changing air flow direction of equipment designed for side to side ventilation. The SCS installer shall provide air flow re director kits for all cabinets in the plans with Core switches or network equipment.

E. Field cuts or openings. Any cabinets with field cuts or perforations will be rejected and the SCS installer shall provide a new cabinet to remedy the condition.

F. Approved manufacturer: Panduit, Ortronics, Eaton, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.21 QUAD POST RACKS

A. Whenever indicated in the design drawings quad post racks shall be provided as shown. Quad post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Quad post racks shall have the following specifications:

1. Depth adjustment: rack rails shall be adjustable from 12.5” to 36” in depth, independent of the structural members allowing racks rails adjustment after racks are anchored.
2. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
3. Rack rails type: standards EIA 19” square holes located in the front and back of rack. Rack rails shall have RU marked and labeled.
4. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
5. Weight capacity: UL listed for 1200 lb or more.

B. Quad post racks shall be provided with the following accessories:
   1. Base dust covers that prevent accumulation of dust and debris in rack base.
   2. Cable runway mounting brackets to support cable runway installed above racks
   3. Isolation pads.
   4. Grounding kit.
   5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
   6. End panels to support vertical wire managers at the end of each rack row.

C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager (front only).
   3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager (rear only).
   3. Capacity: Usable cross sectional area shall be a minimum of: 130 sq-in
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

E. Approved manufacturer: Match selection for Equipment Cabinets [Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal].

2.22 CABLE TIES

A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when j-hooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers including managers behind patch panels, to bundle cables, organize patch cords, etc.

B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
   1. Hook and loop style, re-usable with Velcro no smaller than 0.5” width.
   2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5” width
   3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85”.

C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:

1. Outside plant fiber and copper backbone cables.
2. Inside premise fiber optic backbone cables with interlock armors.
3. Grounding conductors

D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.

E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.

F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.

G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.

H. Approved manufactures: Ortronics, Panduit or approved equal

2.23 IDENTIFICATION AND LABELING TAGS

A. SCS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

A. GENERAL. All installation requirements indicated in specification section 270010 shall be followed.

B. WORKMANSHIP. All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.

C. CABLE LENGTHS. It is the SCS installer's responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.

D. WIRE MAPPING. All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568B standard.

E. FIBER OPTICS TERMINATION POLARITY. All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.

F. POLARITY FOR FIBER OPTICS ARRAY CONNECTORS. Array connectors and cassettes for this project shall use Method C polarity system as outline in TIA-568.B.1

G. LOCATION OF HORIZONTAL TERMINATIONS. In a multi-story facility with telecommunications room in every floor, all horizontal drops, whether terminated in the wall or in floor boxes shall be terminated in the same floor telecommunications room as the location of the final outlet.

H. CABLE BUNDLES. In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR's and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.

I. CLIC FASTENERS: Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR's on the plywood area where ladder tray or rack management is not available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.

J. FIRE STOP PROTECTION: Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.

K. NEW MATERIALS: All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.

L. DAMAGE: The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.

M. AVODING EMI: To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

N. WORK EXTERNAL TO THE BUILDING: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.

O. DEMOLITION. Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
   1. Coordination: Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
   2. Provisions: All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
   3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.
   4. Owners Salvage: The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
   5. Phasing: The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.

P. ICONS. Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the faceplate. Icons for path panels shall match the color of the horizontal cabling.

Q. BLANK INSERTS AND PANELS. All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.

R. PATCH PANEL AND FODC SEPARATION: Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:
   1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
   2. Cables for surveillance cameras shall be separated from cables for any other purpose.
   3. Cables for voice drops shall be separated from cables for data drops.
   4. Cables for any other specialty systems like security systems, nurse call systems or others shall all be terminated in separate patch panels from any other cables.
   5. Horizontal fiber optic cables shall be terminated in separate FODC from fiber optics backbone cables.
   6. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.

S. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief.

At a minimum one rear support bars shall be provided for each two rows of 24 connectors.

T. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:
1. At least one above and below each straight (flat) patch panel.
2. At least one top and bottom of each series of angled or curved patch panels.
3. At least one above and below any network switches.
4. At least one below any rack mounted termination block.

U. CROSS OVER WIRE MANAGERS. Cross over wire managers shall always be used with angled or curved patch panels. One cross over wire manager shall always be installed in the middle of each rack at the same height on every rack.

V. PATCH CORD QUANTITY, COLOR AND LENGTHS. Copper and fiber optics patch cords shall be provided per following chart. All percentage calculations shall be rounded off to the nearest integer number.

TYPE	QTY	COLOR JACKET	LEGTH
4-pair at work area outlet	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket	30% 8', 50% 10' and 20% 14'
4-pair at WAP location	One for 100% of all 4-pair horizontal cables for WAPS in the project + 10% spare	Match horizontal cable color jacket	The SCS installer shall field verify all lengths to match location of WAPS selected by owner or wireless survey. For pricing purposes use 12'
4-pair at Surveillance camera	One for 100% of all 4-pair horizontal cables for cameras in the project +10%	Match horizontal cable color jacket	The SCS installer shall field verify all lengths to match location of cameras. For pricing purposes use 12'
4-pair at patch panel side (excluding surveillance cameras and WAPS)	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket .	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
4-pair at patch panel side (surveillance cameras and WAPS)	One for 100% of all 4-pair horizontal cables in the project +10%	Match horizontal cable color jacket .	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
2-strand fiber optics at work area outlet	One for 100% of all 2-strand horizontal fiber cables in the project + 10% spare	Per fiber type	50% 8' and 50% 10'
2-strand fiber optics at FODC.	One for 100% of all horizontal 2-strand fiber cables and one for 83% of all fiber strands of backbone cables in the project. For example a 24	Per fiber type	For pricing purposes use: 20% 6', 60% 10'. 20% 14' SCS installer shall field verify these percentages to provide more accuracy.

	strand cable shall require 20-2-strand patch cords or 10 for each side of the cable		
One or two pair for copper backbone cross connects	One for 90% of all backbone copper pairs installed in the project.	Gray	For pricing purposes use: 80% 8', 20% 10'. SCS installer shall field verify these percentages to provide more accuracy.

W. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:
1. At each work area outlets, all horizontal cables shall have 12" of slack.
2. At the telecom room side all horizontal cables shall have at least 6' neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
3. Backbone cables at termination points shall have at least 15' of slack neatly organized on the wall using a standard loop and Velcro straps.
4. Outside plant backbone cables run through in-ground pull boxes greater than 24"X24" shall include one service loop inside the box.

X. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no recommendation is specified by cable manufacturer, at least the following criteria shall be meet:
1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
3. The bend radius for interbuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).

Y. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:
1. Inside underground conduits as indicated in design drawings.
2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays or vertical conduit sleeves. This requirement is usually not indicated in the drawings but indicated only in this specification.

3. For backbone fiber optic cable in vertical risers

Z. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction. Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.

AA. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 270526.

BB. RACK INSTALATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.

CC. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526

3.2 IDENTIFICATION AND TAGGING

A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:
   1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
   2. All faceplates indicating all jacks terminated in the faceplate.
   3. All patch panels.
   4. All racks
   5. All termination blocks
   6. All telecommunication rooms and outdoor enclosures.
   7. All interbuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.

B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the TIA/EIA 606-C standard.

3.3 TESTING OF COPPER CABLING

A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C, Cabling Transmission Performance and Test Requirements.

B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.

C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.

D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.

E. General: The installer's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.

F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100% Level III compliant with ANSI/EIA/TIA 568C specifications for testing of the CAT6 cabling. No tester will be approved without meeting these requirements.

G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence. Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.

H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the EIA/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.

I. Any Fail, Fail*, Pass* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.

J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6 permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.

K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtails or special harness could be required to properly test these cables.

L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.

M. All 4-pair patch cords shall be factory tested only.

3.4 TESTING OF FIBER OPTICS CABLING

A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C and the addendum for fiber optic testing.

B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.

C. Cleanness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleanness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleanness of the randomly selected connectors by the A&E.

D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with EIA/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with TIA/EIA-526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90 meters, each tested span must test to a value less than or equal to the value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)

ATTENUATION DUE TO	FIBER TYPE	MAX. ATTENUATION
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre-term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:
   1. Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
   2. Reflective events (connections) shall not exceed:
      a. 0.75 dB in optical loss when bi-directionally averaged
      b. -35 dB Reflectance for multimode connections
      c. -40 dB reflectance for UPC singlemode connections
      d. -55 dB reflectance for APC singlemode connections
   3. Non-reflective events (splices) shall not exceed 0.3 dB.
   4. Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.
   5. Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the unexplained events are located to demonstrate cable has not been kinked or damaged during installation.

F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:
   1. Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
   2. Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
   3. Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
   4. Use launch compensation mode during the test to subtract the effects of the launch and tail cables.
   5. Test from one direction only, unless the presence of “gainers” are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
   6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.

G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm ±10 nm 1300 nm +35 / -15 nm.	1310 nm ±25 nm. 1550 nm ±30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak < -40 dB for mm and < -50 dB for sm.	850 nm: 0.5 [3.7] m typical 1300 nm: 0.7 [3.5] m typical	1310 nm: 0.6 [3.5] m typical 1550 nm: 0.6 [3.5] m typical
Attenuation Dead Zone. Measured at ± 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak < -40 dB for mm. and < -50 dB for sm.	850 nm: 2.2 [10] m typical 1300 nm: 4.5 [13] m typical	1310 nm: 3.6 [10] m typical 1550 nm: 3.7 [12] m typical
Pulse Widths	850 nm: 3, 5, 20, 40,	3, 10, 30, 100, 300, 1000,

(nominal)	200 ns. 1300 nm: 3, 5, 20, 40, 200, 1000 ns.	3000, 10000, 20000 ns
Loss Threshold Setting	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments

H. The Test Report for each fiber strand shall include the following information:
1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
2. Cable/strand ID matching shop drawings labeling system.
3. Name of technicians who performed the test.
4. Date and time the test was performed.
5. Measurement direction (from/to)
6. Jumper reference set up date/time and attenuation value
7. Equipment model and serial number used and calibration date.
8. End to End Attenuation Loss Data for each optical fiber link
9. OTDR Traces, one page per strand. Expand chart to cover most of the page
10. Each event loss data and test limits used, including test limit file date used.

I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

3.5 SYSTEMS WARRANTY AND SERVICE

A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.

B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.

C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.

D. Additional features of the warranty shall include:
1. That the SCS installed system complies with the margin claimed by the manufacturer above the Category 6 channel specifications on all transmission

parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

3.6 SPARE PARTS

A. As part of this contract the SCS installer shall provide the following spare parts.
   1. Ten (10) modular SCS jacks.
   2. Five (5) faceplates
   3. Two (2) faceplates with support post.
   4. Ten (10) fiber optic connector of each type used in the project.

B. As part of this contract the SCS installer shall provide the following tools:
   1. Two (2) modular SCS jacks termination tools when modular SCS jacks required a manufacturer specific tool.
   2. One (1) punch down tool with a 110 blade and one 66 blade.
   3. One electric (1) cable finder.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 270010.

B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

3.8 TRAINING AND INSTRUCTION

A. Training shall only be done after all testing, identification process have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.

B. SCS Installer shall follow all training requirements indicated in specification section 270010

C. The training for the SCS shall include the following topics:
   1. Detail explanation of the identification system.
   2. A walkthrough of all spaces and locations where terminations have been done in the project.

3.9 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

A. The SCS shall follow all requirements for as-build and close out documents indicated in specification section 270010

B. The following are additional requirements supplementing the information provided in specification section 270010:

1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be re-usable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:
    a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
    b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.

END OF SECTION 271000

SECTION 274100 – AUDIO/VISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: The General Requirements, Conditions of the Contract, these Specifications, Drawings, Addenda and Contract Modifications (the Contract Documents), and definitions of legal entity (such as Contract, Installer, Engineer, Owner, etc…) shall apply to the work of this specification section.

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 270010 Technology General Provisions
   2. 270528 Raceways for Technology
   3. 271000 Structured Cabling System
   4. 270526 Grounding and Bonding for Communication Systems

1.2 SCOPE OF WORK (SOW)

A. General: Refer to the requirements of the related documents identified in Part 1.1 of this specification, for scope of work requirements, which are supplemented by this section. This shall constitute the basis for the “Scope of Work” for this specification.

B. System: The goal of the project is to provide a finished, complete audiovisual system with functionality, capacity, and operability, as described in the Contract Drawings and specifications herein. The finished, complete system shall serve as a vehicle for the transport of associated system signals from designated origination points to equipment interfaces and/or identified distribution points per the Contract Documents. The scope of work for the AVS installer shall include, but not limited to the following tasks:
   1. Preparation of shop drawings, submittals, training and as-built information for the system.
   2. Procurement, installation and warranty of all AVS hardware including projectors, flat panel displays, mounts for displays, signal transceivers, players, switchers, servers, etc.
   3. Procurement, installation and warranty of all AVS cabling and wiring, including support system, and fire stopping for all low voltage cabling part of the AVS.
   4. Programming labor of the AVS, including initial software set up, software registration, and initial data input, unless otherwise noted in this specification section.
   5. Attend project plan meetings with the Owner and the Consulting Engineer (A&E) to fine tune data interchange details, network configuration and other user requirements:
   6. Provide training and close out information as indicated in this specification.

C. It shall be understood by the AVS installers that this is an integrated system where multiple pieces of equipment from different manufacturers are required to be

connected/interfaced together to make the AVS operational. To allow for competitive bidding multiple manufacturers are listed in the specifications for many devices and software, but it is the sole responsibility of the AVS installers to verify that their particular equipment and software selection integrate and work seamlessly with other equipment and software from the pool of approved manufacturers. These specifications represent a design guideline and design intent but they are not intended to verify that all possible equipment and software listed in this specification work and integrate seamlessly with any equipment and software form the pool of acceptable manufacturers. Approval of submittals for the AVS by the A&E of the project does not relieve the responsibility for the AVS installers to deliver a working system. Any equipment changes required because of incompatibility between different devices of a particular system, even after the equipment has been approved by the A&E, shall be provided at no additional cost to the owner.

D. The following items are not part of this scope of work:
   1. Pathways for all Audio Visual Systems.
   2. Backing for displays indicated in the Audio Visual Systems.
   3. Power supporting the Audio Visual Systems Equipment.

E. The following is a list of rooms where Audio Visual system shall be provided:
   1. Refer to contract drawings.

1.3 INSTALLER QUALIFICATIONS

A. General: The qualifications and requirements herein apply to the specific technology identified by this specification section. Refer to the specification sections identified in Part 1.1 “Related Documents”, of this specification, for additional requirements, which are supplemented by this section.

B. Installer Qualifications: The Installer directly responsible for the work described in this specification section is also referenced as the AVS Installer. The Installer shall be a licensed and registered contractor who is, and who has been, regularly engaged in providing the installation of audiovisual systems of similar size and complexity for at least the immediate past five (5)-years.

C. Project manager requirements: The project manager for each company participating in the installation of the AVS shall be a Certified Technology Specialist (CTS) by Avixa. Proof of current certification shall be provided with the submittal

D. Programmer-Installer: The AVS Installer must have a factory-trained programmer/installer, for the Project products provided, in full-time employment, as part of their staff. The AVS installer needs to provide certificates of completion of training for the staff that will be taking part in the execution of this project

E. Qualification Documentation: The Installer shall provide the following documentation with their bid package, as evidence that the requirements for the Installer qualifications have been satisfied:
   1. A list of not less than five (5) references for jobs of similar size and complexity including:
      a. Project Names

b. Locations
c. Contact Names
d. Contact Telephone Numbers

2. Location (specific street address) of the office from which this installation and warranty work will be performed. It is preferred that the Installer has established and maintains a permanent office within 150 miles of the project site.
3. Copies of Manufacturer certification certificates. It is required that the Installer possess the following certifications, at a minimum:
   a. Crestron systems certified dealer, installer and programmer.
   b. AMX certified dealer, installer and programmer.
   c. Extron certified dealer, installer and programmer
   d. List all that apply
4. Copies of Licensure certificates.
5. Copies of Insurance and Bonding certificates.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 270010.

B. Specific equipment: When the design drawings indicate a brand and a model number for a piece of equipment as part of the audio-visual system, the AVS Installer needs to provide the same device as indicated. Substitutions for this type of equipment are not acceptable.

C. Non-specific equipment: When the design drawings do not indicate a brand and a model number for a piece of equipment as part of the audio visual system, the AVS installer is free to pick equipment that meets the minimum specifications indicated in this section. The AVS installer needs to submit the selected choice as part of the submittal process

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The AVS installer shall follow all requirements for shop drawings indicated in specification section 270010.

B. Project Start Submittals: A maximum of 60 days after the AVS installer receives a notice to proceed with the project, but no sooner than a year before substantial completion, the following information shall be submitted.
   1. Cut sheets with all specifications of every device, cables and connectors to be used in the project.
   2. One-line diagrams with all devices included in the systems. Each system in a different sheet.
   3. User interface and faceplate color submittal. The AVS installer shall prepare a separate submittal with the shape and color of all user interface plates to be approved by the Architect of the project or the Owner.
   4. Rack elevations of all AV equipment for all rooms in the project.
   5. Conduit rough-in requirements of all wall and ceiling mounted devices for all equipment part of the AVS system.

6. Any installation and rigging details for loudspeaker systems or other heavy equipment part of the AV system.

C. Construction Submittals: During the construction process the AVS installer shall submit various documents for approval prior to continuing with the installation process. Here is some of the information the AVS installer needs to submit:
   1. Before starting the programming process, the AVS Installer shall provide the following information:
      a. A schematic presentation of the layout of all the user interfaces in the project. The AVS Installer needs to get approval of this submittal before starting any programming. These layouts shall include all graphics with all button sizes, shapes, colors and wording to be used in all user interfaces. All keypads shall include working for engraving in the buttons.
      b. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
      c. A layout/presentation of any digital audio programming and user interfaces that are part of the project.
      d. Detailed layout of the DSP filters to be used in each DSP processor.
   2. Any design changes whether originated by the Owner, Designer or by the AVS Installer as a VE suggestion need to follow the same submittal process described in the previous paragraph for all equipment involved on the change.

1.6 PROJECT SPECIFIC SOURCE CODE OWNERSHIP

A. Definition of project specific source code: Project specific source code includes all source code created to generate an executable file to be intended to run in any equipment used in the installation of the AVS. Examples of project specific source code include source code used to generate executable files for control processors, DSP processors and touch panels. Project specific source code does not include source code used to create programming tools and compilers, or source code used to generate operating systems or application programs running in PC based workstations.

B. Ownership: Any project specific source code used in this project shall remain the exclusive property of the Owner. By accepting the contract to perform the work included in this project, the AVS installer or designer and any other companies working creating project specific code during this project relinquish the right of ownership of this source code, and waive any licensing fees or royalties for the use of source code by the Owner or any company authorized by the owner to perform changes in the source code after the project is substantially completed for an undefined period of time.

PART 2 - PRODUCTS

2.1 SYSTEM FUNCTIONS

A. System Signals for All Systems
   1. General: The completed system shall be capable of receiving, processing, routing and distributing the associated signals, noted herein, from and to the

respective devices identified under Part 2 of this specification and the Contract Documents.

2. The system shall provide an audio signal response of ±6dB un-equalized (±3dB equalized) from 65Hz to 18KHz, throughout.
3. Analog video signals through the system shall be maintained to the minimum quality requirements as follows:
    a. The system shall provide a signal response of 0.7Vpp (nominal) @ 300Mhz RGB, throughout the system channel, for all visual content.
4. Digital video signals through the system shall be capable of delivering 1920X1080 resolutions at 24 fps from end to end.
5. Control signals through the system shall be maintained to the minimum level established by the control equipment manufacturer for the control protocol utilized. This level shall be correct at all connection points in the system.

B. Computer Based User Interface
1. General: The computer-based user interface (CBUI) is another way for the Owner to control the AVS. This interface is in the form of a computer software program with the following requirements:
    a. Needs to be an executable file capable of running in any Windows based PC.
    b. One file per controllable room is required.
    c. Needs to have the same user functions available inside the room in touch screens and keypads.
    d. The “look” and layout of the interface shall be the same as the one in the room.
    e. Programs shall be password protected and have SSL.
2. Delivery: The AVS Installer shall provide all the programs in executable and source code format inside. Each file shall be properly labeled with the room description and the room number.

C. Owner Provided Input Sources and Destination Devices
1. General: Design drawings could indicate AV equipment, part of the AVS, to be provided by owner (as OFE or owner furnished) or third parties. Such equipment is explicitly indicated as such in design drawings to distinguish it from all other equipment to be provided by the AVS installer. When such equipment is indicated in the drawings the AVS Installer shall interface with it. Refer to the design drawings for audio, video and control lines required for owner provided equipment.
2. Scope of work: It is in the scope of work of the AVS Installer to run, terminate and connect the audio, video and control lines to owner provided devices as shown in the design drawings. When control lines are indicated in the design drawings, the AVS installer shall program all control features described in each system functions per controllable room, including all features related to owner provided equipment or third party equipment.

2.2 ROOM FUNCTIONALITY

A. Refer to contract drawings for system layouts and functional narrative for each area of the project.

2.3 WIRE, CABLE, CONNECTORS, AND ACCESSORIES

A. General: The AVS Installer shall provide the system components and materials necessary to properly install, support, and terminate all audiovisual cabling, in accordance with the related documents identified in Part 1.1 of this specification. Where the Project Electrical Installer has provided a raceway designated for use by this system, the AVS Installer shall coordinate and install all required cables into the provided raceway. The AVS Installer shall also provide and attach all required cable connectors.

B. Cable: The AVS Installer shall provide all cabling associated with, and required to, provide a complete, operable system in accordance with the Contract Documents. All cable provided by the AVS Installer shall be of a manufacture and quality consistent with the design intent, and shall be reviewed by the Engineer prior to installation.

C. Cabling in air handling spaces. The AVS Installer is responsible for determining the rating of the cables to be used for the AVS, as per current version of the National Electrical Code. If, at the bidding point the AVS Installer is not certain about the type of cables to be used in the project, the AVS Installer shall assume that all cables need to be plenum rated cables.

D. Cabling below grade: When cable part of the AVS have to be run in conduits below slab and grade level, the AVS Installer shall use only cables with water-blocking jackets.

E. Cable signals: The following is a list of signal types and the cables to be used for those signals:
   1. Line level audio signal cable: Provide one (1) twisted pair cable for mono signals and two (2) twisted pair cables for stereo signals. Twisted pair cables to be 22 AWG stranded (7X30) tinned copper conductors with overall foil shield (100% coverage), with 22 AWG stranded tinned copper drain wire.
   2. Microphone level audio signal cable: Provide one (1) twisted pair cable, 20 AWG stranded (7X28) tinned copper conductors, overall foil shield (100% coverage) with a 20 AWG stranded tinned copper drain wire.
   3. Analog video, audio and control over twisted pair cable: Provide one (1) 4-pair 24 AWG twisted pairs solid bare copper conductors with polyolefin insulation. If equipment manufacturer supports the use of standard UTP Category (5e, 6 or 6A) for this application, the AVS installers shall provide cables in compliance with specification section 271000 and all cables part of the AVS shall be included in the same warranty as all cables provided under specification section 271000. If equipment manufacturer recommends the use of low skew cables, only low skew cables shall be used.
   4. Proprietary Control cable (i.e. Cresnet® Signal): Provide one (1) cable with 1 twisted pair 22 AWG stranded bare copper conductors with overall aluminum/polyester foil (100% coverage) and a 24 AWG tinned copper drain wire, and one (1) unshielded twisted pair, 18 AWG stranded bare copper conductors.
   5. Control cable (i.e. RS-232, RS-485 Signal): Provide one (1) cable with 1 or 2 twisted pair 22 AWG stranded bare copper conductors with overall aluminum/polyester foil (100% coverage) and a 24 AWG tinned copper drain wire. Pair count depends on manufacturer's specifications.

6. Digital video, audio and control over twisted pair. Provide one, two or more cables UTP as required by transceiver equipment manufacturer to ensure the digital signal is transported properly up to 328 ft, at maximum resolution indicated in part 2.01 of this specification. If equipment manufacturer supports the use of standard UTP Category (6) for this application, the AVS installers shall provide cables in compliance with specification section 271000 and all cables part of the AVS shall be included in the same warranty as all cables provided under specification section 271000. If equipment manufacturer requires the use of proprietary cables, only these cables shall be used in the project. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.
7. UTP Category cables. Provide UTP category cables for all Ethernet connection part of the AVS as indicated in design drawings, including horizontal cables, patch cords and station cables. All cables part of the AVS shall have all specifications and shall be included in the same warranty as all cables provided under specification section 271000. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.
8. Speaker Cable: Provide two (2) unshielded bare high conductivity ETP copper 16 AWG stranded conductors, with overall jacket.
9. IR control signal cable. Provide one (1) pair, unshielded twisted pair cable with 22 AWG solid copper conductors.
10. HDMI Cables. All HDMI cables longer than 10 meters (32.8 ft.) must include an adaptive cable equalizer capable of providing not less than +40 dB of cable compensation @ 825 MHz. Such device must be capable of operating automatically without the need for human intervention and must include an external AC to DC power converter that can accept 100-240VAC @ 50/60 Hz. Furthermore, such device must also include I2C correction circuitry to mitigate the effects of long cable runs on the DDC clock and DDC data signals. HDMI cables shall have the following requirements:
    a. Support HDMI v2.1 with resolutions up to 8K60 and 4K120 with 12-bit color depth
    b. Support HDMI v2.1 Category 2 data rates (3.4 Gbit/sec.) lengths up to 7.5 meters
    c. Support HDMI v2.1 data rates up to 2.25 Gbit/sec. lengths up to 40 meters
    d. Support PC data rates up to 1.65 Gbit/sec. lengths up to 60 meters
    e. Supports PC resolutions up to 1600x1200 / 60 Hz and 1920x1200 / 60 Hz
    f. Made of AWG-22 gauge wires
    g. Triple shield for noise immunity
    h. Cable jacket shall have dual UL Ratings: UL13 (CL2) and UL758 (AWM20276) for non-plenum spaces. In plenum environments cables shall have a CL2P rating or CMP rating.
    i. RoHS compliant.
    j. Gold plated connectors

F. Connectors and plates: The AVS installer shall provide connector and plates to terminate all wiring part of the AVS, regardless if shown or not in the design drawings. As a general guideline the AVS Installer shall follow these recommendations:
    1. Only use crimp type BNC connectors on coaxial baseband video cables. Use crimp type F connectors on RF based coaxial cables. Use only connectors with the same impedance as the cable where they will be terminated.

2. When custom panels or plates are required in the project, the AVS Installer shall submit detail drawings of all plates for approval by the Design Engineer.
3. Whether shown in the design drawings or not all cables coming out of an outlet box into an equipment shall have a disconnect means at the outlet box with a face plate. Faceplates with grommets are not acceptable as pass-through connections to equipment.
4. All termination of UTP Category (6) cables shall be done in accordance to specification section 271000.

2.4 NETWORKING EQUIPMENT

A. General: All networking equipment required for the AVS shall be provided in the scope of work of the system and it shall be in accordance with this specification.

2.5 CABLE BOX (CABLE RECEIVER)

A. General: Cable boxes also referenced as cable receivers will be owner provided.

2.6 IDENTIFICATION AND LABELING TAGS

A. The AVS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. General: The AVS installer shall follow all installation practices indicated in specification section 270010.

B. Workmanship: The AVS Installer shall adhere to, at a minimum, the following installation practices:
1. Securely mount equipment plumb and square in place. Where equipment is installed in cabinets, provide mounting bolts in all equipment rack fastening holes. All rack mount equipment shall be secured with Rackmount Solutions HTX™ security screws (STAR-TYPE or similar) provided with nylon washers between bolt heads and equipment.
2. Where equipment (such as VHS players, monitors, DA's etc… and other system devices) is packaged by the manufacturer without rack mount ears or braces, as part of a regular manufacture process, the Installer shall provide all required, accessory ears, brackets, and shelves, which are necessary to properly mount the equipment within the designated cabinets and rack locations.
3. Provide appropriate ventilation panels, vents, and/or fans to assure sufficient ventilation for adequate cooling of all equipment.
4. Confirm the polarity and phasing of system components before installation. Connect to maintain uniform polarity and phasing.

5. Insulate all non-insulated, stranded conductors before making termination when connecting to equipment terminals.
6. “Wire”, “wing” and “twist” NUT type connections are not permissible for any type of signal connection.
7. All wiring is to be free from grounds loops, shorts, opens, and reversals.
8. Neatly tie all cabling within equipment cabinets, housings, and terminal cabinets with nylon cable ties at not more than 12" intervals for cables different from 4-pair CAT cables. Use Velcro straps to tying all 4-pair CAT cables. Install in accordance with the latest EIA installation standards. Engineer approved wiring trough may be used in lieu of tie-wraps. Cable routing shall not braid or cross with other wires in parallel more than once.
9. Secure all cables in equipment cabinets and terminal cabinets to provide strain relief at all raceway exits in accordance with NFPA 70 including all supplements. All plugs and receptacles are to be the grounding type.
10. Connect all equipment power to surge/noise suppression outlet strips or associated power conditioning devices.
11. Where system cables are extended through an exposed umbilical connection, the Installer shall harness all associated cable within a common, manufactured, flexible, sheath (ex. Snakeskin™).
12. All racks and cabinets shall be bonded to a grounding system as required by NEC.

C. Raceways. All raceways for audio/visual devices shall have the following specifications:
   1. Refer to specification section 270528 for all raceways specification.
   2. All cables for speaker level signals, regardless of their level shall be run in separate raceways from other low voltage cables.
   3. All cables for microphone level signals, regardless of their level shall be run in separate raceways from other low voltage cables.
   4. Raceways for AV outlets: Outlets for AV cables shall be composed of electrical boxes (sized for the amount of connectors) and a conduit(s) to the nearest accessible ceiling space. All AV outlet boxes shall be at least 2.5” deep.

D. Labeling System. The labeling system for all cables shall be a system that allows for unique identifiers for each cable. Each cable has to have an indicator from where it is coming from and an indicator to where it is going to.

E. Engraving: All push buttons interfaces and connection plates part of the AVS shall be engraved with descriptive wording of the use of the button/plate. The AVS Installer shall submit and receive approval for the proposed wording in each button/plate before doing the engraving. Failure to follow this step might cause the AVS installer to replace the buttons in interfaces and/or plates where the Owner is not satisfied with the wording of the label at no additional cost to the Owner. The color of the wording in the engraving shall have high contrast with the background color of the button.

F. Flat Panel Display Installation: The AVS Installer shall adhere to, at a minimum, the following installation practices for flat panel display devices
   1. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.

2. All walls where flat panel displays will be installed shall be re-enforced with sheet metal behind the drywall. The extent of the re-enforcing shall be the contour of the flat panel display to be installed.
3. When flat panel displays are installed inside a wall niche, the AVS shall provide a wall mount with adjustable depth that allows the flat panel display to be installed flush with the exterior wall.
4. Power and AV outlets to be installed behind flat panel displays shall use an Wiremold Evolution Wall backbox or approved equal
5. For flat panel displays mounted on structures, the installer shall provide anchoring as approved by structure manufacturer.
6. For flat panel displays suspended from the structure above, the installer of this system shall provide all custom brackets and pipes properly secured to the structure to mount the displays

G. Speaker Installation: The Installer shall adhere to, at a minimum, the following installation practices for speakers:
1. All ceiling mounted speaker shall have a support wire tie to the building structure. Ceiling speakers shall not be supported from the ceiling grid.
2. All ceiling mounted speakers shall be installed with a backbox to prevent sound from dispersing into the plenum space and causing noise issues in adjacent rooms.
3. When ceiling speakers are mounted in fire rated partitions, the speakers shall have UL listed speaker back boxes with a fire rating no less than the rating of the partition.
4. All in-wall speakers shall be installed with pre-construction brackets.

H. Equipment Rigging: When speaker assemblies or arrays weight more than 100 lbs, the AVS installers shall follow all rigging instructions from the manufacturer and shall be done by an experienced rigger. The AVS installers shall also adhere to the following practices:
1. Only the rigging equipment and method listed by the manufacturer of the equipment are approved for the installation No substitutions are accepted.
2. Only the rigging points available in the speaker assembly are accepted as means of support.
3. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.
4. Shop drawings for rigging methods shall be signed and sealed by a licensed structural engineer.

I. Floor Boxes. Floor boxes used for connection to teaching lecterns, podiums, conference tables, or mixing boards shall have at least the following minimum requirements:
1. Floor boxes shall be large enough to have at least 3 different compartments, one for power one for voice/data cables and one for AV.
2. Each low voltage compartment shall have a separate raceway back to the accessible ceiling space. If speaker wires are run from the lectern, the AV compartment shall have one 1” and one ¾” conduit to the nearest accessible ceiling space. If no speaker wires are run from the lectern, at least one 1” conduit from the AV compartment to the accessible ceiling shall be provided. Additional conduits might be required depending on the application.

3. There shall be no daisy-chaining of AV conduits between adjacent floor boxes. Floor boxes shall also allow to recess the connectors from the umbilical cord tied to the lectern.
4. Floor boxes shall have a recessed compartment to hold connectors. Floor boxes that leave AV connectors flushed with the floor are not desirable since they become tripping hazards and could be easy broken with the lectern when moved.
5. AV compartments shall have termination plates and connectors for all cables coming from the accessible ceiling space. Pass-through cables shall not be allowed in floor boxes. All connectors shall be properly secured to the plates in the floor box. All unused compartments shall have blank plates.

J. Structured Cabling Infrastructure: The AVS Installer shall adhere to specification section 271000 for all requirements of structured cabling components to be used as part of the AV system. The structured cabling components include but are not limited to:
1. All unshielded twisted pair Category cables and fiber optic cables
2. Termination devices like termination jacks, patch panels and faceplates.
3. All UTP and fiber optics patch cords.
4. All testing procedures for Category and fiber optic cables.

3.2 REQUEST OF IP ADDRESS

A. General: The AVS installer shall follow all requirements indicated in specification section 270010 for the request of IP addresses for devices part of the AVS.

3.3 SOFTWARE PROGRAMMING AND INSTALLER TESTING

A. The software programming and testing of the AVS system will be a multi-step process. The AVS Installer shall provision in the proposal for the time indicated in each of the steps:

B. Briefing Step: A maximum of 45 days after the AVS installer receives the NTP for this project, the AVS installer shall request one or more briefing sessions with the Owner and/or design engineer to go over the expectation of each room and clarify any points that might not be clear to the AVS Installer. Some important notes about this step are:
1. The AVS installer shall allocate at least 8 hours of meeting time
2. Travel time will not be counted as part of the meeting time.
3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
4. Before the start of this step the AVS installer shall have software programming submittals approved as described in part 1 of this specification section.
5. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.

C. Shop Programming Step: Once the briefing step has been completed and approved, the AVS installer shall allocate off-site programming time to accomplish all the requirements listed in this specification and the clarifications done in the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are

required for this step. This step does not require approval by the Owner and/or design Engineer.

D. Field Verification Step: After all AVS equipment has been installed on site and the system has been programmed, the AVS Installer shall request one or more working sessions with the Owner and/or design engineer to verify in the field the functionality of the AVS system. Some important notes about this step are:
   1. The AVS Installer shall allocate at least 10 hours of working sessions.
   2. Travel time will not be counted as part of the working sessions.
   3. The AVS installer shall have different AV media and sources to test all features in the AVS system.
   4. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
   5. Physical installation of all devices will be checked by the Owner and/or the Design Engineer. Any deviations in the installation of the equipment part of the AVS from this specifications and previous meeting will be noted by the Design Engineer in a “punch list”. This punch list will be send to the AVS installer within the next 5 days of the meeting for immediate corrective action. One punch list will be prepared for each room with AVS.
   6. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings that affect the programming sequence. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.

E. Final Adjustment Step: Once the previous step has been approved, the AVS Installer shall allocate time to make any corrections to the AVS system on site based on the conclusions of the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are required for this step. This step does not require approval by the Owner and/or design Engineer.

F. Data Wiring and Fiber Optic Testing: Testing of UTP data wiring, copper patch cords, fiber optic cables and fiber optic patch cords shall be done as indicated in specification section 271000. Testing results shall be submitted as indicated in the same specification section.

G. Signal Adjustment: The AVS Installer shall ensure that the following adjustments, tests and measurements, at a minimum, have been completed:
   1. The system shall be measured and adjusted for optimum signal quality and minimum signal loss, to all audio and video signals, through the system channel, using appropriate test equipment and standardized testing procedures.
   2. The system shall be measured and adjusted for optimum signal-to-noise ratio and maximum headroom in the system electronics.
   3. The system shall be measured and adjusted to eliminate distortions or degradation of signal resulting from, but not limited to, clipping, hum, noise, and RFI interference.
   4. The Installer shall check the quality of each signal, at its source, and compare it against the quality of the signal at various points of its transmission through the system. The Installer shall correct the system for any significant (the lesser of 2dB or the manufacturers throughput requirements) signal distortion or loss.

3.4 SYSTEM WARRANTY AND SERVICE

A. General: The AVS installer shall follow all warranty and service requirements indicated in specification section 270010.

3.5 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The AVS installer shall follow all test requirements indicated in specification section 270010

B. As part of the Engineer's final acceptance all sources, inputs, outputs and interfaces will be tested. Additional notes about the final acceptance test:
   1. It is the sole responsibility of the AVS system installer to estimate the time allocated for this step. It is assume that at this point in time all the features of the AVS system are clear to the Owner and the AVS Installer so this step is just to make sure that all the features are working properly as agreed.
   2. The AVS installer shall have different AV media and input signal generators to test all input plates and sources in the AVS system.
   3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
   4. Failure to complete one or more of the previously issued punch list items or failure to correct any programming changes previously noted will revoke acceptance of the room or system being tested.
   5. Final acceptance will be granted on a room by room basis.

3.6 TEST EQUIPMENT REQUIRED.

A. Test Equipment: The AVS Installer shall supply all testing instruments required for the equipment programming and system tests. The AVS Installer shall use test equipment meeting the minimum specifications, identified herein, to perform system calibrations and adjustments. The AVS Installer shall make available the same test equipment available, for inspection by the Engineer, during Final Acceptance step.

   1. Direct reading Audio Impedance Meter.
      a. Minimum of three frequencies ranging from 250Hz to 4kHz.
      b. Range 1 ohm to 1M ohm.
      c. 10% accuracy.
      d. Direct reading of dBm across 600-ohm load.
   2. Digital Multimeter.
      a. DC to 20kHz bandwidth.
      b. 300V range.
      c. 100mV resolution.
      d. 10M ohms input impedance.
      e. DC resistance to 0.1 ohms.
   3. Dual trace oscilloscope.
      a. 450MHz minimum bandwidth.
      b. 1mV/cm sensitivity.
      c. Dual timebase capability.

4. Sine/Square Wave Generator.
    a. 5Hz to 5kHz bandwidth.
    b. Output level of 0dBm with less than 0.5%THD.
5. Sound Pressure Level Meter:
    a. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2
    b. Accuracy: ±1.5dB (ref 94dB@1KHz)
    c. Resolution: 0.1dB
    d. Digital Display: 4 digital LCD
    e. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
    f. Measurement Range: 30dB to 130dB
    g. Linearity Range: 100dB
    h. Measurement Frequency Range: 31.5Hz to 8KHz
    i. Frequency Weighting: A and C
    j. Response Impulse: Fast and Slow
    k. Microphone: 1/2 " Electret condenser microphone
    l. Sampling time: updated every 0.5s
    m. Bargraph: 4dB steps, 100dB range, 125ms update
6. Digital Video Signal Test pattern generator with output for the following signal types:
    a. Composite Video
    b. Component Video
    c. RGBHV video
    d. HDMI video (1080p 24 fps)
    e. SDI

3.7 TRAINING AND INSTRUCTION

A. General: The AVS installer shall follow all training requirements indicated in specification section 270010. The AVS Installer shall provide the owner with different types of training as described herein.

B. System Administration Training. The AVS installer shall provide system administration training at the job site as described below:
    1. At least 8 hours of training shall be provided.
    2. Travel time will not be counted as part of the training sessions.
    3. Training will be broken down to a maximum of 2 sessions in different days.
    4. The objective of the system administration training will be to properly operate, trouble shoot, calibration and perform specific field repairs to AVS equipment.
    5. Field repair and calibration training will be limited to those repairs notes by the manufacturer of the equipment as field repairs done by non factory trained personnel.
    6. Training shall be done at the job site with all the equipment operational after final acceptance.
    7. Training will be limited to a maximum of 5 attendees per session.
    8. Operation and Maintenance manuals shall be delivered at the beginning of this sessions.

C. User Training. The AVS installer shall provide system administration training at the Job site as described below:

1. At least 10 hours of training shall be provided.
2. Travel time will not be counted as part of the training sessions.
3. Training will be broken down to a maximum of 3 sessions in different days.
4. The objective of the user training will be to properly operate the AVS.
5. Training will be limited to a maximum of 20 attendees per session.
6. User short form guides shall be provided to all attendees of the sessions.
7. Short form guides shall provide the users with quick finding ways to operate the system. If AVS operation is different from one room to the other, one separate short form guide shall be provided for each room.

D. Factory Training: The AVS installer shall provide factory training as described below:
   1. List all factory training.

3.8 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. General: The AVS installer shall follow all as built and close out information requirements indicated in specification section 270010.

B. The following information shall be included in the as built drawings:
   1. Drawings indicating final floor plan locations of all AV devices
   2. One line diagrams with all devices connected in the system.
   3. Mounting details
   4. Any signed and sealed structural calculations required for the AVS

C. Additional close out information to be delivered by the AVS installer:
   1. All programming source code done by the AVS for this project for all pieces of equipment in digital format (no printed copies required).
   2. List of all IP addresses assigned to each equipment part of the AVS.
   3. Compiled executable files as requested for Computer based user interface.
   4. All printed test results.

END OF SECTION 274100

SECTION 281000 ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, programming, training, testing, documentation and warranty support, required to provide a completely operational and working Security System.

B. The Security System Installer (SSI) shall coordinate with the door frame installer, the door installer, the door hardware installer on the placement of all electronic locking hardware and door controls for this project. The SSI shall provide the low voltage power supplies for all electric locks, wire and cable, terminate all connections, and shall interface this equipment with the integrated security system.

C. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) components required for the security system shall be in compliance with specification Section 271000.

D. The scope of work for this specifications also include the following items:

1. The programming of the access control software including the integration described in this specification section.

E. The following parts of the system are not part of this contract:
1. All networking equipment (switches, routers, etc) for the operation of the system
2. All computers and software to run the security system with the exception of the items indicated in this specification.
3. Software licenses for the security system beyond the 12 months included in this contract.

1.2 RELATED DOCUMENTS

A. General Terms and Conditions of the Contract Documents
1. Division 8 – Door Hardware
2. Division 26 – Electrical

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
1. 270010 Technology General Provisions
2. 270528 Raceways for Technology
3. 271000 Structured Cabling System
4. 270526 Grounding and Bonding for Communication Systems
5. 282000 Video Surveillance System

1.3 SECURITY SYSTEM INSTALLER QUALIFICATIONS

A. The SSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of travel to this project.

B. Other required SSI qualifications are:
   1. The SSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The SSI shall be able to perform any and all repairs to the system within 24 hours.
   2. The SSI, as a minimum, must carry a current state issued limited energy license.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 270010.

B. Sensors or door security devices with the exception of card readers shall allow for substitutions.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The SSI shall follow all requirements for shop drawings indicated in specification section 270010.

B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
   1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
   2. Product numbers, specifications, and data sheets for all equipment.
   3. Data sheets and samples of all labeling materials and equipment to be used in the project.
   4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.
   5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
   6. Detailed drawings of all custom products to be used in the project.
   7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
   1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Access controlled doors shall have the door name. All other devices shall have a unique identifier, as they will be programmed in the system.
   2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each door type and for each type of device in the system.
   3. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all access control panels, alarm panels, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
   4. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
   5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
   6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
   7. Outline of the testing process.
   8. Training syllabus for all systems included in this scope.

1.6 ABBREVIATIONS

A. Additional abbreviations used in this document:
   1. ADA - Americans with Disabilities Act
   2. API - Application Programming Interface
   3. ASCII - American Standard Code for Information Interchange
   4. BPS - Bits Per Second
   5. DIN - German Institute of Standardization
   6. DPS - Door Position Switch
   7. FCC - Federal Communications Commission
   8. GUI - Graphical User Interface
   9. ID - Identification
   10. I/O - Input /Output
   11. ISC: Intelligent System Controller
   12. ODBC - Open Database Connectivity
   13. O&M - Operations and Maintenance
   14. PIN - Personal Identification Number
   15. PTZ - Pan/Tilt/Zoom
   16. RAID - Redundant Array of Independent Disks
   17. REX - Request to Exit
   18. RoHS - Restriction of Hazardous Substances Directive
   19. SCS - Security Control System
   20. SDRAM - Synchronized Dynamic Random Access Memory
   21. STP - Shielded Twisted Pair

22. UL - Underwriters Laboratories, Inc.
23. UPS - Uninterrupted Power Supply
24. USB - Universal Serial Bus
25. UTP - Unshielded Twisted Pair
26. VOC - Volatile Organic Compounds

1.7 GLOSSARY OF TERMS

A. The following terms are defined for the purposes of this specification:
1. Access Group: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.
2. Access Mode: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.
3. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
4. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
5. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
6. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
7. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
8. Cardholder: A person who has been issued a valid access card.
9. Card Reader: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.
10. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
11. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
12. Facility Code: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.
13. File Server: Primary host computer in the networked security system which maintains the access control system database.
14. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
15. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
16. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.

17. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
18. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
19. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
20. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
21. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
22. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.
23. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
24. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
25. Time Interval: A time stamp of one start time and one stop time within a time period.
26. Time Period: A user programmable period of time made up of days of the week and hours in the day.
27. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
28. Unsecured side: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.
29. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
30. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

1.8 SYSTEM DESCRIPTION

A. The security systems primary purposes shall be to provide access control and alarm monitoring capabilities for this project. The system shall provide functionality such as the ability to regulate and control access through specific areas of the facility and fully integrate with other security components such as closed circuit television.

B. The system must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided using a single operating environment. The operating environment shall be the fully multi-tasking multi-threading operating System.

C. Alarm monitoring and administrative workstations must be able to connect to, and monitor, field hardware devices such as card readers and intelligent system controllers. Administrative tasks including defining asset information, access groups, time zones, configuring digital video devices, generating reports, creating maps, etc. shall be provided from any client workstation on the network that is licensed to do so. All systems must utilize a single database on the network and must be accessible in real time to any security workstation connected to the network. This shall allow for

automatic change propagation to all client workstations as well as common database consolidation.

D. A real-time graphical map representing the layout of this building shall indicate if an electronically controlled door is in a secure or unsecured mode. Control modules will be required to lock, or unlock, any electronically controlled door at this facility. An automatic cardholder call-up feature shall allow for the quick search and display of images in the database. A System's Operator journal shall be available to log important daily events. A trace function shall be available for System Operator's to locate and track activity on a specific cardholder or at a specific card reader. All system hardware must be controllable using a mouse to click on the associated system icon.

E. The security system shall be designed to support an advanced distributed network architecture, whereas Intelligent System Controllers do not need to be home-run wired back to the database server. All Intelligent System Controllers shall be connected to an Ethernet network via industry standard TCP/IP communication protocol. Network based Intelligent System Controllers shall be able to communicate back with the database server through industry standard network switches and routers.

F. The security system shall support a data encryption utility. In utilizing encryption technologies, data communication shall be protected between workgroups, local area network computers, domain clients and servers, branch sites which may be physically remote, extranets, roving clients, and remote administration of computers.

PART 2 - SYSTEM CHARACTERISTICS

2.1 SECURITY SYSTEM SOFTWARE

A. The SSI shall provide all software required for the complete operation of the access control system.

B. Acceptable products for the security system software are:
   1. Avigilon – Alta Cloud

C. Other access control system software can be accepted prior approval of the A&E.

D. At a minimum the security system software shall provide the following key features:
   1. Ability to integrate with other system with features as indicated in this specification.
   2. Be able to operate with cards with multiple system codes.
   3. Have an integrated platform with the video system.
   4. Support browser based clients and standard client workstation.

2.2 COMPUTER SYSTEM HARDWARE

A. Computer based system are required for the operation of the security system. The following types of computer systems are required for the system:

1. Server: System that communicates with ISC and other hardware. It is also the system with the database of all the components and transactions of the system. Server shall be installed in a secured room.
2. Workstation: System accessible to users for operating, configuring and accessing reports from the security system. Workstations communicate with the server through TCP/IP.
3. Badging workstation: A system used to create the picture IDs for the system
4.

B. BROWSER BASED WORKSTATIONS. When the manufacturer of the security system offers browser based access to the security system, workstations will be provided by owner. Browser based workstations are only allowed in the system if they provide a complete functionality of the system. If the browser based workstation offers only a partial set of functions compared to a Client based workstations, browser based workstations will only be allowed additional to client based workstations.

C. CLIENT BASED WORKSTATIONS. When the manufacturer of the security system requires a software client to be installed in a workstation for the management of the system and the SSI is required to provide the hardware platform for the workstation, the SSI shall provide workstations in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:
1. Processor speed: MSSM + 30%
2. Cache memory: MSSM + 30%
3. Front side bus speed: MSSM +30%
4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
5. Hard drive capacity: MSSM + 100%
6. CD/DVD Drive: DVD ROM Drive SATA, internal
7. Network Card: Single 1 GB connections
8. Power supply: High Output Power Supply
9. USB ports: Minimum six (6) USB 2.0
10. Mounting: Desk mounted. If rack mounted is required a rack shelf shall be provided to mount the workstation
11. Operating system: As required by security system software
12. Additional software: Antivirus and Internet Security package with a 1 year license
13. Warranty: 3 –year warranty.

D. BADGE PRINTER: All photo identification workstations in the project shall include one badge printer. The badge printer shall have the following specifications:
1. Printer type: Color dye sublimation or monochrome thermal transfer printing
2. Printer speed: 225 card per hour, full color single sides.
3. Resolution: 300 dpi
4. Card type: PVC, PVC composite, adhesive backed
5. Card width/length: CR-80, CR-79, ID-1 Format, ISO7810
6. Card thickness: 10 mil. To 40 mil.
7. Card feeder capacity: 100 cards (30 mil)
8. Communications interface: Built-in 10/100Base-T.
9. Accessories to be provided: Smart-card encoder-ISO 7816, ribbons and cleaning supplies to make 3,000 cards.
10. Design selection: Zebra ZC350 or similar, with proven drivers to interface with access control software system.

2.3 INTELLIGENT SYSTEM CONTROLLER (ISC)

A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components like card readers, inputs and outputs. Controllers shall operate as autonomous, microprocessor based processing units:
   1. ISCs shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
   2. ISCs shall be part of a fully distributed processing-control network.
   3. The portion of the database associated with a ISC, and consisting of parameters, constraints, and the latest value or status of points connected to that ISC, shall be maintained in the ISC.

B. ISC can be one single hardware board or multiple hardware boards linked together. The following functions shall be fully implemented and operational within each ISC:
   1. Monitoring inputs (open, closed or fault).
   2. Controlling outputs.
   3. Automatically reporting alarms to the system server.
   4. Reporting of sensor and output status to the system server on request.
   5. Maintaining real time, automatically updated by the system server at least once a day.
   6. Communicating with the system server through a secured encrypted Ethernet TCP/IP communication.
   7. Communicating with other ISC or hardware devices through serial RS-422/RS-232/RS-45 encrypted lines.
   8. Executing ISC resident programs.
   9. Diagnosing.
   10. Downloading and uploading data to and from the system server.

C. ISC Operations at a Location:
   1. Globally operating I/O linking and anti-passback functions between ISCs within the same Location without system server or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the system server or workstations are off-line.
   2. In the event of communication failure between the system server and a Location, there shall be no degradation in operations at the ISCs at that Location. ISCs at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
   3. Buffered events shall be handled in a first-in-first-out mode of operation.

D. Individual ISC Operation:
   1. ISCs shall transmit alarms, status changes, and other data to the system server when communications circuits are operable. If communications are not available, ISCs shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the system server, shall be stored for later transmission to the system server. Storage capacity for the latest 1024 events shall be provided at each ISC.
   2. Card-reader ports of an ISC shall be custom configurable for at least 120 different card-reader or keypad formats (Weigand). Multiple reader or keypad formats may be used simultaneously at different ISCs or within the same ISC.

3. ISCs shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
4. ISCs that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
5. Initial Startup: When ISCs are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each ISC.
6. On failure for any reason, ISCs shall perform an orderly shutdown and force ISC outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
7. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which ISCs shall resume normal operation.
8. After ISC failure, if the database and application software are no longer resident, ISCs shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, ISCs shall immediately resume operation. If not, software shall be restored automatically from the system server.

E. Communications Monitoring:
1. System shall monitor and report status of serial communications loop of each Location.
2. Communication status window shall display which ISCs are currently communicating, a total count of missed polls since midnight, and which ISC last missed a poll.
3. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each ISC.

F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the system server at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

G. All ISCs shall be UL listed. Input points in ISCs shall be UL 294 listed.

H. Basis of Design:
1. System Controller:
2. Dual reader control module:
3. Sixteen (16) Input module:
4. Sixteen (16) Output module:

2.4 POWER SUPPLY/ENCLOSURES – ACCESS CONTROL SYSTEM

A. All ISCs and other boards part of the access control system shall be installed inside a metal enclosure with a power supply as recommended and designed by the manufacturer of the equipment.

B. The low voltage power supply shall convert a 115 VAC or 24 VAC 60 Hz input to a continuously supplied current of 12 or 24 VDC. The power supply shall be UL listed, fused protected and class 2 rated.

C. The power supply shall include a battery charger to provide backup power when main power goes down. If ISC has a battery charger and input built in, then the power supply does not need this feature.

D. Plug in transformers feeding a low voltage power supply feeding an access control panel are not allowed unless they are mounted inside another lockable enclosure. External multi-output individually fused protected outputs power supplies feeding all access control board are acceptable as long as they are located next to the access control panels.

E. Maintenance free batteries shall be provided with all power supplies or ISC and shall be mounted inside the same enclosure. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.

F. All enclosures for ISCs, other electronic boards, power supplies or battery cabinets shall be UL listed NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4X enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

G. Basis of design: Altronix

2.5 CONTACTLESS SMART CARD READER

A. The standard smart card reader for use throughout this facility shall be a switchplate style reader in low profile weatherized polycarbonate housing suitable for mounting in either an indoor or outdoor environment. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall contain an integral magnet for use with an external magnetic reed switch to provide tamper protection when connected to an external alarm. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate at a frequency of 13.56MHz. All RF data transmitted between this device and the smart card shall be encrypted for additional protection using a secure algorithm. The reader shall provide an audiovisual indication to signify access granted or access denied. This operation shall be displayed by a high intensity LED light bar which shall change from red, amber, or green based on the status of the operation. The housing shall mount on an industry standard single gang electrical junction box. It shall have a read range of 4.0 to 4.5 inches when used with a standard smart access card and 1.0 to 2.0 inches when used with a key tag.

B. The mullion style readers shall only be used where wall mounting is not possible (for example glass/aluminum store-front systems).

C. The smart card reader with keypad shall have a standard contactless smart card and shall have a twelve (12) key keypad. Readers with keypad shall be used where indicated in design drawings.

D. With every badging station provided for this project, a verification reader with keypad shall be provided. This reader shall also have writing capabilities to the access cards. This reader shall be provided with USB interface and a stand for desktop mount.

E. Communications between the readers and the ISC shall be through a Wiegand interface

F. Basis of design selection: HID i-Class SE series.

2.6 CONTACTLESS SMART CARD

A. The contactless smart cards for the access control system shall be receptive to a standard smart card reader. Body shielding or variable environmental conditions shall have no adverse effect on their operation. The card shall be a read only read/write type device

B. The following card quantities shall be provided for this project.

CARD TYPE	**QTY**
Keyfob	0
Tag with adhesive back	0
Single technology card for direct printing and thermal transfer	100
Single technology clamshell high durability card	0

C. All card ordered for this project shall have the same system code.

D. All read/write cards ordered for this project shall have a 16K bit dual application area.

E. All access cards or tags shall be purchased through the HID Corporate 1000 program with the facility code assigned to the owner.

F. Basis of Design: HID i-Class SE

2.7 LOCKING DEVICES – SPEICIFED UNDER DIV 8

A. The SSI shall coordinate with the door hardware installer on the placement of electronic locking hardware required for this project. The SSI shall provide all necessary wire and cable, and the low voltage power supplies for door locks. The SSI shall also be responsible for terminating all connections and interface this equipment with the integrated security system.

2.8 DELAYED EGRESS ELECTROMAGNETIC LOCKS

A. The delayed egress electromagnetic locks for this project shall be a NFPA 101 compliant units with a holding force of 1,500 lbs. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.

B. The delayed egress electromagnetic lock shall have the following options at a minimum: Bypass monitor, door status switch, and dynastat force sensor.

C. Accessories: The SSI shall provide all accessories for proper mounting of the delayed egress electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets.

D. Basis of design: Dynalock 3101C – Gen II.

2.9 ELECTROMAGNETIC LOCKS

A. The electromagnetic locks for this project shall provide a locking force of 1,500 lb. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.

B. The electromagnetic lock shall have the following options at a minimum: bi-color LED indicator and door status switch.

C. Accessories. The SSI shall provide all accessories for proper mounting of the electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets

D. Basis of design: Dynalock 3000.

2.10 REQUEST TO EXIT EGRESS MOTION SENSOR

A. The egress sensors shall utilize passive infrared technology to detect the motion of individuals approaching a door. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door. This device shall be field adjustable to fit the monitoring requirements of the location where installed.

B. All request to exit motion sensors shall be provided with a trim plate for mounting the detector over a standard single gang junction box.

C. Basis of design: Detection Systems/Bosch model DS150i or an approved equal

2.11 MAGNETIC DOOR POSITION SWITCH – DPS

A. The standard recessed door position switch shall be Interlogix 1078 series or approved equal. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-lock into a predrilled 3/4” or 1” diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V.

B. The standard position switch for a roll up door shall be an Interlogix 2207AH high security contact or approved equal.

C. On banks of doors where multiple doors are being monitored, door contacts shall be wired in series. All double doors shall receive (1) magnetic door position switch on each door leaf and shall report as one alarm point.

D. On exterior doors with impact resistant listings, use only surface mounted door position switches in lieu of the standard recessed door position switches. The design selection is the Interlogix 1085T or approved equal.

2.12 SURGE PROTECTION

A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lighting protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equal.

B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.13 POWER SUPPLY – DOOR LOCKING HARDWARE AND SENSORS

A. Power supplies for door locks or powered sensors (i.e. request to exit motion sensors) shall be completely separate from power supplies for ISC or electronic hardware part of the card access system.

B. The power supply for door locks and powered sensors shall convert a 115 VAC 60 Hz input to a continuously supplied current of 24 VDC. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

C. The power supply for door locks and powered sensors shall include a battery charger and a battery input to provide power to the locks after a main power system failure. The switchover to stand-by battery shall be automatic when main AC power fails.

D. Power supplies for regular locking hardware shall be installed next to access control panels.

E. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.

F. The power supply for door locks and powered sensors shall have the following features:
   1. Number of outputs: 16 programmable as fail-safe or fail secure individually
   2. Fire alarm disconnect: Yes, latching or unlatching and individually selectable for any of the inputs.
   3. Output protection: PTC
   4. Monitoring: AC fail and low battery with dry contact closure.

G. Basis of design: Altronix Maximal series.

2.14 DIN-RAIL MOUNTED RELAYS

A. General Description: Any time the access control system needs to switch any load that is not considered a Class 2 circuit as defined in the NEC article 725, or any load that works at voltages higher than 24 V (AC or DC) an external relay shall be used to switch the load. The Access control relay from an RIM or and OCM shall drive the coil of the external relay which contacts shall control the load. These additional relays shall always be mounted in a DIN rail and will be references in this specification as the DIN-rail mounted relays. These DIN rail mounted relays shall have the following specifications:
   1. Number of contacts: 2 –Poles
   2. Contact type: Form C
   3. Contact material: AgCdO (silver tin oxide) or Gold plating
   4. Contact rating: 8 A minimum or as required by load
   5. Insulation voltage: 250V IEC, 300V UL
   6. Coil voltages: 24 VDC
   7. Enclosure design: Slim line design. Width less than 0.5”

B. All DIN rail mounted relays shall be provided with a base made of molded high dielectric material, with terminal screw sockets for all contacts. All bases shall be capable of mounting on a standard DIN (#3) 35 mm wide rail and shall be of the screw terminal type.

C. All DIN rail mounted relays shall be provided with end clamps at the ends of each row of devices and shall be mounted inside security enclosures.

D. Basis of design: Rockwell Automation series 700-HK or equal.

2.15 DIN-RAIL MOUNTED TERMINAL BLOCKS

A. General Description: When multiple terminations are required for cabling part of the security system separate from the termination blocks mounted on the access control equipment, DIN rail mounted terminal blocks shall be used to make all wire termination. Other termination methods such as wire nuts, crimp on connectors, shall not be used. The specifications of the DIN rail mounted terminal blocks are:

1. Block type: Feed-through block, for single conductor or two conductors, modular system. SSI to select according to application. Block shall be specifically designed for mounting on a DIN rail. Other types of blocks designed for direct surface mounting on a panel are not allowed.
2. Termination type: Captive screw connection.
3. Wire range per contact: AWG 28 to AWG 12
4. Maximum voltage rating: > 600V AC/DC
5. Maximum current rating: >20 A
6. Size: Termination block shall separate termination point from enclosure back panel no less than 0.5”

B. DIN rail mounted termination blocks shall be provided with all accessories including: DIN rail, end barriers, end anchors and jumpers.

C. Basis of design: Allen-Bradley 1492 series blocks, or similar from Eaton or Phoenix Contact.

2.16 WIRE & CABLE

A. Cables for un-powered security sensors shall have the following specification:
1. Minimum cable gauge: AWG 20
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

B. Cables for powered security sensors shall have the following specifications:
1. Minimum cable gauge: AWG 20
2. Number of conductors: 4, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white and green.
6. Voltage rating: 300V
7. Cable shield: No cable shields

C. Cables for access control readers shall have the following specifications:
1. Minimum cable gauge: AWG 22
2. Number of conductors: 6, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white, green, orange (or brown) and blue.
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (overall) with a AWG 24 tinned copper drain wire

D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:

1. Minimum cable gauge: AWG 24
2. Number of conductors: 2-paired, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Polyethylene
5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
8. Nominal characteristic impedance: 120 Ohms
9. Nominal capacitance: 12.8 pF/ft.
10. Nominal delay: 1.6 ns/ft.
11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.

E. Cables for door locks and low voltage power supplies shall have the following specifications:
1. Minimum cable gauge: AWG 18
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

F. Cables for loop detectors shall have the following specifications:
1. Minimum cable gauge: AWG 16
2. Number of conductors: 1, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Cross-linked polyethylene (XLPE)
5. Conductor insulation colors: Black
6. Voltage rating: 600V
7. Cable shield: No cable shields

G. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000.

H. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SSI shall always estimate proper values.

I. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces above ceilings in this project shall be treated as plenum spaces. All cables with a NEC type TC shall be run fully in conduit from the panel to the device and shall be separated from other communication or Class 2 rated cables.

J. Cable jackets for this project: Except when cables are run continuously in conduit all cable jackets for access control cables shall be plenum rated.

K. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.

L. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.17 IDENTIFICATION AND LABELING TAGS

A. The SSI shall follow labeling materials indicated in specification section 270010

PART 3 - EXECUTION

3.1 SECURITY DOORS FUNCTIONALITY

A. The following paragraphs described the expected functionality of the typical security doors. The SSI shall use this description to draw the one line diagrams part of the shop drawings and described in part 1 of this specification. The SSI shall make sure the proposed wiring for each door type produces the desired functionality for each door type.

B. All control logic for this functionality shall be accomplished through local input/output events. Global events to accomplish these requirements are not allowed. Failure of the access control server shall not limit the functionality of the doors. When the word reader is used in the following descriptions, it means it is a generic device, it could be any type of reader (biometric, iClass, prox) with or without keypad, see the design drawings for particular selection for every door.

C. Devices indicated in the following paragraph as provided by Door Hardware Installer are only the devices that are associated with the security system. For further instructions of additional passive door hardware devices to be provided, see Division 8 specifications.

3.2 SECURITY SYSTEM INTEGRATION

A. General: A. The access control system software shall integrate with the other security system components as indicated in this section. The SSI shall be responsible for programming all security systems in such a way that interaction between the different systems is achieved to provide a higher degree of security in the building. The minimum required integration features between the access control and the other security systems are described below:

B. ACCESS CONTROL AND DIGITAL VIDEO RECORDING SYSTEM
   1. The Access control software proposed shall integrate with the new Digital Video Recording System (DVRS) proposed for this project (refer to specification section

282000 for details on the Digital Video Recording System). The integration shall make the following features possible from the Access Control GUI:

a. Event video tagging. Selectable security events in the access control system shall tag the recorded video, so when the operator reviews the event, video from that moment in time when the event took place shall be retrieved automatically and brought into a window of the access control GUI.
b. DVRS playback control: Through the access control GUI, the operator shall be capable of controlling the video playback. The operator shall be capable of retrieving any recorded video from any camera by using a time search or an event search. The operator shall be capable of controlling the speed of the playback by selecting frame by frame playback or playback at higher speeds.
c. Live video: The operator shall be capable of displaying live video in window in the access control GUI. The operator shall be capable of selecting the camera in the system that he/she wants to see. Up to 4 live video windows (live or recorded) shall be possible in every workstation running the access control GUI.
d. PTZ Control: The operator shall be capable of controlling all PTZ features of a camera by simply using buttons in the Access Control screen with the orientation of movement.
e. Alarm event: Any alarm event (like video analytic alarms, or video motion detection) in the DVRS shall be transferred to the access control system for processing as any other alarm in the access control system. Alarms shall be uniquely identified in the access control system.
f. Status events: Any status events (system errors, or administration events) in the DVRS shall be transferred to the access control system for processing as any other status event in the access control system. Events shall be uniquely identified in the access control system.
g. Export/load video file: the operator shall be able to export or load video files compatible with the recording format of the DVRS from the access control GUI.
h. Recorder authentication: Since login is required for most DVRS, the login action on the Access Control System shall also grant access to the DVRS. Separate or further login to the DVRS shall not be required.
i. Dry contact control: The operator shall be capable of triggering relay contacts part of the DVRS equipment from the access control GUI.
j. Video locking: The operator shall be capable of locking video on the DVRS to prevent it from being purged accidentally. Locked video can be set to automatically purge or archive based on user defined thresholds.

C. CCTV SYSTEM

1. Activation of access control system alarms (like door held open, door forced open, stolen/lost card used, duress alarm, alarms coming from other systems, etc) shall call presets in the nearest CCTV cameras (one or more) to point towards the device that is in alarm. This action shall take place without any operator's intervention.
2. Activation of access control system alarms shall call any associated camera to the triggered alarm to the operator's workstation alarm monitor. This action shall take place without any operator's intervention. When the alarm is cleared by the operator the image of the alarm monitor shall be removed. Alarms from doors in

detention areas shall be received in the monitors in Master Control Room, alarms from doors in other areas shall be received in Building control room.

3. Video loss alarm: loos of video signal on any of the surveillance cameras in the system shall trigger an alarm in the access control system.
4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
5. Graphic camera calling: Surveillance cameras shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically open a video window with a live stream from that camera.

D. ALARM SYSTEM.

1. Alarm events: Activation of a device in the alarm system shall be treated as an access control alarm event, calling camera presets, calling any associated cameras to the operator's alarm monitors and creating automatic intercom calls (if available). This action shall take place without any operator's intervention.
2. Status events: Status alarm conditions (faults or errors) shall be reported to the access control system with unique identifiers.
3. Graphic status: All alarm devices shall be represented with graphic icons in the graphic maps part of the access control system GUI. Alarm devices shall represent their status with a different color, red for "on alarm" condition, and green for "no alarm" condition in the graphic maps.

E. Different methods of integration are allowed between the access control system and the other systems. Integration methods are given different hierarchy as follows, relay integration is lowest hierarchy, serial line integration is considered medium hierarchy integration and API integration is considered high hierarchy integration. At a minimum integration between the different security system shall be provided with the integration method explained below. It is acceptable for the SSI to propose integration methods with higher hierarchy integration methods, but not with lower hierarchy methods. The requested integration methods with each system are as follows:

1. Access control system and DVRS API integration.
2. Access control system and CCTV system API integration.
3. Access control system and Intercom system API integration.
4. Access control and door entry system Relay integration
5. Access control and Alarm system API integration
6. Access control and Detention system Relay integration
7. Access control and Paging system Serial line integration or API.
8. Access control and AV system Serial line integration or API.

3.3 INSTALLATION PRACTICES

A. General: The SSI shall follow all installation practices indicated in specification section 270010.

B. Access control panels and multi-output power supplies shall be installed as to have in any cluster of panels no less than 2 spare ports (reader ports for access control) available per cluster of panels.

C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.

D. All buzzers inside card readers shall be wired as to function to alert users of different door status like (door held open alarm and door forced open alarm).

3.4 WIRING METHODS

A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.

B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.

C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.

D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

E. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the SSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

F. All termination blocks shall always be mount inside a security enclosure, with a hinged cover and lock. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.

G. Termination blocks shall be used for wire terminations next to access control panels or for termination above the security doors. Termination blocks are not required for connection to security devices at the door side.

H. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.

I. All penetrations through fire rated barriers shall be provided, by the SSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.

J. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

K. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).

L. All cables run part of the security system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times.

M. All cables for security equipment shall be installed in conduit to the nearest accessible ceiling space, J-hook to the cable tray and from the cable tray and from the tray to the equipment cabinets. The SSI shall provide all j-hooks to support the cables part of these components.

N. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.

O. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

P. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.5 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.

B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the SSI shall be submitted for approval to the A&E.

C. All access control panels, alarm panels, PLCs, or Intercom exchanges shall include a work sheet attached to the interior of the panel/ equipment in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.6 SECURITY SYSTEM PROGRAMMING

A. Programming: It is the responsibility of the SSI to program all requested features in the access control system and the integration to other security systems. The programming responsibilities of the SSI include but not limited to:

1. Program all security doors to achieve the desired operation as described in this specification section. The SSI shall coordinate with the owner the door names and numbers, building names, room names and numbers to be used for the programming.
2. Program all components of the system to achieve the functionality described in this specification.
3. Program at least 5 access profiles for card holders and all access profiles for doors.
4. Create at least 5 administrator profiles. The owner will program any additional card holder profiles required in the system.
5. Program at least twenty five (25) users in the system. The SSI shall get this information from the owner. The owner will program all other users in the system.
6. Program all required security features like macros and integration with other security modules like intercom and CCTV system.
7. Program all interfaces with the elevator control systems.
8. Program all GUIs in the system. The SSI shall use Autocad drawings to create all maps of the facility with the corresponding icons for control, operation and visualization of the security system. The SSI shall chose a scale for the drawings that allows all icons to be places without overlap and close enough to the actual physical location of the equipment in the map as to avoid ambiguity of the actual location of the devices. Nested maps shall be programmed to go from a complete building view to a detail zoned identifying all devices in the area.
9. The SSI shall coordinate with the owner what alarms from the access control system are to be considered major alarms. All major alarms shall be programmed by the SSI to provide the operator detail information on the type of operating procedure expected during those alarms. All mayor alarms shall be programmed as to provide the operator and input field to type the response taken by the operator.
10. All programming of remote monitoring features for the security system like telephone numbers to dial, reporting codes and alarm formats.
11. All alarm messages and descriptive text of those messages shall be programmed.

B. DOOR INTERLOCKS: When indicated in the drawings (or in the sally port) two doors that have a controlled door interlocks, the SSI shall program the security system as to provide the following functionality: While one door is opened the other door shall not be possible to be opened not by using a valid transaction at the reader neither by issuing a remote release command from the access control system.

C. The SSI shall work with the owner during the programming of the system to fine tune all programming requirements of the system, as per owner's request. Fine tune is defined for this purpose as changing all field parameters available in the system, as specified, to complete software options available in the system. Fine tuning does not indicate adding additional software modules or additional hardware.

3.7 ADDITIONAL INSTALLER RESPONSIBILITIES

A. Upon project commencement, the SSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.

B. During the installation process the SSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
   1. Quantity and location of all equipment installed.
   2. Cable and wire runs along with the designations tags assigned to each.
   3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.

C. The SSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.8 REQUEST OF IP ADRESSES

A. The SSI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.9 SYSTEM WARRANTY AND SERVICE

A. General: The SSI shall follow all warranty and service requirements indicated in specification section 270010.

3.10 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The SSI shall follow all test requirements indicated in specification section 270010.

B. Additional requirements for the system acceptance test:
   1. The day of the final acceptance test the SSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
   2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
   3. During the final acceptance test every single device in the security system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.

C. Testing of all structured cabling system part of the Security System shall be done in accordance of specification section 271000

3.11 SPARE PARTS

A. As part of this project the SSI shall provide the following spare parts:
   1. One (1) Intelligent System ISC (ISC)
   2. One (1) Standard card readers
   3. One (1) Card reader with a keypad
   4. Two (2%) percent of all installed field devices, like local alarms, duress buttons, door position switches, tamper switches, request to exit motion sensors, etc.
   5. One (1) Power supply for locks
   6. One (1) power supplies for access control panels.
   7. Four (4) surge protection devices of each type used in the project.

B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.12 TRAINING AND INSTRUCTION

A. General: The SSI shall follow all training requirements indicated in specification section 270010.

B. The SSI shall provide three (3) levels of training for this project as explained in this section.

C. USER TRAINING.
   1. User training shall be provided for security personnel interacting with the security system in areas different from the security monitoring rooms. The purpose of this training is to explain clearly how the field devices operate and what the different status indicators mean.
   2. This training shall cover operation of devices and doors like:
      a. Operation and indication of all types of readers in the project
      b. Resetting door alarms (local) for all door types.
      c. Resetting of duress alarm buttons.
      d. Operation of door interlocks
      e. Operation of the duress alarm notification system
   3. This training shall be provided by personnel working directly for the SSI.
   4. At least 4 separate sessions (on 4 different days) of this type of training shall be provided (one session video-taped only).
   5. Each session could have up to 20 trainees.
   6. No training material is expected to be provided

D. OPERATOR/ADMINISTRATION TRAINING.
   1. Operator/Administration training shall be provided for security and IT personnel interacting with the security system in all security monitoring rooms. The

purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.

2. This training shall cover at least the following topics:
   a. All content provided during the user training.
   b. Operation of the Access control software (all aspects).
   c. Operation of all devices inside the security monitoring room.
   d. Alarm response and alarm reset in the security monitoring room
   e. Data backup/restore and achieving.
   f. File import/export.
   g. Badging system operation (complete description)
   h. Creating reports and print outs.
   i. Basic system troubleshooting.
   j. Creating users and password reset.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 20 trainees.
6. The approved O&M manuals shall be available at the time of the training.

E. MAINTENANCE TRAINING.

1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
2. This training shall cover at least the following topics:
   a. Trouble shooting and replacement of all field devices.
   b. Installation of all field panels and settings (jumpers, dip switches, etc).
   c. Wire labeling system.
   d. Software system installation and recover from system crashes.
   e. Detail explanation on all physical keys used in security devices.
   f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
   g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 5 trainees.
6. The approved O&M manuals shall be available at the time of the training.

3.13 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

A. General: The SSI shall follow all as built and close out information requirements indicated in specification section 270010

B. Additional requirements for as-built documentation shall include:

1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.

C. Close out information shall also include:
1. Two (2) digital backups of all configuration files and databases part of the security system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
2. Testing reports for structured cabling system used for the Security system.

END OF SECTION 281000

SECTION 282000 CLOSED CIRCUIT TELEVISION/VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The scope of work shall include furnishing all labor, all security video cameras, pan/tilt/zoom (PTZ) cameras, mounts, housings, power supply systems, connectors, monitors and consoles, workstations, network storage managers, video encoders, video decoders, video console displays and keyboards, all other hardware and software and documentation required to provide a completely operational and working Closed Circuit Television (CCTV) System.

B. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher)) components required for the video surveillance system shall be in compliance with specification Section 271000.

C. The following parts of the system are not part of this contract:
   1. All networking equipment (switches, routers, etc) for the operation of the system
   2. Software licenses for the video surveillance system beyond the 12 months included in this contract.

1.2 RELATED DOCUMENTS

A. General Terms and Conditions of the Contract Documents
   1. Division 16 – Electrical

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 270010 Technology General Provisions
   2. 270528 Raceways for Technology
   3. 271000 Structured Cabling System
   4. 270526 Ground and Bonding for Communications Systems
   5. 281000 Electronic Security System

1.3 CCTV INSTALLER QUALIFICATIONS

A. The Video Surveillance or CCTV installer (CI) selected for this project must be a direct representative of the products they intent to provide. All technicians assigned to install and configure this system shall be factory trained. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name.

B. Other required CI qualifications are:

1. The CI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The CI shall be able to perform any and all repairs to the system within 24 hours.
2. The CI, as a minimum, must carry a current state issued limited energy license.
3. The CI shall have staff trained in programming the CCTV system as described in this specification. The CI shall submit as part of the qualifications required, the resume of the programmers for the CCTV system as well as the training certificates for this staff from the manufacturer of the system.

1.4 MATERIALS ALTERNATES AND SUBSTITUTION

A. General: See details for alternates and substitution in specification section 270010

B. Cameras can be substituted as long as they have the same performance specification as the cameras used as basis of design and as long as they are supported by the DVMS. It is the responsibility of the CI to verify and assure the cameras proposed as substitution are supported by the DVMS. Any cost associated with certifying a proposed camera to the DVMS to be used in this project shall be covered by the CI.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The CI shall follow all requirements for shop drawings indicated in specification section 270010

B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 60 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the Architect and Engineer (A&E) of the project for review, as part of the product/installer approval process.
   1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
   2. Product numbers, specifications, and data sheets for all equipment.
   3. Data sheets and samples of all labeling materials and equipment to be used in the project.
   4. A compete explanation of the identification method to be used for all equipment and cabling part of the CCTV system.
   5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
   6. Detailed drawings of all custom products to be used in the project.
   7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:

1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. All cameras shall indicate the camera number in the system and the type of camera and mounting.
2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each camera type.
3. Storage calculation. The CI shall provide a spreadsheet with all the cameras in the project and the proposed recording frame rates, resolutions, activity percentages and times of recording with the total number of storage bytes per camera and a total for the system. The total storage capacity shall be indicated in Terabytes.
4. Bandwidth calculation. If the CI is not responsible for the networking equipment, the CI shall provide a bandwidth calculation. This calculation shall be presented in the form of a spreadsheet using MBPS as the units listing all cameras in the project. The spreadsheet shall have subtotals per network region associated with a storage area.
5. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
6. Video recording server assignment. A list of all the video servers to be provided in the project with a list of all cameras assigned to each server. Each server shall have a total bit rate estimated for all the cameras recorded showing that the capacity requirements of the server comply with the requirements in this specification.
7. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all camera power supply, multiport encoder/decoders, computer monitor outputs, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
8. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
9. A field of view study. This field of view is a collection of still pictures with the precise field of view for each camera to be installed in the project. The field of view shall be the same coverage as the camera specified and will be used to verify installation of the cameras and during acceptance test.
10. Outline of the testing process.

1.6 ABBREVIATIONS

A. The following abbreviations are used in this document:
1. API - Application Programming Interface
2. ASCII - American Standard Code for Information Interchange
3. BPS - Bits Per Second
4. CIF - Common Intermediate Format (352 X 240)
5. 2CIF - Common Intermediate Format (704 X 240)
6. 4CIF - Common Intermediate Format (704 X 480)
7. DVI - Digital Visual Interface
8. FCC - Federal Communications Commission
9. GUI - Graphical User Interface

10. HDMI - High Definition Multimedia Interface
11. ID - Identification
12. I/O - Input /Output
13. IPS - Images Per Second
14. MBPS - Mega Bits per Second
15. NTP - Network Time Protocol
16. NTSC - National Television Standard Committee
17. ODBC - Open Database Connectivity
18. ONVIF - Open Network Video Interface Forum
19. O&M - Operations and Maintenance
20. PAL - Phase Alternating Line
21. PIN - Personal Identification Number
22. PTZ - Pan/Tilt/Zoom
23. RAID - Redundant Array of Independent Disks
24. RoHS - Restriction of Hazardous Substances Directive
25. SDRAM - Synchronized Dynamic Random Access Memory
26. STP - Shielded Twisted Pair
27. TCP/IP - Transmission Control Protocol/Internet Protocol
28. UL - Underwriters Laboratories, Inc.
29. UPS - Uninterrupted Power Supply
30. USB - Universal Serial Bus
31. UTP - Unshielded Twisted Pair
32. VOC - Volatile Organic Compounds

1.7 SYSTEM DESCRIPTION

A. The CCTV system shall be a TCP/IP network-based, fully distributed digital video system. The CCTV system will utilize local area networks (LAN) as a transmission medium for video, configuration, as well as storage of all data. The CCTV system shall provide full video control at the management point indicated in the design drawings, with additional full selection capability at any point within the network from a workstation or a video console display. The CCTV system shall provide unlimited expansion capability for the addition or modification of any video device or computer workstation.

B. The CCTV system shall permit normal and event monitoring of all secured areas on digital monitors as required or shown in the specifications and drawings. In all cases, the equipment shall be state of the art, standardized commercial off-the-shelf, and modular. In all cases, the method of communication from remote locations within the network to the central components shall be transparent to the user. Equipment shall be selected and installed so repairs may be accomplished on site by module replacement, utilizing spare components whenever possible.

C. The intent of this specification is to provide the owner with a distributed networked digital security system. Supplied by the CI, the CCTV system shall be complete and operational per the performance requirements and objectives of these specifications. The CI shall be responsible for the coordination of related work with other trades affecting his/her work or the work of others.

D. The CCTV System shall be fully integrated with other security components such as access control, alarm monitoring and intercom communications. The system shall be fully integrated with the access control application to allow events to be directly linked to the CCTV surveillance recording system. See specification section 281000 for details of the integration scope of work and the performance required.

E. All cameras shall be connected and controlled through a CCTV workstation utilizing a standard mouse and keyboard.

PART 2 - PRODUCTS

2.1 DIGITAL VIDEO MANAGEMENT SYSTEM

A. The digital video management system shall be composed of off the shelf management servers, storage system and the DVMS Software. The recording system shall be based on a unified NVR composed of a complete server, storage array, storage drives and expansion modules as required.

B. The DVMS recording servers shall process all video streams for recording, live viewing, and playback for the cameras assigned to that recorder. Servers shall be provided in quantities as to not any single server being used at more than 75% of the maximum bit rate capacity of the server. Quantities of servers indicated in the drawings are preliminary and the CI shall provide calculations to the A&E of the final quantity of servers to be provided.

C. The SAN storage arrays and storage expansion shall provide a network attached storage medium for the video servers.

D. The drawings provide a total video storage capacity of 140 TB. This has been determined to be the required RAID-5 storage with all cameras recorded at max resolution, and with frame rates as indicated in paragraph 3.5 for a total of 30 days. It shall be the responsibility of the CI to provide the correct amount of storage based on the camera resolutions indicated on the drawings recording at the parameters provide, but no less than the 140 TB indicated previously.

2.2 DIGITAL VIDEO MANAGEMENT SYSTEM SOFTWARE

A. The CI shall provide all software required for the complete operation of the video surveillance system.

B. The approved products for this system are:
   1. Avigilon

C. Other access control system software can be accepted prior approval of the A&E.

D. At a minimum the video surveillance system software shall provide the following key features:
   1. Ability to see live video and recorded video in the same application software.

2. Ability to export video to an open standard file like AVI files
3. Ability to integrate with other system with features as indicated in this specification.
4. Support browser based clients and standard client workstation.
5. Have video analytics incorporated into the DVMS.

2.3 DVMS MANAGEMENT SERVER

A. The DVMS management server shall have the following specifications:
1. Processor: Two (2) Eight Core Processors, at 2.0GHz CPU, Energy Smart
2. Front side bus: 1333 MHz
3. Cache: 4 MB Level 2 / 12 MB Level 3
4. Memory: 32 GB DDR3-1333MHz, Energy Smart
5. Graphics card: SVGA Graphic Card (with VGA connector)
6. Hard drive configuration: Integrated SAS/SATA Raid 6
7. Back plane: 1X8 bay for 2.5” hard drives
8. Hard drives: Four (4) 73GB 15,000 RPM SAS SCSI 3Gbps 2.5” HotPlug hard drives
9. CD/DVD Drive: 24x CD-RW/DVD Rom Drive SATA, internal
10. Network Card: Dual 10/100/1000 Base-T
11. Power supply: Energy Smart redundant power supply with dual cords. NEMA 5-15p 15A 10 ft. cords.
12. USB ports: Minimum six (6) USB 2.0
13. Serial ports: Minimum one (1) RS-232 in DB-9 connector.
14. Options: USB to PS2 adapter for KVM connectivity
15. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
16. Operating system: Windows 200X Server as recommended by Nice Systems, with software licenses to connect all workstations and cameras in the project plus 2 spare licenses for workstations and 10 spare licenses for cameras.
17. Warranty: 3 –year warranty.
18. Design Selection: Dell or HP.

2.4 CCTV WORKSTATION

A. The rack mounted CCTV Workstations shall be a certified industry standard computer in a rack configuration. It must meet all requirements established by the DVMS software manufacturer. As a minimum the system capacity shall be as follows:
1. Processor: Two (2) Six Core Xeon Processors at 3.46 Ghz CPU
2. Front side bus: 1333 MHz
3. Cache: 12MB
4. Memory: 12GB SDRAM, 1333MHz, ECC
5. Ports: 1 Parallel, 2 Serial (DB-9), 10 USB 2.0
6. Graphics card: Two 4GB Graphics Cards SLI, with quad DVI outputs each
7. Hard Drive: Three (3) in RAID 1 configuration 600GB SATA 10K RPM 3.0 Gb/s Hard Drive
8. CD/DVD Drive: One (1) 16X DVD+/-RW SATA with DVD burning software and DVD player software.
9. Network Card: 10/100/1000 Base-T

10. Mounting: rack mounted
11. Accessories: Standard USB keyboard and USB optical mouse.
12. Operating system: Windows version as recommended by Lenel Systems.
13. Other software: Anti-virus software included with one year license.
14. Warranty: 3-years
15. Design Selection: Dell Precision R5500 or equal on HP

B. The desk mounted CCTV workstation shall be a supplier certified industry standard computer. It must meet all requirements established by the DVMS software manufacturer and shall have a recommended minimum system capacity as follows:
1. Processor: One (1) Intel i7 processor at 3.4 Ghz CPU
2. Front side bus: 1333 MHz
3. Cache: 8MB
4. Memory: 8GB SDRAM, 1333 Hz
5. Ports: 1 Serial (DB-9), 10 USB 2.0, 2-line in audio, 2 line out audio,
6. Graphics card: 1GB Graphic Card, with dual DVI outputs with sound
7. Speakers: Sound bar to be mounted under the flat panel display. External speakers desk mounted not acceptable.
8. Hard Drive: 500GB SATA 6.0 Gb/s with 16MB DataBurst Cache Hard Drive
9. CD/DVD Drive: One 8X Blu-ray Disc Burner with Blu-ray burning software and Blu-ray player software.
10. Network Card: 10/100/1000 Base-T
11. Power supply: 88% Efficient power supply
12. Energy Efficiency: Energy Star 4.0 Category B, EPEAT gold
13. Mounting: rack mounted, desk mounted, mini-tower or small form factor chassis as indicated in workstation list. For rack mounting, desk top units fitting a rack tray are acceptable. Mini-tower configurations on a shelf are not acceptable for rack mount.
14. Accessories: Standard USB keyboard and USB optical mouse For rack mounted devices, USB to PS2 adapters are required.
15. Operating system: Windows version as recommended by Lenel.
16. Other software: Anti-virus software included with one year license.
17. Warranty: 3-years
18. Design Selection: Dell Optiplex 990 family or equal on HP.

C. The CCTV workstations shall include monitors, converters, and extenders as indicated on the drawings.

D. The CCTV workstation shall include the Lenel SkyPoint viewing software.

2.5 DVMS VIDEO SERVER

A. The DVMS video server shall process the video streams from the IP cameras for recording on the storage array or viewing at workstation and decoder locations. A maximum of 36 cameras shall be programmed per server.

B. The DVMS video server shall use commercial off the shelf server equipment with dual redundant hot swap power supplies. The server shall have a minimum of 12 GB RAM.

C. The DVMS video server shall have Two 1 GbE ports for connection to the security network and Two 1 GbE iSCSI ports for connection to the iSCSI network switch.

2.6 DVMS STORAGE ARRAY

A. The DVMS storage array shall store all recorded video for the required amount of time. The storage array shall also provide the interface with up to three storage expansion units connected via JBOD cable.

B. Total capacity of the storage shall be submitted as part of the shop drawing submittal process based on final camera selections submitted for approval by Architect and Engineer.

C. Each storage array shall have two 1GbE iSCSI ports for connection to the iSCSI network switch.

D. Recording software installed shall be compatible and approved for use with the Lenel SkyPoint DVMS software and the manufacturer of the computer storage hardware.

2.7 SURGE PROTECTION

A. All CCTV components mounted outside the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For coax connections provide CX-06-BNCY line protectors manufactured by EDCO or an approved equal.

B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equa.

2.8 WIRE & CABLE

A. All UTP Category horizontal cables and fiber optic cables for the CCTV system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000. Color jacket for wiring for the CCTV system shall be yellow.

B. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Installer shall always estimate proper values.

C. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.

D. Cable jackets for this project: Except when cables are run continuously in conduit all cable or patch cord cables; jackets for CCTV cables shall be plenum rated.

E. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.

F. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.9 IDENTIFICATION AND LABELING TAGS

A. The CI shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. General: The CI shall follow all installation practices indicated in specification section 270010

B. For all building exterior applications, CCTV imagers shall be day/night type of cameras.

3.2 WIRING METHODS

A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.

B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.

C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.

D. All penetrations through fire rated barriers shall be provided, by the CI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.

E. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

F. All cameras shall have a camera interface box with disconnect means to horizontal cabling for testing purposes and service. Camera interface boxes shall be located in accessible ceiling spaces as close as possible to the camera. Disconnect means shall be provided for UTP cables in the form of an 8-pin modular plug and receptacle. Disconnect means shall be provide for low voltage camera power cables in the form of insulated spade connectors (female connectors in load side, male connectors in camera side).

G. All video cable connectors and terminations shall be 3-way crimp-on type and shall including connector cables for 24 VAC input and video/data coax output. Twist on style connectors will not be acceptable for any terminations on this project.

H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY Raps" (Thomas & Betts or equal). Lacing of cables shall not be permitted.

I. All cables run part of the CCTV system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times

J. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

K. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.

L. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

3.3 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.

B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CI shall be submitted for approval to the A&E.

C. All camera power supplies, patch panels shall include a work sheet attached to the interior of the equipment cabinet in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.4 CCTV SYSTEM PROGRAMMING

A. The CI shall program the CCTV system and the integration to the Security System as indicated in specification section 281000.

B. IP Video Management System (IPVMS) programming: The CI is responsible for all programming and installation labor associated with the IPVMS and the CCTV workstations, as well as all components to make the system operational. The CI shall

program the IPVMS system as to create the minimum amount of traffic in the network, and still comply with all resolutions and frame rates as indicated in this specification.

C. IP video frame rate setting: The CI shall program all settings for the IPVMS following these criteria:
   1. The system shall be programmed for 2 different modes of operation: high activity mode and low activity mode. The CI Installer shall work with the owner to establish in a regular week for each area of the building what hours in each day are considered high activity and what hours of each day are considered low activity.
   2. All cameras in low traffic interior non-public hallways or rooms shall be recorded normally at 2fps @ highest resolution during high activity mode. During high activity mode frame rate shall be increased to 15 fps upon motion detection or alarm from access control system in the field of view for at least 5 minutes after motion ceased or alarm cleared. During low activity mode these cameras shall be recorded at 1 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after motion ceased.
   3. All cameras in public areas inside the building shall be recorded at least at 15 fps @ highest resolution during high activity mode. During low activity mode cameras in these areas shall be recorded at 4 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after the motion ceased.
   4. All site and exterior cameras shall be recorded at 15 fps @ highest resolution at all times.

3.5 ADDITIONAL INSTALLER RESPONSIBILITIES

A. Upon project commencement, the CI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.

B. During the installation process the CI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
   1. Quantity and location of all equipment installed.
   2. Cable and wire runs along with the designations tags assigned to each.
   3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.

C. The CI Project Manager shall maintain continuous coordination with the consulting engineers. The engineers shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the CI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.6 REQUEST OF IP ADRESSES

A. The CI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.7 SYSTEM WARRANTY AND SERVICE

A. General: The CI shall follow all warranty and service requirements indicated in specification section 270010.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The SSI shall follow all test requirements indicated in specification section 270010.

B. Additional requirements for the system acceptance test:
   1. The day of the final acceptance test the CI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
   2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
   3. During the final acceptance test every single camera will be tested in the system. When possible, CCTV equipment will be tested for operation during main power failure. All features requested in this specification will be tested

C. Testing of all structured cabling system part of the Video Surveillance system shall be done in accordance of specification section 271000

3.9 SPARE PARTS

A. As part of this project the SSI shall provide the following spare parts:
   1. One (1) camera of each type in the project. Electronics only, no enclosures
   2. One (1) additional surge suppression of each type used in the project.

B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.10 TRAINING AND INSTRUCTION

A. General: The CI shall follow all training requirements indicated in specification section 270010.

B. The CI shall provide two (2) levels of training for this project as explained in this section.

C. OPERATOR/ADMINISTRATION TRAINING.
   1. Operator/Administration training shall be provided for security and IT personnel interacting with the CCTV system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
   2. This training shall cover at least the following topics:
      a. Operation of the CCTV system software (all aspects).
      b. Operation of all devices inside the security monitoring room.
      c. Alarm response and alarm reset in the security monitoring room
      d. Data backup/restore and achieving.
      e. File import/export.
      f. Creating reports and print outs.
      g. Basic system troubleshooting.
      h. Creating users and password reset.
   3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
   4. One session of this type of training shall be provided. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
   5. Each session could have up to 20 trainees.
   6. The approved O&M manuals shall be available at the time of the training.

D. MAINTENANCE TRAINING.
   1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
   2. This training shall cover at least the following topics:
      a. Trouble shooting and replacement of all field devices.
      b. Installation of all cameras and their settings (jumpers, dip switches, etc).
      c. Wire labeling system.
      d. Software system installation and recover from system crashes.
      e. Detail explanation on all physical keys used in CCTV devices.
      f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
      g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project (i.e. the control system for the video wall).
   3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
   4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
   5. Each session could have up to 5 trainees.
   6. The approved O&M manuals shall be available at the time of the training.

3.11 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. General: The CI shall follow all as built and close out information requirements indicated in specification section 270010

B. Additional requirements for as-built documentation shall include:
   1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
   2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.

C. Close out information shall also include:
   1. Two (2) digital backups of all configuration files and databases part of the CCTV system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
   2. Testing reports for structured cabling system used for the CCTV system.

END OF SECTION 282000

SECTION 283111 - FIRE EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the installation of a complete networked combination In-building Fire Emergency Voice/Alarm Communications System (EVACS)/In-building Mass Notification System (MNS) as shown on the drawings and as herein specified.

B. The In-building Fire Emergency Voice/Alarm Communications System (EVACS)/In-building Mass Notification System (MNS) shall provide fire protection and warning to the entire facility.

C. All equipment, devices and wiring required to form a complete code-compliant fire alarm system and comply with the requirements of this specification shall be included.

1.2 RELATED WORK/SECTIONS

A. In addition to this section, the requirements of the conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

B. The work covered by this section of the specifications is to be coordinated with the related work as specified elsewhere under the project specifications.

1.3 QUALITY ASSURANCE

A. NEC Compliance Comply with NEC requirements as applicable to construction and installation of fire alarm systems and components.

B. The complete installation is to conform to the applicable sections of NFPA-72, NFPA 71, Local Code Requirements and National Electric Code with particular attention to Article 760.

C. Additionally, the entire installed system and all integrated system operations shall be within the guidelines of the International Building Code.

D. UL Compliance and Labeling Provide components which are UL listed and labeled in accordance with the following UL Standards

1. UL 268 – Standard for Smoke Detectors for Fire Alarm Signaling Systems
2. UL 864 (11th edition) - Standard for Control Units and Accessories for Fire Alarm.
3. UL 1481 - Standard for Power Supplies for Fire-Protective Signaling
4. UL 1971 – Standard for Signaling Devices for the Hearing Impaired
5. UL 2572 - Standard for Control and Communication Units for Mass Notification Systems.
6. Other UL listings Each device, component and sub-component of the fire alarm system shall be listed for its intended function.

E. NEMA Compliance Comply with applicable portions of NEMA Std. Pub. SB 4 pertaining to installation of fire alarm systems.

F. The system is not required to be U.L. certificated. However, the following items shall be included in the bid

1. System installation, checkout/testing, and system demonstration for the Owner, Engineer, and Authority Having Jurisdiction per NFPA-72 requirements and per the Construction Drawings and Specifications.
2. Minimum of one year of Central Station monitoring (including cellular carrier subscription service).

G. Ten months following the start of the Contractor's warranty period, the Fire Alarm Fire Alarm Subcontractor shall provide to the Owner options for renewal of annual maintenance and testing services for up to five (5) years.

1.4 SUBMITTALS

A. Shop Drawings As a minimum, the fire alarm and fire detection shop drawing submittal shall include the following

1. Complete data sheets bearing the printed logo or trademark of the fire alarm control panel manufacturer for all equipment including but not limited to the following

a. Control Panels (FACP)
b. Amplifiers [integral with control panels or remote (FAAP) as indicated on the drawings]
c. Local Operator Console (LOC)
d. System power supplies with battery backup and charger
e. Standby batteries and battery charger
f. Each separate type of automatic smoke and heat detector to be connected to the system
g. Manual alarm initiating stations
h. Visual alarm notification appliances
i. Audible notification appliances
j. Combination audible/visual notification appliances
k. Control and monitoring modules
l. Magnetic door holders
m. Remote station reporting device (digital communicator)
n. As-Built Drawings Cabinet
o. Any other items of fire alarm equipment required by the drawings and/or specifications

2. Battery manufacturer date-codes keys.
3. Evidence of listing of all proposed equipment by Underwriter's Laboratories for application as fire alarm equipment.
4. Provide complete narrative descriptions of all system operations including but not limited to alarm initiations, building alarm signals, automatic and manual voice controls, trouble and supervisory signals, auxiliary control module functions, LOC functions, silence and resetting procedures.

5. Submit a list of every system address provided for alarm initiation, status monitoring, supervised signaling, and auxiliary controls.
6. Complete calculations showing the following

    a. Battery calculations for all system power supplies and amplifiers.
    b. Voltage drop (visual notification appliance circuits)
    c. Speaker circuit losses *(maximum allowable loss on a given speaker circuit is 2dBA)*.

7. Written certification by the contractor that no battery, power supply or circuit on the system has an electrical load greater than 80% of its actual capacity, when all items are taken into account.
8. Provide scaled floor plans, riser diagrams, factory wiring diagrams, field wiring diagrams indicating the wiring of all devices to include raceway size and routing, junction boxes, and conductor size, type and quantity in each raceway. Information to be included on layout plans shall include but shall not be limited to the following

    a. Circuit tags on all circuit legs.
    b. Labeling of all initiation devices (to include signaling circuit designation and device address).
    c. Labeling of all visual notification appliances with specific device identifier label and notification circuit number.
    d. Labeling of all speakers with specific device identifier label and speaker circuit number.
    e. Connections to HVAC systems.
    f. Connections to fire protection systems.
    g. Connections to elevator systems

9. Submit labeling scheme for typical alarm and supervisory points as they are to appear at the specified display points. Include all abbreviations for device types and operational areas.
10. Provide specifications of all cable types labeled with their intended application. This cable shall have been tested and approved by the fire alarm control panel manufacturer for use with the manufacturer's equipment.
11. Provide a table listing all duct smoke detectors, duct width, and sampling tube length for each duct detector application. Duct widths are to be derived from HVAC drawings (where applicable) and verified in the field prior to installation. The contractor is responsible for adjustments to sizes of sampling tubes as needed to adapt to duct size field changes.
12. The Contractor **shall not** purchase any materials or equipment prior to receipt of approved shop drawings.

1.5 QUALITY ASSURANCE

A. National Electrical Code (NFPA-70), with particular attention to Article 760.

B. National Fire Alarm and Signaling Code (NFPA-72).

C. International Building Code (IBC)

D. Provide components which are United Laboratories (UL) listed and labeled in accordance with the following UL Standards

1. UL 268 – Standard for Smoke Detectors for Fire Alarm Signaling Systems
2. UL 864 (9th edition) - Standard for Control Units and Accessories for Fire Alarm.
3. UL 1481 - Standard for Power Supplies for Fire-Protective Signaling
4. UL 1971 – Standard for Signaling Devices for the Hearing Impaired
5. UL 2572 - Standard for Control and Communication Units for Mass Notification Systems.
6. Other UL listings Each device, component and sub-component of the fire alarm system shall be listed for its intended function.

1.6 AS BUILT DRAWINGS

A. See Specification 26 0501 - ELECTRICAL COORDINATION.

1.7 SYSTEM DESCRIPTION

A. The major system elements include but are not limited to the following items

1. Control Panels (FACP)
2. Amplifiers [integral with control panels or remote (FAAP) as indicated on the drawings]
3. Local Operator Console (LOC)
4. Manual pull stations
5. Visual alarm notification appliances
6. Audible notification appliances
7. Audible/visual notification appliances
8. Smoke detectors
9. Heat detectors (where applicable)
10. Carbon Monoxide Detectors
11. Remote station reporting device (digital communicator)
12. Batteries and chargers at fire alarm control panels, power extender panels, and remote amplifier panels.

B. Audible & visual occupant notification configuration

1. The system shall be configured to automatically activate all visual notification appliances and broadcast an alert tone followed by a pre-recorded voice evacuation message throughout all areas of the facility upon activation of any manual or automatic fire alarm initiation device.
2. All amplifiers, speaker circuits and connected speakers shall be configured to allow independent and selective manual paging to each separate building. The system shall be configured (switches, amplifiers, circuiting, programming) with paging zones set up as follows

a. All-Call

C. The building's fire alarm system shall signal all system alarm, trouble and supervisory conditions to the remote monitoring station.

1. All fire alarm systems shall be configured to delay the signaling of building trouble conditions signaling from the moment any trouble condition is detected as noted herein.

    a. Trouble conditions

        1) With exception of primary power failure trouble conditions, only trouble conditions that are sustained for periods that exceed 30 seconds shall signal the owner's designated remote monitoring station.
        2) Primary power failure trouble conditions that are sustained for periods of less than 2 hours **shall not** signal the owner's designated remote monitoring station (to avoid nuisance signaling during short term power failures, short term brownout conditions, etc.).

    b. All supervisory conditions detected by the fire alarm systems shall signal owner's designated remote monitoring station immediately.
    c. All alarm conditions detected by the fire alarm systems shall signal the owner's designated remote monitoring station immediately.

D. Power Extenders with battery backup and charger, locations as shown on plans. Provide additional units as required for power to all notification appliances.

E. Conduit routing and system wiring is not shown on the plans. It shall be the responsibility of the fire alarm installer to coordinate with the fire alarm manufacturer to determine the conduit requirements (size and routing) and wiring required for system operation.

F. Surge Protective Devices (SPD) shall be provided as recommended by the manufacturer for all copper cables (at each end - install at cable termination points.) that enter and leave the buildings and for all 120V circuits serving fire alarm panels.

G. The system shall be electrically supervised non-presignal type.

H. Operation of any manual or automatic device shall

1. Activate the audible and visual indicators and event message display at the local fire alarm control panel (FACP) and the local operator consoles (LOC) indicating the status of the event, initiating device or zone.
2. Activate remote station alarm, supervisory and trouble reporting procedure through the digital communicator and telephone system.
3. Initiate the local emergency visual evacuation signal throughout the building.
4. Initiate the local emergency voice evacuation message broadcast throughout the building.
5. The system may be "reset" to normal standby condition upon restoring the initiating device to "normal" and activating the "reset" switch on the FACP panel or the "reset" switch at the LOC Panel(s).

I. All trouble and supervisory events shall cause the audible trouble signal to sound at the system control panels and LOC panel(s). Trouble and supervisory events shall be silenced locally by a switch at the control panels or LOC panel. Visual indication of all trouble and supervisory events shall be displayed as follows

1. The common trouble lamp shall illuminate and the trouble/supervisory event shall be displayed alpha-numerically on the LCD display on the control panels

and LOC panel(s). Visual indication of trouble events shall remain until the condition is corrected and the system is reset. Visual indication of supervisory events shall remain until the condition is corrected and the system is reset (latching applications) or until the supervisory condition is self-restored (non-latching application). Trouble/supervisory events include but are not limited to the following

a. Ground, fault, or open on a signaling, 24VDC power circuit, or notification circuit.
b. Failure of a system component or device.
c. Loss of 120-volt operating power to control panel (see specifications on delay of remote reporting of this signal).
d. Activation of any fire protection system supervisory point.

J. The main control panel (FACP) and Local Operator's Console (LOC) shall display system events via color touch screen liquid crystal display (LCD) screens. A consistent system of definitive and distinctive abbreviations shall be utilized to maintain a concise format of all displays. Upon activation of a fire alarm initiation and/or supervisory device, the FACP panel and LOC shall display information as follows.

1. Device type (i.e. smoke detector, duct smoke detector, fire suppression system, manual pull station, etc.).
2. Air handler designation (if device is a duct smoke detector located at an air handler).
3. Floor level.
4. For fire protection system flow switches (where applicable), the display shall indicate the zone or area(s) served by that branch of the fire protection system.
5. For fire protection system tamper switches (where applicable), the display shall indicate the room name and room number where device is located.

K. For multiple alarm events, the FACP panel and LOC shall be furnished with a buffer memory and controls to scroll all events on the display panel.

L. All initiating devices shall be equipped with a local LED indicator to indicate alarm status of the device.

M. There shall be independently supervised notification appliance circuits for visual and audible notification appliances. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

N. All auxiliary manual controls shall be supervised so that all switches must be returned to the normal automatic position to clear system trouble.

O. Each independently supervised circuit shall include a discrete panel readout to indicate disarrangement conditions per circuit.

P. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.

Q. The System Expansion Modules shall be electrically supervised for module placement. Should a module become disconnected from the controls, the system trouble indicator must illuminate, and audible trouble signal must sound.

R. The system shall have custom programmed select switches configured for disabling and enabling circuits and individual or grouped input/output modules and initiation devices for maintenance or testing purposes.

S. The system shall be configured for control of auxiliary equipment as follows

1. Provide individual, remote addressable output modules with form "C" contacts for control of auxiliary equipment as noted on the plans.
2. Addressable output modules shall not reset until the system is manually reset.
3. All addressable output modules shall be configured for programmable activation by any initiation point or grouping of initiation points.
4. Provide heavy duty slave relays as required to accommodate the current and voltage requirements of the peripheral systems connected to the fire alarm system.

1.8 ADDITIONAL CONTROL PANEL FUNCTIONS FOR ALL FACP PANELS

A. General

1. Provide controls at the fire alarm control panel's main display in the form of "toggle" style push buttons located behind the outer door of the FACP panel. The buttons shall be labeled with regards to the affect they have and the part of the system they affect. To activate these options, pressing the desired button once shall illuminate the amber LED beside the button. A status change in the system shall be annunciated by the main display and keypad. Pressing the button again shall deactivate the amber LED and the display shall cause this function to return to its previous state.
2. Provide programmable control switches with amber “active” status LED indicators for the functions specified herein.
3. The system shall allow any combination of these functions to be active at the same time to achieve desired system performance.

B. Provide the following controls

1. **Panel Disable** With this feature activated, the panel shall display all events or conditions currently active on the system; however, all outputs (relays, control modules, audible & visual notification appliances) shall be disabled, even in the event of an alarm. This is a global condition and affects the entire building.
2. **HVAC Bypass (where applicable)** This option prevents the fire alarm from shutting down the building's air handlers in the event of an alarm. This is a global condition configured such that no matter where in the building an alarm is generated, the HVAC systems will not be shut down by the fire alarm system. This is primarily used during system tests and inspections, when the system is being closely monitored, to prevent unwanted service interruptions.
3. **Output Functions Disable** This function shall completely disable all notification appliances, HVAC shutdown functions, and other local building system outputs. This mode of operation is used to test initiation devices without disruptions to the building occupants; and is intended for use when there is an operator at the panel and the system is being closely supervised.

1.9 POWER REQUIREMENTS

A. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure.

B. Provide battery chargers at all system panels as recommended by the system manufacturer. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel. All battery charging and recharging operations shall be automatic. The charging equipment shall be capable of recharging the batteries within 24 hours.

1. With exception of batteries for amplifiers, all batteries shall be sized with 20% minimum spare capacity. “Derating” factors do not qualify as spare capacity.

C. All circuits requiring system operating power shall be 24VDC and shall be individually fused at the control panel.

D. Date marking of batteries

1. All system batteries shall be permanently marked by the manufacturer with the month/year of manufacture using the month/year format.

a. Date-codes are not acceptable.

2. All system batteries shall be marked with machine generated stick-on labels by the contractor with the month/day/year of installation

1.10 COMMUNICATION WITH ADDRESSABLE DEVICES

A. The system must provide communication with all initiating and control devices individually. All of these devices are to be individually annunciated at the FACP panel and LOC panel(s). Annunciation shall include the following conditions for each point

1. Alarm
2. Trouble
3. Open
4. Short
5. Ground
6. Device Fail/or Incorrect Device

B. All addressable devices are to have the capability of being disabled or enabled individually.

C. Identification of Addressable Devices Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide fire alarm system components and as manufactured by the following manufacturers (or approved equal):

1. Notifier
2. JCI-Simplex
3. FCI

2.2 GENERAL

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. This shall include, but not be limited to, control panel(s), manual pull stations, automatic fire detectors, speakers, strobe units, monitoring devices, control devices, all wiring, raceways, connections to devices, outlet boxes, junction boxes, and all other necessary material for a complete operating system.

B. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.

2.3 FIRE ALARM CONTROL PANELS AND EMERGENCY VOICE CONTROL UNITS (FACP)

A. Each Fire Alarm Control Panel shall be modular with solid state, microprocessor based electronics.

B. Each fire alarm control panel shall allow for loading or editing special instructions and operating sequences as required. The system is to be capable of onsite programming to accommodate and facilitate expansion, building parameter changes or changes as required by local codes. All software operations is to be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

C. The ability for selective input/output control functions based on ANDing, ORing, NOTing, timing and special coded operations is to also be incorporated in the resident software programming of the system.

D. A local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound differently during each keypress to provide an audible feedback (chirp) to ensure that the key has been pressed properly.

E. Panel Display

1. Display specifications (See Part 1 of this specification for panels designated to have display units)

a. Color
b. Touchscreen
c. LCD (provide the largest LCD display panel available by the manufacturer)

F. Password Protection The system shall be provided with 4 levels of password protection with up to 16 passwords.

G. Equipment Enclosures Provide cabinet(s) of sufficient size to accommodate the aforementioned equipment. The cabinet(s) shall be equipped with locks and transparent door panel(s) providing freedom from tampering yet allowing full view of the various lights and controls.

H. The maximum time period allowable between an alarm initiation and status display at the FACP and LOC panel(s) shall be 5 seconds.

I. All panel functions shall be field programmable.

J. Remote reporting shall be provided via a digital cellular communicator (redundant communication path not required per NFPA-72, Part 26.6.3.3).

1. Provide a digital cellular alarm communicator (CDACT) capable of programmable point (device) transmission of fire alarm, supervisory and trouble signals to a UL Listed Central Station or Remote Monitoring Station (Owner preference). The CDACT shall be programmed and configured to report alarm, trouble and supervisory signals based on individual initiation device point addresses as well as general system trouble conditions.
2. Provide one (1) year of monitoring service.
3. Provide an exterior-mounted remote antenna (coordinate location with Engineer/Owner) as required for boosting signal strength. Provide coax cable as required in ¾" conduit between the remote antenna and the communicator. Coordinate all work with the Owner and the Owner's remote monitoring station service provider.

K. In-building Emergency Voice Alarm/Communications System/In-building Mass Notification system configuration

1. Automatic Fire Alarm notification Provide a voice message programmed for automatic fire alarm evacuation. The evacuation message shall be preceded by a 1,000KHz alert tone (3 times), originating from a tone generator, followed by the following pre-recorded female voice message (or approved equal messaging) *"Your attention please (2 times). A fire alarm has been reported in the building. Please proceed quietly and calmly the nearest stairway and exit the building. Do not use the elevators".* The alert tone and voice message shall repeat until the system is reset or silenced.
2. System shall be integrated with the main control panel (FACP).
3. System amplifiers shall be integral with FACP panels, or shall be provided in remote amplifier cabinets.
4. The integrated voice system shall utilize distributed amplification configured as required for optimum system performance (per manufacturer's system requirements).
5. The voice system shall utilize 70vrms or 25vrms remote amplifier panels and transformers as required for distribution to all system speakers. **The amplifiers shall be modular and sized as required to supply a *minimum* of 0.5 Watts of power for each connected system speaker (greater where required per speaker tap**

schedule shown on the drawings). Amplifiers shall automatically transfer to standby battery when commercial power fails or is disconnected.

a. The audio control modules supplied shall communicate via high speed network communications lines.
b. Provide a microphone preamplifier circuit.
c. Providing a variety of digital WAV files with various tones for use in the system. Software configuration shall determine which tone usage. Minimum available signal configurations shall be

1. Low Whoop, Hi/Lo and Wail.
2. 900Hz, 1000Hz, 2000Hz, Horn, and Chime; each steady, zone coded, individual coded or pulsed at 120 ppm, 30 ppm, or temporal code 3.

6. The master microphone module shall be permanently mounted behind the locked access door, visible through the viewing window in the FACP panel and provide firefighters with the means of issuing voice message instructions to specific audio zones, groups of zones or all zones. The microphone, and the press-to-talk switches shall be supervised. This module shall contain a local speaker with volume control to monitor selected audio channels.
7. All amplifiers shall be supervised and provide automatic switching of backup amplifier outputs.
8. Manual switch and annunciator modules shall be provided on the face of the designated FACP panel and LOC.

a. Each push-button switch shall have (3) associated status LEDs (red, yellow, and green), configurable to indicate any combination of functions.
b. Each LED shall be capable of displaying status of the controlled zone via either a steady or flashing state to denote the active status circuit and indicate trouble.
c. All switch activation and LED status indications shall be software mapped to any system functions desired.
d. Systems requiring the use of multiple switches to activate groups of zones or functions shall not be acceptable.
e. Switch/module units shall be provided as follows

1) FACP One (1) 16-switch modules
2) LOC One (1) 16-switch module

L. FACP Model Numbers

1. FACP

a. Notifier N16x

b. JCI-Simplex 4010ES

c. Gamewell FCI E3

d. Approved equal

2. FAAP

a. FAAP: FCI-INX (or equal by one of the other listed manufacturers)

2.4 ALARM NOTIFICATION DEVICES

A. Alarm notification devices shall include

1. Speaker/strobes (combination audiovisual)
2. Strobes (visual only)
3. Speakers (audible only)

B. Audible/visual notification appliances shall meet the following requirements

1. Wall appliance color White
2. Ceiling appliance color White
3. Strobes

a. Synchronized flashing for all units within any viewing area. Strobe flash frequency shall be 1 fps.
b. UL 1638 is listed as a Visual Signaling Appliance for wall or ceiling mounted configuration as shown on the drawings.
c. Multi-candela type with field selectable candela ratings as follows

1) 15 cd
2) 30 cd
3) 75 cd
4) 95 cd
5) 110 cd
6) 135 cd
7) 185 cd

d. Minimum strobe candela settings shall be as noted on the drawings. Final settings shall be adjusted as required based on existing building conditions to ensure compliance with NFPA-72.
e. Synchronized flashing for all strobe units within any viewing area (including strobes powered from different remote power supplies for which network synchronization modules shall be used). Strobe flash frequency shall be 1 fps.
f. UL 1638 listed as a Visual Signaling Appliance for wall or ceiling mounted configuration as shown on the drawings.
g. “ALERT” label on baffle for combination mass notification and fire alarm use (as permitted by NFPA-72).

4. Speakers (standard output)

a. Supervised with DC blocking capacitor.
b. Mylar cone sealed back construction.
c. 25VRMS.
d. Minimum dBA outputs (Reverberant per U.L. Standard 1480) measured at 10' at all power taps

1) 77 dBA @ 1/4W
2) 80 dBA @ 1/2W
3) 83 dBA @ 1W

4) 86 dBA @ 2W

e. Frequency response 400Hz - 4KHz (fire alarm signaling)
f. UL 1480 listed as a Speaker Appliance for wall or ceiling mounted configuration as shown on the drawings.

5. Speakers (high output)

a. 15W high efficiency compression driver.
b. 25/70/100VRMS taps (set at 25V).
c. Minimum dBA outputs (Reverberant per U.L. Standard 1480) measured at 10' at all power taps

1) 90 dBA @ 0.94W
2) 93 dBA @ 1.8W
3) 99 dBA @ 7.5W
4) 102 dBA @ 15W

d. UL 1480 listed.

6. Sprinkler bells

a. 24VDC with supervised with DC blocking capacitor.
b. Heavy duty cast housing.
c. Designed for fire alarm operation.
d. 6” diameter with vibrating, steel alloy gong.
e. -40 – 150 degrees F operating temperature range.
f. Surface weatherproof backbox.
g. Red powder coat finish.
h. UL listed.

C. Visual components shall operate from the 24V DC polarized indicating circuits.

D. All audiovisual devices shall have meet the equivalent requirements of the Americans with Disabilities Act (ADA).

E. Flush devices shall mount on 4 x 4-inch or 2-gang electrical boxes. Box depth shall be coordinated with device supplier.

F. Outdoor devices exposed directly to weather shall be U.L. listed as weatherproof assemblies (back box and trim) for outdoor applications with conduit entries and mounting holes sealed with silicone sealing.

2.5 ADDRESSABLE DEVICE TYPES

A. General The system control panels, over the two wire signaling channels, must be capable of communicating with the types of addressable devices specified below. All smoke detectors and heat detectors and the associated control panel hardware and software shall utilize the latest and most advanced intelligent detection technology available from the manufacture at the time of bidding.

B. Photo-electric Smoke Detectors

1. Photo-optic sensing chamber, UL listed to Standard 268.
2. Low voltage, 2-wire solid state design incorporating tamper proof, plug-in head assembly.
3. Tamper-resistant design.
4. Intelligent addressable design with integral addressable transponder. Detector shall utilize fuzzy logic intelligence to continually analyze the ambient conditions present and shall signal the host control panel accordingly when ALARM or TROUBLE conditions are detected.
5. Separate detector mounting base Molded construction equipped with terminal screws for all wiring connections, designed for mounting on any standard 4-inch square outlet box for concealed wiring, or special box for surface raceway.
6. Design to produce TROUBLE signal if detector head is removed from its mounting base and ALARM signal if detection chamber is removed.
7. LED that blinks when sensor is being polled and glows steadily when in alarm.
8. Factory set device type code.

C. Automatic heat detectors Combination rate-of-rise and fixed temperature type.

1. Combination rate-of-rise and fixed temperature type (135 degrees F threshold), automatically restorable.
2. Low voltage, 2-wire solid state design incorporating tamper proof, plug-in head assembly.
3. Tamper-resistant design.
4. Intelligent addressable design with integral addressable transponder. Detector shall utilize fuzzy logic intelligence to continually analyze the ambient conditions present and shall signal the host control panel accordingly when ALARM conditions are detected.
5. Separate detector mounting base Molded construction equipped with terminal screws for all wiring connections, designed for mounting on any standard 4" square outlet box for concealed wiring, or special box for surface raceway.
6. Detector shall report the detector status to the control panel. The control panel shall determine whether the condition at the detector is indicative of a NORMAL, ALARM, or SENSOR TROUBLE condition.
7. Design to produce TROUBLE signal if detector head is removed from its mounting base and ALARM signal if detection chamber is removed.
8. LED that blinks when sensor is being polled and glows steady when in alarm.
9. Factory set device type code.

D. Automatic fire detectors for ductwork

1. Provide intelligent, addressable type photo-electric smoke detectors as specified herein.
2. Duct accessories Cast metal construction, with pre-cut keyed air sampling tubes (suitable for mounting detector either perpendicular or parallel to ducts) custom sized per existing air handler ductwork. Field verify all duct dimensions prior to ordering sampling tubes. *Uniform width sampling tubes cut in the field to fit ductwork are not acceptable*.
3. Provide recessed adjustable screw to permit regulation of air flow, designed to allow easy detector removal for cleaning or service without removing entire unit from duct.
4. Provide a remote test station with red LED alarm lamp for each duct detector in a readily accessible location near each detector. Wire each test/alarm station to its respective detector.

    a. Permanently label each station with the respective air handler designation.

E. Addressable Pull Stations

1. Pull stations shall be addressable. The stations shall be manufactured from high impact red Lexan or cast metal. Lettering shall be raised and painted white. Stations shall be single-action pull type requiring a firm downward pull to activate.
2. The station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks.
3. The front of the station is to be hinged to a backplate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. The station shall consist of high impact Lexan, red in color.
4. The addressable manual station shall be capable of field programming of its "address" location on an addressable signaling line circuit.
5. There shall be no limit to the number of stations which may be activated or "in alarm" simultaneously.

F. Carbon Monoxide Detectors

1. Multi-criteria detection device (Smoke, Light/flame, Carbon monoxide, Heat). UL listed to Standards 268 & 2075.
2. Low voltage, 2-wire solid state design incorporating tamper proof, plug-in head assembly.
3. Intelligent addressable design with integral addressable transponder.
4. Sounder base with local audible signal (temporal 4-count per NFPA-720). Configurable via programming to alarm individually or in tandem with any one or combination of other CO detectors connected to the fire alarm system.
5. Molded construction is equipped with terminal screws for all wiring connections, designed for mounting on any standard 4-inch square outlet box for concealed wiring, or special box for surface raceway.
6. Design to produce TROUBLE signal if detector head is removed from its mounting base and ALARM signal if detection chamber is removed.
7. LED that blinks when sensor is being polled and glows steadily when in alarm.
8. Factory set device type code.
9. End of life warning signal at the control panel for CO cell.
10. One address for all modes of detection.
11. Each mode of detection shall be capable of being active or disabled through programming.

2.6 DOOR HOLDERS (MAGNETIC TYPE)

A. Operation Electromagnetic door holder/releases shall be controlled with addressable control modules by the local building fire alarm control panel. Doors shall release when an alarm is initiated by either of the local smoke detectors located immediately on either side of the smoke door.

B. Operating voltage of holder/releases shall be dual voltage (120 volt A.C. & 24 volt D.C.) door holder/releases.

C. Furnish, install, and wire one addressable control module for each door holder. Furnish, install and wire a power circuit for all door holders from the local fire alarm control panel.

2.7 CONTROL MODULES

A. Addressable (field programmable).

B. Supervised.

C. Lexan coverplate.

D. Contacts shall be form "C", rated at 2A, 24 VDC and 0.5A, 120 VAC.

E. Where higher contact current ratings are required for the controlled device, provide heavy duty relays with proper Form "C" contact ratings slaved directly off of a control module through a supervised control circuit.

F. Provide supervised 24VDC circuits as required, powered from the local fire alarm control panel, for activating control modules and relays.

G. Coordinate contact voltage and current ratings with existing voltage and current ratings of controlled devices.

2.8 AUXILIARY RELAYS

A. Specifications

1. Electrically held.
2. 7A contact rating (@24Vdc & 120Vac).
3. 24Vdc coil, 15mA coil current (@24Vdc).
4. Form “C” contacts.
5. LED status indicator.

B. Model PAM-SD (or approved equal)

2.9 MONITORING MODULES

A. Addressable (field programmable).

B. Supervised.

C. Lexan coverplate.

D. Field assignable personality codes as follows

1. Normally open alarm - Latching
2. Normally open alarm - Delayed latching
3. Normally open active - Non-latching
4. Normally open active - Latching

2.10 LOCAL OPERATOR CONSOLES (LOC)

A. LOC panels shall be wall mounted 60" AFF (measured to top of panel) where shown on the plans.

B. All LOC panels shall have the following features

1. Mircroprocessor based with EPROM memory buffer.
2. Trouble buzzer.
3. Back-Lit, color touch screen liquid crystal display (LCD) screen (alpha/numeric).
4. Indicator LED's

    a. Normal
    b. Alarm
    c. Supervisory
    d. Trouble

5. Password enabled control of all panel control functions.
6. Panel control functions shall be configured as follows

Control Switch	Software Configured Setting
Back scroll	Enabled
Next/ Acknowledge scroll	Enabled
Trouble silence (for Local buzzer only)	Enabled
Alarm Silence (Silences Speakers)	Enabled
Reset	Disabled (May Override by Password)
Drill/All Call	Disabled (May Override by Password)

C. The LOC shall display system events as specified in part 1.

D. The LOC shall be compatible with the FACP panel communications protocol.

E. The LOC shall display all points that report to its host FACP panel.

F. The LOC shall have a user-selectable auto acknowledge software feature whereby all inactive messages are automatically purged from the memory buffer and the internal tone generator is disabled upon system reset. The auto-acknowledge feature shall be enabled as the default mode.

G. Furnish a remote microphone (paging) unit that is integral with the Fire Alarm LOC, wall mounted in a semi-flush style enclosure.

H. The LOC shall have the following microphone/paging features

1. Microphone unit with primary features that match the microphone unit provided in the FACP panel.
2. Digital audio communications path derived from the Voice Communications Panel (FACP).
3. A minimum of 16 programmable buttons with active/inactive status indicators that shall be programmed for selection of the following select be used for a range of functions, including

    a. Each paging zone.
    b. All-call paging.
    c. Control for HVAC shutdown, door release, or other emergency functions.
    d. Manual initiation of each prerecorded Mass Notification message.
    e. Other functions programmed as directed by the Owner (coordinate prior to programming).

4. The system shall support up to 7 remote microphone units
5. See the drawings for LOC unit location(s).

I. Provide supervised 24VDC power to the panel from the host FACP panel.

2.11 SYSTEM WIRING

A. General

1. Survivability and pathway configurations

    a. Unless otherwise specified herein, all circuits covered under this specification shall have a pathway survivability level of 0 (pathway defined by NFPA-72 as *“any circuit, conductor, optic fiber, radio carrier, or other means for transmitting system information to remain operational during fire conditions”*).

2. All cables installed underground or below building foundations shall be U.L. listed for exposure to wet locations (West Penn Aquaseal or approved equal).
3. All signaling circuit cables and voice audio circuit cables shall be provided as follows.

    a. NEC Type FPLP for all non-riser type cables (U.L. listed for fire alarm use).
    b. NEC FPLR (not a applicable to this project).
    c. Minimum size shall be #18AWG.

4. All Ethernet IP interface (LAN/WAN connection) circuits shall be as follows.

    a. NFPA-72 Class C.
    b. NEC Type BL.
    c. UTP, Category 6.

5. All floor-to-floor cables serving non-voice audible notification appliances, visual notification appliances, and 24VDC powered devices shall be provided as follows (manufacturer’s requirements shall take priority)

    a. NEC Type FPLR riser type cables, manufactured specifically for fire alarm system applications.
    b. Minimum size shall be #14AWG.

6. All horizontal circuits serving non-voice audible notification appliances, visual notification appliances, and 24VDC powered devices shall be provided as follows (manufacturer's requirements shall take priority)

    a. NEC Type FPLP, manufactured specifically for fire alarm system applications (non-riser type cables).
    b. 600V, THWN insulated wiring.
    c. Minimum size shall be #14AWG.

7. Separation shall be maintained for circuits utilizing copper conductors as required per NFPA 70, Article 760.

B. Initiation device signaling circuit pathways shall be Class B.

1. Floor-to-floor initiation device signaling circuit cable shall be FPLP type as classified by NEC Article 760.

C. LOC signaling circuit pathway shall be Class B.

1. LOC signaling circuit cable shall be FPLP type as classified by NEC Article 760.

D. Visual notification appliance circuit pathways shall be Class B.

E. Audible (voice) notification appliance circuit pathways shall be Class B.

F. All circuits shall be protected (power limited) as required per NFPA 70 to allow notification circuits to be installed in the same conduit as initiation and signaling circuits.

G. Fire Alarm circuits may be solid or stranded as recommended by the equipment manufacturer for each specific application.

2.12 GROUNDING OF LOW VOLTAGE SURGE SUPPRESSION DEVICES

A. Install a #12AWG THHN green insulated equipment grounding conductor in all fire alarm conduits serving low voltage surge suppressors. Connect the grounding conductor to each surge suppressor's grounding terminal and to the ground lug in the power supply or control panel enclosure serving the fire alarm devices connected to the associated fire alarm circuit(s).

2.13 REMOTE MICROPHONE (PAGING) UNITS

A. Furnish a remote microphone (paging) unit that is integral with the Fire Alarm LOC, wall mounted in a semi-flush style enclosure.

B. Remote microphone (paging) units (LOC) shall have the following features

1. Microphone unit with primary features that match the microphone unit provided in the FACP panel.
2. Digital audio communications path derived from the Voice Communications Panel (FACP).

3. A minimum of 16 programmable buttons with active/inactive status indicators that shall be programmed for selection of the following select be used for a range of functions, including

    a. Each paging zone.
    b. All-call paging.
    c. Control for HVAC shutdown, door release, or other emergency functions.
    d. Manual initiation of each prerecorded Mass Notification message.
    e. Other functions programmed as directed by the Owner (coordinate prior to programming).

4. The system shall support up to 7 remote microphone units
5. See the drawings for LOC unit location(s).

2.14 BATTERIES

A. System batteries shall be sealed lead acid type listed for use with Fire Alarm systems.

B. All batteries furnished shall be new (unused) and shall be installed within one (1) year from the date of manufacturer.

2.15 AS-BUILT AND O & M CABINET

A. Provide a heavy duty red hinged cabinet with locking door adjacent to the FACP panel for NFPA-72 Record of Completion and for storage of the on-site fire alarm as-built drawings and O & M manual.

B. The cabinet shall be a surface type enclosure constructed of 16 gauge cold rolled steel and shall be finished with a durable red textured, heat- resistant baked-on enamel finish.

C. The cabinet door shall have a stainless steel piano hinge and a high security CAT 30 keyed door lock. The lock shall be keyed like the fire alarm cabinet.

D. The cabinet shall have a factory mounted code/graphic frame mounted on the door to house the required UL Fire Alarm System Certificate and NFPA-72 Record of Completion document.

1. The frame shall be 8.75” X 11.125” and shall be manufactured from 18-gauge steel with a baked-on red paint finish.
2. The frame shall be provided with a shatter proof Lexan glass

E. Dimensions

1. Cabinet 26-1/4” W x 14-1/4” H x 4” D
2. Door 8-1/2” W x 11” H

F. Model

1. Cabinet Space Age #SSU00677 (or approved equal)
2. Door Space Age #SSU52010 (or approved equal)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The Contractor is responsible for assuring that conduit size and wire quantity, size, and type is suitable for the equipment supplied. The Contractor shall review the proper installation of each type of device with the equipment supplier.

B. All wiring shall be installed in conduit in unfinished spaces and above ceilings, and unless noted otherwise shall be installed in wiremold where located below finished ceilings in finished spaces.

C. Furnish and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760A and B. Upon completion, the Contractor shall so certify in writing to the Owner.

D. For ceiling device installations in suspended tile ceilings, adjustable T-bars & extra deep boxes shall be provided to accommodate specific ceiling types and to provide ample capacity and space for wiring pulling and circuit terminations.

E. Backboxes for all speakers and speaker/strobes shall be extra deep type with depth as required per the manufacturer’s published appliance data sheet.

F. The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

G. Make all fire alarm wiring continuously from control panel (or power extender panel) to device terminals.

H. T-taps are not allowed without approval (submit formal request for specific T-tap applications early in submittal phase and prior to submittal of layout drawings)

I. Protect detectors during construction period as required by NFPA-72.

J. Smoke detectors shall be mounted only in an orientation for which they have been listed.

1. Smoke detectors shall not be located any closer than 3'-0" from any ceiling type HVAC supply or return air grille and shall not be located anywhere within the direct path of any side-wall type HVAC supply air grilles. Separation shall be greater where higher air velocities dictate, and smoke detection performance is likely to be impaired. All devices requiring relocation after installation that were not brought to the attention of the Engineer shall be relocated at the Contractor’s expense.

K. Final locations of all visual notification appliances and combination visual/audible notification appliances shall be adjusted as required up to 3’ maximum from the nearest obstruction (casework, smart board projectors, etc.) to provide unobstructed direct visibility of all visual appliances in the field of view. Review Architectural drawings (where applicable) prior to rough-in phase and report all discrepancies to the Engineer in writing. All devices requiring

relocation after installation that were not brought to the attention of the Engineer shall be relocated at the Contractor's expense

L. Installation and testing of all fire alarm system devices and equipment shall be performed by a qualified electronics contractor licensed specifically for signal systems installation. This Contractor shall be a factory trained representative of the equipment manufacturer and shall be licensed and authorized to install and maintain the fire alarm system approved for the installation.

3.2 CONTROL MODULES

A. Control modules shall be installed within 18 inches of their associated devices to be controlled and in a readily accessible location.

B. Verify locations of interface points with all existing systems in the field with the owner prior to conduit rough-in.

C. Provide control module interfaces for systems including but not limited to the following

1. HVAC unit controllers
2. Smoke door holders
3. Sound reinforcement systems
4. Other (as noted on the drawings)

3.3 MONITORING MODULES

A. Monitoring modules shall be installed within 24 inches of their associated devices to be controlled and in a readily accessible location.

B. Verify locations of interface points with all existing systems in the field with the owner prior to conduit rough-in.

C. Provide monitoring module interfaces for systems including but not limited to the following

1. As noted on the drawings.

D. The contractor shall be responsible for assigning the proper "personality code" for each monitoring module depending on the application.

3.4 PROGRAMMING

A. The system installer shall provide complete programming for all systems whether programming is factory installed or installed in the field by the system installer.

B. The system installer shall derive all user specified programming information (building designations, room descriptions, etc.) from the actual room names and numbers *not the construction drawings*.

C. Provide pre-recorded digital (WAV files) evacuation messages as coordinated with the Engineer and Owner during the submittal review phase. Multiple messages shall be provided for various emergencies including but not limited to fire (automatic), active shooter/terrorist (manually initiated), and emergency weather (manually initiated).

D. All programming changes required by the Owner to render the system usable and functional by the Owner's standards shall be made at the contractor's expense.

3.5 LABELING

A. Control panels, remote amplifier panels (FAAP), local operator consoles (LOC) , and power extender panels (FPE) shall be permanently labeled with their respective panel designations in accordance with general Division 26 labeling requirements.

B. Initiation devices and addressable monitoring and control modules shall be labeled with the SLC loop and address using machine generated stick-on labels.

C. Duct smoke detector test switches and remote alarm indicators shall be labeled with their associated air handler and “SUPPLY” or “RETURN” air duct designation using machine generated stick-on labels.

D. All Fire Alarm panels powered with 120V A.C. power shall be permanently labeled with the following information in accordance with general Division 26 labeling requirements

1. Room name/number containing the 120V panelboard feeding the fire alarm panel.
2. Host 120V branch circuit panelboard and branch circuit number designation.

3.6 120V BRANCH CIRCUIT BREAKER LOCK-OUT, MARKING, AND LABELING

A. All 120V branch circuit breaker handles serving fire alarm panels shall be provided with a “lock-out” type accessory per NFPA-72 requirements with a pad lock (keyed alike - furnish ten keys to the Owner) that allows the circuit breaker to be locked in the “ON” position and allow the circuit breaker to trip in an overload condition.

B. All 120V branch circuit breaker handles serving fire alarm panels shall be permanently marked with red color per NFPA-72 requirements.

C. The 120V panelboard index circuit designations for all 120V branch circuit panelboards serving fire alarm panels shall be identified typically “FIRE ALARM CIRCUIT-FACP”, FIRE ALARM CIRCUIT-FPE”, etc. per NFPA-72 requirements.

3.7 TESTING, GUARANTEE, SERVICE

A. Provide initial certification testing of the system in accordance with the procedures outlined in NFPA 72. The minimum required tests are as follows

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits utilizing an insulation testing device.

3. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
4. Perform the following tests for all system batteries in strict accordance with NFPA-72

    a. Charger test.
    b. Discharge test.
    c. Load voltage test.

5. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
6. Test each initiating and notification circuit. One connection each should be opened at not less than 10 percent of the initiating and notification devices.
7. Test each initiating and notification device for alarm operation and proper response at the control unit.
8. Test smoke detectors and carbon monoxide detectors with listed aerosols acceptable to the manufacturer or other such testing methods which are approved by the manufacturer.
9. Test heat detectors with U.L. listed heat generating test equipment.
10. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual.
11. Verify that each alarm notification device functions as specified. Determine that the system is operable under trouble conditions as specified.
12. Duct Smoke Detector Testing

    a. Use ignitable smoke emitters (by Regin, STI, or equal) to smoke test all duct detectors by introducing test smoke into the air ducts.

13. Field verification of auxiliary function interfaces

    a. Field-verify and pretest each and every interface with existing systems (air handler shut-down, elevator recall, kitchen hood suppression systems, etc.).
    b. Submit a report to the Engineer at least seven (7) calendar days prior to scheduled acceptance testing with final confirmation of proper functioning of each auxiliary system. Each and every auxiliary system shall be listed in line item format with “PASS”/” FAIL” condition documented.

14. Provide all labor required for making one post-acceptance testing field adjustment to all audible notification appliance dB settings as directed by the Owner, Engineer, or Authority Having Jurisdiction (final scope of adjustments to be established by the Engineer following acceptance testing).
15. Provide all other testing required by NFPA 72 but not specified herein.

B. Document all testing in accordance with the National Fire Alarm Code. Submitted documentation shall include but shall not be limited to the following items

    1. Fully completed NFPA-72 Record of Completion form (2019 Edition).
    2. Fully completed NFPA-72 Inspection and Testing form (2019 Edition).

C. Upon completion, the Contractor shall conduct a functional test of the entire system for the Authority Having Jurisdiction, Owner and Engineer.

1. Additional testing and demonstration for the Authority Having Jurisdiction, Owner and Engineer shall be provided as required until the system is demonstrated to be free of unexplained alarms, troubles, faults, or any abnormalities.

D. In the event that additional software programming is necessary due to changes stemming from acceptance testing, the system programming shall be modified and shall be retested per NFPA-72 requirements.

E. All components, parts and assemblies supplied by the manufacturer shall be guaranteed by the manufacturer against defects in materials and workmanship for a period of one (1) year.

F. The equipment manufacturer shall have a local branch office or authorized factory distributor staffed with trained, full-time employees who are capable of performing testing, inspection, repair and maintenance services for the life of the fire alarm system.

3.8 COMPLETION

A. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.

B. Certification

1. The contractor shall certify in a letter to the Engineer that the complete system has been checked in accordance with the required NFPA-72 testing standards and has been installed in accordance with the contract documents and that all items have been labeled.

C. A factory representative shall provide a minimum of 8 hours of owner training in the complete operation and maintenance of the fire alarm system. Final training schedule shall be scheduled with the Owner before building acceptance.

D. Two (2) weeks prior to the final completion, provide to the Owner (through the engineer) a complete printout of the system programming along with CD Rom disk copy of the program. CD Rom disks shall include all manufacturer’s software necessary to perform maintenance and adds. Software shall be installed on the Owner's computer as directed by Owner. Moves and changes to the system shall be provided to the Owner two (2) weeks prior to the final completion.

3.9 SPARE PARTS SPARE PARTS

Device	Qty.
Smoke detectors	2
Complete duct smoke detector assembly (including detector, housing and sampling tube)	1
Manual pull stations	2
Speaker/strobe units (ceiling type)	2

Strobe units (ceiling type)	2
Speaker only units (ceiling type)	1
Speaker/strobe units (wall type)	2
Strobe units (wall type)	2
Speaker only units (wall type)	1
Monitoring module	1
Control modules	1

3.10 KEYS

A. Keys and locks for all equipment shall be identical where possible. Provide not less than six keys of each type required. Identify keys by an appropriate number stamped on each key or on a metal tag attached thereto. Provide a key numbering chart in the operation and maintenance manual furnished.

END OF SECTION

SECTION 283150 – EMERGENCY RESPONDER RADIO COVERAGE SYSTEM (ERRC)

PART 1 - GENERAL

1.1 SCOPE

A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the installation of a complete Emergency Responder Radio Coverage System (ERRC) covering the entire facility.

B. The system design and installation shall be compatible with the radio systems and frequencies used by local emergency responders.

C. The system shall ensure two-way radio communication with the public safety radio system throughout the facility. The system design shall include, but not be limited to, the following primary components

1. Donor antenna
2. Bi-Directional Amplifiers
3. Battery backup units
4. Coaxial distribution system including surge arrestors, attenuators, splitters, couplers and connectors.
5. Directional or Omni-directional antennas or radiating coaxial cables shall be used to provide coverage throughout the facility.

1.2 QUALITY ASSURANCE

A. FCC compliance. The emergency responder radio coverage system installation and components shall comply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219.

B. U.L. 2524 (3rd Edition) **listed**.

C. Lead installation personnel shall have qualifications in accordance SCFC 2021 -510-5.2.

D. The system design and installation shall be in accordance with South Carolina Fire Code (SCFC) 2021 Article 510 and 2019 NFPA-1221.

1.3 SUBMITTALS

A. Submit design drawings, antenna mapping plans, catalog cuts and descriptive literature for approval.

PART 2 - PRODUCTS

2.1 800 MHz System

A. The ERRC system shall be as follows or approved equal

1. Fiplex.

B. Major system components shall be as follows or approved equal

1. Donor Antenna

    a. Yagi (746 – 896 MHz)
    b. Manufacturer/Model Westell #SCI-AY

2. In-building Distribution Antenna

    a. Omni-directional (694 – 6000 MHz)
    b. Gain range 2.2 – 7.1 dBi
    c. Input power 50W @ 77 degrees Fahrenheit (ambient)
    d. Horizontal beamwidth 360°
    e. Mounting Ceiling
    f. Size 13" diameter
    g. Manufacturer Galtronics

3. Bi-directional Amplifier

    a. Class B.
    b. Frequency range 851 – 869 MHz
    c. Composite output power 27dBm
    d. Impedance 500 Ohms
    e. Manufacturer/Model Fiplex #DHS7-A

4. Coaxial cable

    a. Manufacturer/Model

        1) Cable BDA-CABLE-10A
        2) Jumper BDA-JMPRG-10

5. Splitters, couplers and attenuators

    a. Manufacturer/Model Provide per manufacturer’s recommendations

6. Battery Backup Unit (BBU)

    a. Input power 100W
    b. Input voltage 120VAC
    c. DC Output power 270W @ 24VDC
    d. Output voltage 24VDC
    e. Duration on battery power 24 hours (in continuous use mode)
    f. NFPA-1221 compliant

g. Battery enclosure NEMA 4
h. Manufacturer/Model Fiplex #BTTY-100100

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be performed in accordance with manufacturer's design shop drawings. System components requiring 120V power shall be connected to the standby generator power system.

B. Provide and coordinate fire alarm system supervisory connections as required per NFPA-1221.

3.2 ACCEPTANCE TESTING

A. The system shall be tested and demonstrated to the Authority Having Jurisdiction (AHJ) in accordance with the procedure listed in IFC 510.5.3 to ensure that two-way coverage for each area of the building is a minimum of 90 percent. The test procedure shall be conducted as follows

1. The building shall be divided into a grid of 20 approximately equal test areas.
2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.
3. Failure of a maximum of two nonadjacent test areas shall not result in failure of the test.
4. In the event that three of the test areas fail the test, in order to be more statistically accurate, the floor shall be permitted to be divided into 40 equal test areas. Failure of a maximum of four nonadjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 90 percent coverage requirement.
5. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered failure of that test area. Additional test locations shall not be permitted.
6. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building owner so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building owner shall be required to rerun the acceptance test to reestablish the gain values.
7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at time of installation.

END OF SECTION

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

C. Section 015713 - Temporary Erosion and Sediment Control.

D. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.

E. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

F. Section 024100 - Demolition: Removal of built elements and utilities.

G. Section 312200 - Grading: Topsoil removal.

H. Section 312200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

I. Section 312323 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

J. Section 312323 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SITE CLEARING

A. Comply with other requirements specified in Section 017000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

A. Do not remove or damage vegetation beyond the limits indicated on drawings.

B. Install substantial, highly visible fences at least 3 feet high (at least 1 m high) to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.

C. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

D. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
   3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.

E. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 312200
GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site for site structures.

C. Finish grading.

1.02 RELATED REQUIREMENTS

A. Section 311000 - Site Clearing.

B. Section 312316 - Excavation.

C. Section 312316.13 - Trenching: Trenching and backfilling for utilities.

D. Section 312323 - Fill: Filling and compaction.

E. Section 329219 - Seeding: Finish ground cover.

F. Section 329223 - Sodding: Finish ground cover.

G. Section 329300 - Plants: Topsoil in beds and pits.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: See Section 312323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil , unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 312323 for filling procedures.

G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

H. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch (13 mm) in size. Remove soil contaminated with petroleum products.

C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches (75 mm).

D. Place topsoil in areas where seeding are indicated.

E. Place topsoil during dry weather.

F. Remove roots, weeds, rocks, and foreign material while spreading.

G. Near plants spread topsoil manually to prevent damage.

H. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

I. Lightly compact placed topsoil.

J. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.05 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.06 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

3.07 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

END OF SECTION

SECTION 312316
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Document Report of Subsurface Exploration and Engineering Evaluation prepared by Summit Engineering, Laboratory & Testing, P.C. dated March 8, 2023_: Geotechnical report; bore hole locations and findings of subsurface materials.

B. Section 015713 - Temporary Erosion and Sediment Control: Slope protection and erosion control.

C. Section 024100 - Demolition: Shoring and underpinning existing structures.

D. Section 210553 - Identification for Fire Suppression Piping and Equipment: Underground warning tapes at underground fire suppression lines.

E. Section 220553 - Identification for Plumbing Piping and Equipment: Underground warning tapes at underground plumbing lines.

F. Section 230553 - Identification for HVAC Piping and Equipment: Underground warning tapes at underground HVAC lines.

G. Section 260553 - Identification for Electrical Systems: Underground warning tapes at underground electrical lines.

H. Section 311000 - Site Clearing: Vegetation and existing debris removal.

I. Section 312200 - Grading: Soil removal from surface of site.

J. Section 312200 - Grading: Grading.

K. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

L. Section 312323 - Fill: Fill materials, backfilling, and compacting.

M. Section 313700 - Riprap.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bedding and Fill to Correct Over-Excavation:
   1. See Section 312323 for bedding and corrective fill materials at general excavations.
   2. See Section 312316.13 for bedding and corrective fill materials at utility trenches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.
   1. Resurvey benchmarks during installation of excavation support and protection systems and notify Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 311000 for clearing, grubbing, and removal of existing debris.

C. See Section 312200 for topsoil removal.

D. Locate, identify, and protect utilities that remain and protect from damage.

E. Notify utility company to remove and relocate utilities.

F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

G. Protect plants, lawns, rock outcroppings, and other features to remain.

H. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.03 EXCAVATING

A. Excavate to accommodate new structures and construction operations.

B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 SUBGRADE PREPARATION

A. See Section 312323 for subgrade preparation at general excavations.

B. See Section 312316.13 for subgrade preparation at utility trenches.

3.05 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities according to Sections 210553, 220553, 230553, and 260553.

C. See Section 312323 for fill, backfill, and compaction requirements at general excavations.

D. See Section 312316.13 for fill, backfill, and compaction requirements at utility trenches.

E. See Section 312200 for rough and final grading and topsoil replacement requirements.

3.06 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

3.07 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION

SECTION 312316.13
TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Document Report of Subsurface Exploration and Engineering Evaluation prepared by Summit Engineering, Laboratory & Testing, P.C. dated March 8, 2023 : Geotechnical report; bore hole locations and findings of subsurface materials.

B. Section 033000 - Cast-in-Place Concrete.

C. Section 312200 - Grading: Site grading.

D. Section 312316 - Excavation: Building and foundation excavating.

E. Section 312323 - Fill: Backfilling at building and foundations.

1.03 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill - Fill Type A-1, A-2 or A-3: Subsoil excavated on-site.
   1. Graded.
   2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.

B. Structural Fill - Fill Type A-1, A-2 or A-3: Subsoil excavated on-site.
   1. Graded.
   2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.

C. Concrete for Fill: Lean concrete.

D. Granular Fill - Fill Type A-1: Coarse aggregate, complying with State of South Carolina Highway Department standard.

E. Topsoil: See Section 312200.

2.02 ACCESSORIES

A. Geotextile: See Section 310519.

2.03 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 312200 for additional requirements.

C. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Architect.

3.03 TRENCHING

A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove excavated material that is unsuitable for re-use from site.

G. Remove excess excavated material from site.

H. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

I. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect.

3.04 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.05 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Correct areas that are over-excavated.
   1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated:

H. Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

3.07 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch (25 mm) from required elevations.

3.08 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION

SECTION 312500
EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Permanent erosion and sediment control.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for permanent erosion control structures indicated on drawings.

B. Section 312323 - Fill: Filling and compaction.

C. Section 313700 - Riprap: Stabilization using riprap.

D. Section 321123 - Aggregate Base Courses: Aggregate base course.

E. Section 329219 - Seeding: Permanent turf for erosion control.

F. Section 329223 - Sodding: Permanent turf for erosion control.

G. Section 329300 - Plants: Permanent plantings for erosion control.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with requirements of SCDHEC and the City of Columbia for erosion and sedimentation control, as specified by the NPDES, for Phases I and II, and in compliance with requirements of Construction General Permit (CGP), whether the project is required by law to comply or not.

2.02 ACCESSORY MATERIALS

A. Fill Material: See Section 312323.

B. Mulching Material: See Section 329219.

C. Grass Seed for Permanent Cover: See Section 329219.

D. Sod for Permanent Cover: See Section 329223.

E. Plants for Permanent Cover: See Section 329300.

F. Crushed Stone and Gravel: See Section 321123 for aggregate.

G. Riprap: See Section 313700.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish documentation required to obtain applicable permits.

3.03 FIELD QUALITY CONTROL

A. Provide analysis of topsoil fill; see Section 014000.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

C. Submit minimum 10 oz (280 g) sample of proposed topsoil. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

3.04 INSTALLATION

A. Hydroseeding: Apply seeded slurry with a hydraulic seeder at a rate of 2,000 lbs per acre evenly in two intersecting directions.

3.05 MAINTENANCE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.

B. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

C. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.

D. Repair deficiencies immediately.

3.06 CLEAN UP

A. Clean out sediment control structures that are to remain as permanent measures.

END OF SECTION

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.6 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites , including Formosan termites (Coptotermes formosanus). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

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

a. BASF Corporation.
b. Bayer Environmental Science.
c. Ensystex, Inc.
d. Syngenta Crop Protection, LLC.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
3. Masonry: Treat voids.

4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 313116

SECTION 313700
RIPRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Riprap .

1.02 RELATED REQUIREMENTS

A. Section 312323 - Fill: Aggregate requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Riprap: Provide in accordance with South Carolina.

B. Aggregate: Granular fill, see Section 312323.

PART 3 EXECUTION

3.01 PLACEMENT

A. Place riprap at culvert pipe ends, embankment slopes and as indicated.

END OF SECTION

SECTION 321123
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Paving aggregates.

1.02 RELATED REQUIREMENTS

A. Section 312200 - Grading: Preparation of site for base course.

B. Section 312316.13 - Trenching: Compacted fill over utility trenches under base course.

C. Section 312323 - Fill: Topsoil fill at areas adjacent to aggregate base course.

D. Section 312323 - Fill: Compacted fill under base course.

E. Section 321216 - Asphalt Paving: Finish and binder asphalt courses.

F. Section 321313 - Concrete Paving: Finish concrete surface course.

G. Section 330561 - Concrete Manholes: Manholes including frames.

1.03 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses 2017 (Reapproved 2021).

B. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).

C. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.

D. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).

E. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2023.

1.04 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When aggregate materials need to be stored on site, locate where indicated on drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Coarse Aggregate Type 5, 57, 67, 789: Coarse aggregate, complying with State of South Carolina Highway Department standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Spread aggregate over prepared substrate to a total compacted thickness indicated on Construction Plans.

B. Under Bituminous Concrete Paving:
   1. Place coarse aggregate to a total compacted thickness indicated on Construction Plans.
   2. Compact to 95 percent of maximum dry density.

C. Under Portland Cement Concrete Paving:
   1. Place coarse aggregate to a total compacted thickness indicated on Construction Plans.
   2. Compact to 95 percent of maximum dry density.

D. Place aggregate in maximum 4 inch (100 mm) layers and roller compact to specified density.

E. Level and contour surfaces to elevations and gradients indicated.

F. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

G. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6.4 mm) measured with 10 foot (3 m) straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch (6.4 mm).

C. Variation From Design Elevation: Within 1/2 inch (12.8 mm).

3.05 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for general requirements for field inspection and testing.

B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

D. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Single course bituminous concrete paving.

C. Double course bituminous concrete paving.

D. Surface sealer.

1.02 RELATED REQUIREMENTS

A. Section 312200 - Grading: Preparation of site for paving and base.

B. Section 312323 - Fill: Compacted subgrade for paving.

C. Section 321313 - Concrete Paving: Concrete substrate.

D. Section 321313 - Concrete Paving: Concrete curbs.

1.03 REFERENCE STANDARDS

A. AI MS-2 - Asphalt Mix Design Methods 2015.

B. AI MS-19 - Basic Asphalt Emulsion Manual 2008.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with State of South Carolina Highways standard.

B. Mixing Plant: Complying with State of South Carolina Highways standard.

C. Obtain materials from same source throughout.

1.05 FIELD CONDITIONS

A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate for Base Course: In accordance with State of South Carolina Highways standards.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

A. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 AGGREGATE BASE COURSE

A. Place and compact aggregate base course.

3.03 PREPARATION - PRIMER

A. Apply primer in accordance with manufacturer's instructions.

B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).

C. Use clean sand to blot excess primer.

3.04 PREPARATION - TACK COAT

A. Apply tack coat in accordance with manufacturer's instructions.

B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).

3.05 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Install Work in accordance with State of South Carolina Highways standards.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

D. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.06 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

A. Place asphalt binder course within 24 hours of applying primer or tack coat.

B. Place asphalt wearing course within two hours of placing and compacting binder course.

C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.07 SEAL COAT

A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.

3.08 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch (12 mm).

3.09 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for quality control.

B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

A. Section 032000 - Concrete Reinforcing.

B. Section 033000 - Cast-in-Place Concrete.

C. Section 312200 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.

D. Section 312323 - Fill: Compacted subbase for paving.

E. Section 321216 - Asphalt Paving: Asphalt wearing course.

1.03 REFERENCE STANDARDS

A. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide 2022.

B. ACI SPEC-301 - Specifications for Concrete Construction 2020.

C. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on joint filler, admixtures, and curing compound.

PART 2 PRODUCTS

2.01 FORM MATERIALS

2.02 REINFORCEMENT

A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 032000.

2.03 CONCRETE MATERIALS

A. Concrete Materials: As specified in Section 033000.

2.04 ACCESSORIES

2.05 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.

1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended by manufacturer.

D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard (0.89 kg per cubic meter), or as recommended by manufacturer for specific project conditions.

E. Concrete Properties:

1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4,000 psi.

2.06 MIXING

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 321123 for construction of base course for work of this Section.

3.03 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

3.04 PLACING CONCRETE

A. Place concrete in accordance with State of South Carolina Highways standards.

B. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

3.05 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 3/8 inch (10 mm) wide expansion joints at 20 foot (6 m) intervals and to separate paving from vertical surfaces and other components and in pattern indicated.

3.06 FINISHING

A. Area Paving: Light broom, texture perpendicular to pavement direction.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius (6 mm radius).

C. Curbs and Gutters: Light broom, texture parallel to pavement direction.

3.07 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch (6 mm) in 10 ft (3 m).

B. Maximum Variation From True Position: 1/4 inch (6 mm).

END OF SECTION

SECTION 321723
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Painted pavement markings.

1.02 RELATED REQUIREMENTS

A. Section 321216 - Asphalt Paving.

B. Section 321313 - Concrete Paving.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.04 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).

1.05 SEQUENCING

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Painted Pavement Markings:
   1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
   2. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Velvet Zone Marking Paint.
   3. Kelly-Moore Paints; 1254 Waterborne Fast Dry Traffic Interior/Exterior Paint, Flat.

2.02 PAINTED PAVEMENT MARKINGS

A. Comply with State of South Carolina Highway Department standards.

B. Painted Pavement Markings: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Identify existing markings for removal.

B. Verification of Conditions: Verify that pavement is dry and ready for installation.

C. Notify Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

A. Establish survey control points for locating and dimensioning of markings.

B. Place barricades, warning signs, and flags as necessary to alert approaching traffic.

C. Clean surfaces prior to installation.
   1. Remove dust, dirt, and other debris.

3.03 INSTALLATION

A. General:
   1. Position pavement markings as indicated on drawings.

2. Field location adjustments require approval of Architect.

B. Painted Pavement Markings:
   1. Apply in accordance with manufacturer's instructions.
   2. Apply in accordance with State of South Carolina Highway Department standards.

3.04 PROTECTION

A. Prevent approaching traffic from crossing newly applied pavement markings.

B. Replace damaged or removed markings at no additional cost to Owner.

C. Preserve survey control points until pavement marking acceptance.

END OF SECTION

SECTION 323113 – STAGGERED ALUMINUM PLANK SCREENING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the following fence system:
   1. Semi-private staggered panels fabricated with extruded aluminum planks and structural aluminum profiles including extruded aluminum fence posts and aluminum panel gates, offset front to back to create shadowbox. Semi-private panel security screening and gates shall be furnished and installed as shown on the plans and specified herein, overall height of semi private screening shall be as noted on drawings.
   2. Integral gates.

1.2 REQUIREMENTS

A. Furnish materials, labor, expertise, and equipment necessary to complete all work specified in this section and as shown on the drawings.

B. Structural Performance: Provide product and installation capable of withstanding the effects of gravity lads and the following loads and stresses within limits and under conditions indicated.
   1. Uniform pressure of 30 lbf/sq. ft. acting inward or outward.
   2. Thermal Movements resulting from a temperature change (range) of 120 degrees Fahrenheit ambient and 180 degrees Fahrenheit material surfaces.

C. Footings and Concrete Anchorage to be Delegate Design by fence manufacturer by licensed SC Engineer.

1.3 SUBMITTALS

A. Shop drawings and manufacturer’s literature: Provide specifications and construction detail drawings to substantiate quality of materials and provide details of fabrication and installation.

B. Submittals shall be in accordance with standard construction practices to include complete detailed layout of all panels, posts, gates. Submittals shall include plan layout, elevations and section views of panels, posts, and gates.
   1. Include signed/sealed drawings by Delegated Design.

C. Certificate: Manufacturer’s certification that materials meet specification requirements.

1.4 REFERENCES

A. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plates.

B. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Ally Extruded Bars, Rods, Wire, Profiles, and Tubes.

C. ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test.

D. ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation.

E. ASTM B117 – Standard Practice for Operating Salt Spray Apparatus.

F. ASTM D822 – Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

G. AWS D1.2 Structural Welding Code – Aluminum.

1.5 QUALITY ASSURANCE

A. Installation of fence and materials shall conform to the requirements of the fence manufacturer.

B. The fence shall be warranted from any defects in materials and workmanship for a period as specified in the relevant section of the contract documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Semi-private panel security fence:
   1. Basis-of-Design Manufacturer:
      a. PalmSHIELD
      b. Similar products by other manufacturers will be considered if submitted as substitution during bidding.
   2. Material Descriptions:
      a. Extruded Aluminum: ASTM B 221, Alloy 6063 – Temper T-6.
      b. Sheet Aluminum: ASTM B211, Alloy 6063 - Temper T6.
      c. Powder Coating Material Hardness: ASTM 3363 2H.
   3. Panel Description:
      a. Panel Height: See drawings.
      b. Panel Width: Not to exceed 60”.
      c. Semi-private system consisting of horizontal planks fabricated with extruded aluminum framing structural profiles and supported by extruded aluminum fence posts. Planks are offset front to back to create shadowbox.
      d. Infill. Alternating 1” x 5” x .090” tubular extruded aluminum sections. Planks are offset front to back to create shadowbox.

e. Vertical Framework: PalmSHIELD exclusive 4” wide x 2” deep x 1/8” tapered aluminum channel compression profile. Patent pending.
f. Horizontal Top Cap: 4” x 3” x 1/8” aluminum channel.
g. Horizontal Bottom Cap: 4” x 3” x 1/8” aluminum channel.
h. Cross Bar: 1” x 1/8” aluminum flat bar.

4. Fence Posts:
   a. Panel posts shall be PalmSHIELD exclusive 4” deep x 3” wide I-Beam Post. Patent pending. Extruded tubular aluminum sections with solid aluminum caps. Length as specified on the contract drawings.
      1) 5/16” double walled webbing with 5/8” wide cavity.
      2) 5/16 flanges.
      3) Inner flange mechanically fastened to webbing with 3/8” stainless steel fastener.
      4) Outer flange and webbing form one extrusion.
   b. On center post spacing shall be as specified by manufacturer.
   c. All fence posts to be plated with 10” x 10” x 3/4” aluminum plates with four 3/4” holes for anchors. Provide reinforced concrete footing depth and width as designed by fence manufacturer.
5. Fittings and accessories: All fittings and accessories shall be stainless steel and sized as specified by the fence manufacturer. Fence panels to be attached to posts with 1/4” x 1” stainless steel screws. Panels and posts are predrilled to support level installation.
6. Anchor Bolts: Anchor bolts shall be provided by manufacturer and adequate to support loads based on screening height, exposures and loading.
7. Gates: Swing to exterior of enclosure, size as shown on contract drawings.
   a. Panel spacing, style and appearance shall be identical to fence panels.
   b. Gate hinges to be Gorilla barrel hinge with 3/4” rod, ball bearing, and grease zert. Hinge plate to be 1/2” thick plates offset to create a 5/8” gap. Standard hardware as required by the gate manufacturer for complete functional operation. Hinges to be bolted to gate frame and field welded to steel gate posts.
   c. Gate latch to be internal lock with exterior grab handles. Lock may be keyed and rekeyed. Lock is accessible from both sides of gate.
   d. Welded frame, size as shown on the contract drawings, extruded aluminum tubing with aluminum fixed panels to match fencing material.
   e. Drop rods to be 1” schedule 40 pipe and through bolted to gate frame.
   f. Hardware: Size and type as determined by the manufacturer. Provide three hinges per leaf.
      1) Provide 1 inch diameter center cane bolt assembly and strike, each door.
      2) Provide pad lockable slide bolt assembly.
   g. Gate shall have welded frame fabricated from extruded aluminum tubing with aluminum panels to match fencing material. Frame configurations shall be as indicated on the contract drawings.
   h. Gate posts shall be as determined by manufacturer. Gate posts to be specified to support gates.
8. Factory Finish: Aluminum fence panels, posts and gates shall receive polyester powder coating.
   a. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

b. Color shall be as selected by Architect from manufacturers full range of colors and finishes.
c. Minimum hardness measured in accordance with ASTM D3363 2H.
d. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
e. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95% relative humidity after 1,000 hours, less then 3/16 inches undercutting.
f. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted 45 degrees.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that final grading in fence location is completed and without irregularities which will interfere with fence installation. Palm SHIELD is designed to be installed on a level surface. Variations in height, slopes, stairs, steeping shall be shown on contract drawings and on submittal drawings.

B. Field verify all fence dimensions and layout prior to commencing installation.

C. Do not commence work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fence in accordance with manufacturer's installation instructions.

B. Install fence plumb and level. Posts are plated and mounted to top of surface.

C. Do not install bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Secure fence panels with stainless with 1/4” x 1” stainless steel screws to fence posts. All posts and panels will be predrilled to support level installation.

E. Gates:
1. Install gates and adjust hardware for smooth operation.

END OF SECTION 323113

SECTION 329219
SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.

B. Placing topsoil.

C. Hydroseeding, mulching and fertilizer.

D. Soil pH neutralizer.

E. Maintenance.

1.02 RELATED REQUIREMENTS

A. Section 312200 - Grading.

B. Section 329119 - Landscape Grading.

1.03 REFERENCE STANDARDS

1.04 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Sample: Submit minimum 10 oz (280 g) sample of proposed topsoil. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Certificate: Certify seed mixture approval by authority having jurisdiction.

D. Test Reports: Indicate nitrogen, phosphorus, potash, soluble salt, organic matter, and pH.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

A. Seed Mixture:
   1. Merion Blue Grass: ____ percent.
   2. Kentucky Blue Grass: ____ percent.
   3. Creeping Red Fescue Grass: ____ percent.
   4. Streambark Wheat: ____ percent.
   5. Red Top: ____ percent.
   6. Norlea Perennial Rye: ____ percent.
   7. Clover: ____ to ____ percent.

B. Regulatory Requirements:
   1. Comply with regulatory agencies for fertilizer and herbicide composition.
   2. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

2.02 SOIL MATERIALS

A. Topsoil: Type ____; see Section 329119.

B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

C. Topsoil: Excavated from site and free of weeds.

D. Regulatory Requirements:
   1. Comply with regulatory agencies for fertilizer and herbicide composition.
   2. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

2.03 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Fertilizer: Recommended for grass, slow release nitrogen, biological materials, and biostimulant materials; of proportion necessary to eliminate deficiencies of topsoil.
   1. Manufacturers:
      a. Profile Products; BioPrime: www.profileevs.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

C. Soil pH Neutralizer: Recommended for planting and re-vegetating areas with acidic soils, as indicated by analysis.
   1. Manufacturers:
      a. Profile Products; NeutraLime Dry: www.profileevs.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

D. Biostimulant: Recommended to accelerate vegetation establishment.

E. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

F. Erosion Fabric: Jute matting, open weave.

G. Stakes: Softwood lumber, chisel pointed.

H. String: Inorganic fiber.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION

A. Prepare subgrade in accordance with Section 312200.

B. Place topsoil in accordance with Section 329119.

3.03 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.04 SOIL NEUTRALIZER

A. Apply in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply soil neutralizer at same time or with same machine used to apply seed.

D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.

E. Lightly water to aid dissipation.

3.05 SEEDING

A. Apply seed at a rate of ____ lbs per 1000 sq ft (____ Kg per 1000 sq m) evenly in two intersecting directions. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Do not sow immediately following rain, when ground is too dry, or during windy periods.

D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.

E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.

F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.06 HYDROSEEDING

A. Apply seeded slurry with a hydraulic seeder at a rate of ____ lbs per 1000 sq ft (____ Kg per 1000 sq m) evenly in two intersecting directions.

B. Do not hydroseed area in excess of that which can be mulched on same day.

C. Immediately following seeding, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.

E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.07 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

3.08 MAINTENANCE

A. See Section 017000 - Execution Requirements, for additional requirements relating to maintenance service.

END OF SECTION

SECTION 330561
CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete manholes.

B. Grade adjustments.

C. Frames and covers.

1.02 RELATED REQUIREMENTS

A. Section 312316 - Excavation.

B. Section 312323 - Fill.

C. Section 333113 - Site Sanitary Sewerage Gravity Piping.

1.03 REFERENCE STANDARDS

A. AASHTO HB - Standard Specifications for Highway Bridges 2005, with Errata.

B. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

D. ASTM C55 - Standard Specification for Concrete Building Brick 2022.

E. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2020.

F. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants 2009 (Reapproved 2019).

G. ASTM C1634 - Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units 2023.

PART 2 PRODUCTS

2.01 CONCRETE MANHOLES

A. Weight Rating: H 10 according to AASHTO HB.

B. Precast Concrete Manholes: Comply with ASTM C478/C478M, reinforced.
   1. Wall Thickness: 6 inches (152 mm).
   2. Base Thickness: 12 inches (305 mm).
   3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
   4. Joint Sealant: Comply with ASTM C990.

C. Grade Adjustments:
   1. Concrete Bricks: ASTM C1634 or ASTM C55 Grade N, cored, normal weight.

D. Frame and Cover: Cast iron construction, ASTM A48/A48M Class 30B, machined flat bearing surface; hinged; sealing gasket.

2.02 ACCESSORIES

A. Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.

B. Precast Concrete Manholes:
   1. Place base section plumb and level.

2. Install joint sealant uniformly around section lip.

C. Grade Adjustments:
1. Lay brick or masonry units uniformly on mortar bed with full head joints, running bond. Top with mortar, plumb and level.
2. Place adjacent materials tight, and smooth following design grades.

D. Frames and Covers:
1. Place frame plumb and level.
2. Mount frame on mortar bed at indicated elevation.
3. Place grate in frame securely.

END OF SECTION

SECTION 331416
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water pipe for site conveyance lines.

B. Pipe valves.

C. Fire hydrants.

1.02 RELATED REQUIREMENTS

A. Section 099113 - Exterior Painting.

B. Section 211100 - Facility Fire-Suppression Water-Service Piping.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 330561 - Concrete Manholes.

1.03 REFERENCE STANDARDS

A. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2021.

B. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.

C. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals 2019.

D. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2023.

E. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service 2019.

F. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm) 2022.

PART 2 PRODUCTS

2.01 WATER PIPE

A. PVC Pipe: AWWA C900 Class 100:
   1. Fittings: AWWA C111/A21.11, Schedule 40 per ASTM D2466 or schedule 80 per ASTM D2467.
   2. Joints: ASTM D3139 compression gasket ring.

B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.02 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves 3 Inches (75 mm) and Over:
   1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.

2.03 HYDRANTS

A. Hydrants: Type as required by utility company.

B. Pressure Rating: According to utility company.

C. Finish: Primer and two coats of enamel in color required by utility company.

2.04 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.03 INSTALLATION - PIPE

A. Route pipe in straight line.

B. Install pipe to allow for expansion and contraction without stressing pipe or joints.

C. Slope water pipe and position drains at low points.

3.04 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with Section 211100.

D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground in accordance with Section 211100.

E. Locate control valve 4 inches (100 mm) away from hydrant.

F. Provide a drainage pit 36 inches (900 mm) square by 24 inches (600 mm) deep filled with 2 inches (50 mm) washed gravel. Encase elbow of hydrant in gravel to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer.

G. Paint hydrants in accordance with Section 099113.

END OF SECTION

SECTION 333113
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

1.02 RELATED REQUIREMENTS

A. Section 312316 - Excavation: Excavating of trenches.

B. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

C. Section 312323 - Fill: Bedding and backfilling.

D. Section 330561 - Concrete Manholes.

1.03 REFERENCE STANDARDS

A. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.

B. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Plastic Pipe: ASTM D2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter indicated on Construction Plans bell and spigot style solvent sealed joint end.

B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 312316.13 for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
   1. Plastic Pipe: Also comply with ASTM D2321.

B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

C. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.

END OF SECTION

SECTION 334211
STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stormwater drainage piping.

B. Stormwater pipe accessories.

1.02 RELATED REQUIREMENTS

A. Section 312316 - Excavation: Excavating of trenches.

B. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

C. Section 312323 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS

A. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2022a.

B. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2022a.

C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2021.

D. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2021.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

A. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class III with Wall type A; mesh reinforcement; inside nominal diameter indicated on Construction Plans, bell and spigot end joints.

B. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.

2.02 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 312316.13 - Trenching for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

C. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.

END OF SECTION

SECTION 334213
STORMWATER CULVERTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe culvert, joints and accessories.

1.02 RELATED REQUIREMENTS

A. Section 312316 - Excavation: Excavating of trenches.

B. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

C. Section 312323 - Fill: Bedding and backfilling.

D. Section 313700 - Riprap.

1.03 REFERENCE STANDARDS

A. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2022a.

B. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2022a.

PART 2 PRODUCTS

2.01 CULVERT PIPE, GENERAL

A. Regulatory Requirements: Comply with applicable code for materials and installation of the work of this section.

2.02 CONCRETE CULVERT PIPE

A. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class III with Wall Type A; mesh reinforcement; bell and spigot end joints:
   1. Shape: Circular with a nominal diameter indicated on Construction Plans.

2.03 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 EXCAVATING

A. See Section 312316.13 - Trenching for additional requirements.

B. Excavate culvert trench to 12 inches (300 mm) below pipe invert. Hand trim excavation for accurate placement of pipe to elevations indicated.

3.02 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe and accessories in accordance with manufacturer's instructions

C. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

D. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.

E. Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.

3.03 PIPE ENDS

3.04 TOLERANCES

A. Lay pipe to alignment and slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

END OF SECTION

SECTION 334600
STORMWATER MANAGEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stormwater ponds.

B. Outlet structures for stormwater ponds.

1.02 RELATED REQUIREMENTS

A. Section 312316 - Excavation.

B. Section 312316.13 - Trenching.

C. Section 312323 - Fill.

D. Section 334211 - Stormwater Gravity Piping.

1.03 REFERENCE STANDARDS

A. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures 2021.

B. ASTM D3282 - Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes 2015.

PART 2 PRODUCTS

2.01 STORMWATER PONDS

A. Fill: See Section 312323.

B. Impermeable Layer: Group A-4 in accordance with ASTM D3282.

2.02 OUTLET STRUCTURES FOR STORMWATER PONDS

A. Precast Concrete: Reinforced, integrated lift rings, in accordance with ASTM C913.
   1. Concrete: 4,000 psi (27.5 MPa) minimum 28 day compressive strength.
   2. Wall Thickness: 4 inches (102 mm).

B. Trash Racks: Cast iron, heavy duty bar screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify excavations are at correct topographies and areas to be filled are not compromised with surface or ground water.
   2. Verify items provided by other sections of work are properly sized and located.

3.02 POND CONSTRUCTION

A. Fill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.

3.03 POND OUTLET CONSTRUCTION

A. Precast Structure: Place structure sections plumb and level, trim to correct elevations.

B. Set trash racks level without tipping, to correct elevations.

END OF SECTION