

SPECIFICATIONS FOR ELECTRICAL CONTRACTORS
THE UNIVERSITY OF TENNESSEE
KNOXVILLE, TENNESSEE

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SECTION 16050

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section and all following Division 16, Electrical Specifications.

1.02 SCOPE:

- A. Furnish all labor, materials, equipment and services necessary for and reasonably incidental to the complete installation of all electrical as shown on the drawings and as specified herein to result in a finished and operating facility.
- B. Principal features of the installation are as follows:
 - 1. Service entrance, branch panelboards, wiring devices, etc.
 - 2. Lighting fixtures and lamps.
 - 3. Wiring in connection with mechanical equipment.
 - 4. Outside lighting and control.
 - 5. Emergency lighting system.
 - 6. Telephone system provisions.
 - 7. Control systems.
 - 8. Control wiring provisions.
 - 9. Electric unit heaters.
 - 10. Underground system installation.
 - 11. Connection of equipment.

12. Demolition of existing electrical systems.
13. Fire alarm system.
14. Sound system.
15. Computer system provisions and relocation of existing computer equipment.
16. Security and CCTV systems.

1.03 CODES AND STANDARDS:

- A. The entire electrical installation shall be made in strict accordance with the requirements of any and all City, County, State or Federal codes of Law having jurisdiction, the requirements and recommendations of the Board of Fire Underwriters, including all amendments and/or additions to the said codes, laws, requirements, and recommendations, the requirements and recommendations of the local utility, the Owner, and the Standard Building Code Congress International, Inc. Standard Codes.
- B. Should any work shown on the drawings or herein specified be construed as being contrary to or not conforming to the previously mentioned codes, laws, etc., the same shall be brought to the attention of the Designer or Owner's Representative to be reviewed, approved, and/or corrected prior to final bid date.
- C. Should any work shown on the drawings or herein specified be more rigid as to requirements than the requirements of the various codes, the drawings and specifications shall be followed in executing the work.
- D. The Contractor shall file with proper authorities all necessary drawings as required by various codes, laws, ordinances and/or other requirements.
- E. Permits, inspections and fees: The Contractor shall obtain all permits and inspections required for the work, and shall pay all costs and fees thereof including the Power Company's contribution to construction costs.

1.04 RELATED PROJECT DOCUMENTS:

- A. The complete set of project documents contain requirements that relate to the electrical construction work specified by the Division 16 electrical specifications and illustrated by the electrical design drawings. All project documents shall be referenced and conformed with for the required electrical installation work. Each Division 16 specification section or subsection relates to all other Division 16 sections or subsections. No specification section may be used as stand alone requirements.

1.05 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical construction products of types required for this project, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with not less than 5 years of successful experience in installation of products similar to those required for this project.
- C. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical equipment and installation required for this project.
- D. NEC Compliance: Comply with NEC and NESC as applicable to installation of equipment and installation required for this project.
- E. Comply with all current work safety rules and regulations as well as the owners safety requirements and regulations.

PART 2 - GENERAL ELECTRICAL REQUIREMENTS

2.01 REQUIREMENTS:

- A. Drawings indicate the general character, scope, and arrangements of the electrical installation. Approval of any change or departure from the drawings must be obtained from the Designer or Owner's Representative.
- B. Equal Products: Those items on the drawings or in these specifications designating particular product numbers limit their use only as to design, workmanship and quality, not manufacturer. Approval for alternate or substitute items shall be secured from the Owner's Representative, and submittals for

approval must be accompanied by all necessary descriptions, catalog sheets, etc. Authority over such submittals shall rest with the Owner's Representative.

- C. **Workmanship:** All work shall be performed by skilled workmen in a manner reflecting the best modern construction practices. It shall present, upon completion, a neat, orderly, finished appearance. All evidence of debris associated with the work shall be removed from the premises. Conform to all OSHA workplace requirements.
- D. **Coordination with other trades to the fullest of ability in relation with others to result in a professional installation shall be complete, and more specifically, as follows:**
1. The drawings and specifications are based on the best information available when prepared. Frequently minor changes occur with respect to the architectural plans, construction, and the requirements of equipment furnished by others. The electrical contractor shall recognize this in bidding, supervising, and in planning construction.
 2. Before locating conduit runs, boxes, etc., the drawings shall be carefully checked to see that they are in accord with the electrical drawings. Required adjustments shall be made with the General Contractor's superintendent and with the Designer.
 3. Before proceeding with the wiring for mechanical, owner furnished material and equipment trades, each item requiring electrical work shall be reviewed with those responsible for their installation. The electrical contractor shall become well acquainted with their characteristics, location and arrangement for mounting. Changes in wiring arrangements and other adjustments necessary or desirable shall be reviewed with the Owner's Representative for authorization. This applies also to all equipment for which wiring is required, such as HVAC units, water heating, pumps, thermostats, motors, pushbuttons, limit switches, fire protection systems, shop equipment, cooking equipment etc., as they occur.
- E. **Allowances for Contingencies:** No change in contract price will be allowed for alternate work which requires approximately the same work to adjust or relocate electrical components or devices as part of the construction coordination work. An adequate allowance shall be included in the bid price for such coordination contingencies and for the additional work required by these coordination adjustments.

- F. Record Drawings: The job supervisor shall maintain a set of prints on the job to be used to illustrate and note job changes as they occur. This shall include the locations of concealed or underground lines sizes over 1", the type of lighting fixtures provided, and any other information necessary to record the job as actually installed. Upon completion of the prints, the electrical contractor shall furnish to the Designer at the contractor's expense, a set of reproducible drawings containing the above-mentioned field notes.
- G. Coordinate the proposed locations of major raceway systems, equipment, and materials. Include the following:
1. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance. Comply with code requirements for working space about electrical equipment.
 2. Exterior wall and foundation penetrations.
 3. Fire-rated wall and floor penetrations.
 4. Equipment connections and support details.
 5. Sizes and location of required concrete pads and bases.
 6. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 7. Penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 8. Coordinate and integrate ceiling installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.
- H. Materials shall be new and unused and shall bear the Underwriters' Seal where applicable.
- I. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- J. Retain two sets of all equipment or device installation instructions and submit to the Owner's Representative prior to project completion.

3.01 ROUGH-IN:

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to individual equipment shop drawings prior to rough-in installation work.
- B. Refer to equipment specifications in Divisions 2 through 16 and the complete project drawing set for rough-in requirements.

3.02 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- F. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- G. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to

arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner's Representative.

- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.03 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Owner's Representative, uncover and restore Work to provide for Owner's Representative observation of concealed Work.
 - 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to

removal of electrical items indicated to be removed and items made obsolete by the new Work.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Patch existing finished and disturbed new finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required or the surface and building components being patched.

3.04 TEST AND GUARANTEES:

- A. The Contractor shall perform, prior to final acceptance, an operations test to all electrical equipment. The entire installation shall be free from grounds and short circuits. Before the Owner operates the equipment for the first time, the Contractor shall furnish a person familiar with the equipment to instruct and assist the Owner's personnel in the proper operation and maintenance of said equipment.
- B. Warranty-Guarantee: The electrical contractor shall warrant that all work executed under this Division of the specifications will be free from defects in materials and workmanship for a period of one year from the date of final acceptance of the building. The above parties agree that they will, at their own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the warranty-guarantee.

3.05 PROTECTION OF MATERIALS:

- A. All work, fixtures, and materials shall be protected at all times. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemical, or mechanical injury. At final completion, all work shall be thoroughly cleaned and delivered in an unblemished condition.
- B. The Contractor shall defer the installation of all electrical fixtures liable to damage until authorized by the Owner's Representative. After fixtures are

permanently installed, they shall be completely protected against breaking, damage, or the depositing of any waste or materials therein or thereon until the system is accepted.

- C. Touch up all damaged painted surfaces on equipment to match original paint.

3.06 SHOP DRAWINGS AND MAINTENANCE MANUALS:

- A. Shop Drawings: Furnish quantity, in accordance with Division I requirements, shop drawings and wiring diagrams for the following:
 - 1. Panelboards.
 - 2. Fire Alarm System.
 - 3. Security System.
 - 4. CCTV System.
- B. Materials and Equipment Submittals: Furnish catalog sheets or cuts for all items above, and submit catalog data of the following:
 - 1. Lighting fixtures.
 - 2. Exit signs.
 - 3. Emergency lighting fixtures.
 - 4. Panelboards.
 - 5. Wiring devices.
 - 6. Control devices.
 - 7. Disconnect switches.
 - 8. Fire stop assemblies.
- C. Furnish all equipment submittals in one package to Engineer for approval. All partial submittals will be rejected, or will be held unchecked until submittals are complete.

- D. Maintenance Manuals: Upon completion of the work, deliver to the Designer for the Owner's use, two copies each of complete operation and maintenance instructions and data for the electrical equipment furnished under the electrical contract work. Data shall include catalog pages or data sheets for each piece of equipment, wiring diagrams showing the internal and external elements and their connections, manufacturer's maintenance manuals, bills of materials showing necessary data for ordering repair parts, and approved shop drawings. This information shall be furnished for the following systems and items.
1. Lighting fixtures.
 2. Exit signs.
 3. Fire alarm system.
 4. Panelboards.
 5. Emergency lighting system.
 6. Security System.
 7. CCTV System.

3.07 WORK IN CONNECTION WITH EQUIPMENT FURNISHED BY OTHERS:

- A. Mechanical: Furnish and install all necessary wiring for the supply and control of all mechanical work, including plumbing, heating, air conditioning, and ventilation. Furnish and install disconnect switches for motors where required by the codes. The contractor shall make provisions for variations in the mechanical equipment and make connections as required by the actual equipment furnished.
- B. Motor Wiring:
1. Services to equipment shall be checked out against that required by the equipment prior to service connection. Should the equipment require service different to that provided, the contractor shall call that fact to the attention of the Designer prior to connection of the service. Check equipment to determine whether proper control and safety devices are provided to insure proper operation. Assist Owner in the initial operation of the equipment, and make any necessary adjustments to the service for proper operation.

2. Motor and Motor Controls: Where required, the manual motor starters shall be suitable for the application, Square D Co., Type F, K, M or T with proper overload protection, mounted in an appropriate box with a 120-volt pilot light. Disconnect switches shall be the heavy-duty type with "Dual Element" fuses, with an enclosure suitable for the application. Provide accessories necessary for the application.
 3. Equipment shall be controlled by manual and automatic systems as required by the control documents, shown on the drawings and specified in this section of the specifications.
 4. Air Conditioning and Heating Equipment: All air conditioning and heating equipment shall have fused disconnect switches or breakers installed at the unit. These switches or breakers shall be sized and be of the type as it appears on the label of the equipment.
 5. Install and connect all package control equipment and control devices furnished under other divisions of these specifications including all interconnecting control wiring.
- C. Work in Connection with Motors:
1. Rotation: All motors shall be checked for proper rotation just as soon as power is available. Should any motor rotate in the wrong direction, it shall be re-connected for proper operation.
 2. Overload Heaters: Check all motor starters overload heater elements for the proper size to conform to the name plate rating of the motor. Should an improper size unit be installed, the attention of the Owner's Representative and the starter supplier shall be called to that fact.
 3. Connection: The raceway connection to the individual motors shall be by means of a short length of flexible conduit. All pump motors shall be connected with type "UA" liquid tight flexible conduit. Connectors used with liquid tight flexible conduit shall be of a type made for the purpose and that will establish a continuous ground. All motors and all controls therewith shall be connected up completely as required for proper operation of the system involved.
- D. Fire Protection Equipment: Furnish and install all necessary wiring for the power supply, control, fire alarm connection, and code compliance requirements for

sprinkler, standpipe, or other fire protection systems. The fire protection work shall be in accordance with applicable sections of the NFPA codes.

- E. Owner Furnished: Furnish power wiring and connections to all equipment furnished by others and shown on the plans.

3.08 TEMPORARY WIRING

- A. The installation of the temporary wiring shall comply with the current codes and rulings of the local inspector. All breakers serving receptacle outlets shall have ground fault protection.
- B. In renovation construction, maintain the existing lighting and power systems as required for temporary power or provide temporary wiring and lighting in accordance with (A.) above.

END OF SECTION 16050

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SECTION 16060 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Extent and types of electrical identification are indicated herein and as follows:

1. Operational instructions and warnings.
2. Danger signs.
3. Equipment/system identification signs.
4. Conduit Identification.
5. Power and control wiring identification.
6. Terminal marking.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification products which may be incorporated in the work include, but are not limited to, the following:

W.H. Brady Co.
Ideal Industries, Inc.
Seton Name Plate Co.

2.02 ELECTRICAL IDENTIFICATION MATERIALS:

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either

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prenumbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification. Provide markers for all field control wiring.

- C. Self-Adhesive Plastic Signs: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application (as examples: 208V, EXHAUST FAN).
 - 1. Colors: Unless otherwise indicated or required by governing regulations, provide orange signs with black lettering.
 - 2. Mark the identification of all disconnects switches.
- D. Engraved Plastic-Laminate Signs: Provide engraving stock melamine plastic Laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Mark all panelboard and equipment panels.
- E. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- F. Fasteners: Self-tapping stainless steel screws.

2.03 LETTERING AND GRAPHICS:

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

- A. General Installation Requirements:
 - 1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

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2. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.
 3. Conduit Identification: Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color-coded method, apply color-coded identification on electrical conduit in a manner similar to piping identification. Except as otherwise indicated, use orange as coded color for conduit.
 4. Equipment/System Identifications: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access panel/doors to electrical facilities.
 - c. Transformers.
 - d. Control stations.
 - e. Motor disconnects.
 - f. Telephone and communication switching equipment.
- B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners.

END OF SECTION 16060

SECTION 16070

ELECTRICAL CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electric connections are hereby defined to include, but not necessarily limited to, connections for providing electrical power to equipment, control wiring connections, communication connections.
- B. Types of electrical power and electrical system connections specified in this section includes, but is not limited to the following:
 - To motors.
 - To equipment.
 - To resistance heaters.
 - To HVAC equipment.
 - To motor starters.
 - To motor control equipment.
 - From motor starters to motors.
 - To plumbing equipment.
 - To lighting fixtures.
 - To transformers, inverters, rheostats, and similar current adjustment features of equipment.
 - To ground.
 - To master units of communication, signal, and alarm.
- C. Motor starters and controls not furnished integrally with equipment are specified in applicable Electrical work sections along with installation specifications.
- D. Refer to other specifications sections for motor starters and controls furnished with equipment; not work of this section.
- E. Junction boxes and disconnect switches required for motors and other electrical units of equipment are specified in applicable Electrical work sections.
- F. Refer to other specifications sections and the drawings for control system wiring work described and installed under Electrical work.

- G. Refer to specification sections and plans of other work Divisions for specific individual equipment power requirements.
- H. Furnish all labor and material and making power connections to all electric equipment furnished under the Architectural, Plumbing, Heating, Air Conditioning and equipment sections of the specifications and plans.
- I. Provide the electrical installation of all control devices, including 115-volt, 1-phase firestats, mount all electrical equipment non-furnished as an integral part of the equipment, all control and power conduit, wiring, disconnect switches, etc., to make the installation. The mechanical section shall furnish all control devices for HVAC and plumbing systems.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

- 3-M Corp.
- AMP Products Corp.
- Appleton Electric Co.
- Burndy Corp.
- Ideal Industries, Inc.
- T and B/Thomas and Betts Corp.

2.02 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements; comply with NEC requirements for

raceways. Provide products complying with Electrical Work basic materials and methods section "Raceways", and in accordance with the raceway material required for the project.

- C. Wire, Cable, and Connectors: Provide wires, cables, and connectors complying with Electrical Work basic materials and methods section "Wires and Cables".
- D. Wire: Unless otherwise indicated, provide wires/conductors for electrical connections which match wires/conductors of wiring supplying power.
- E. Connectors and Terminals: Provide electrical connectors and terminals as recommended by connector and terminal manufacturer for intended applications.
- F. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, solder, electrical soldering flux, wire nuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Install electrical connections as indicated; in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- C. Coordinate installation of electrical connections for equipment with equipment installation work.
- D. Cover splices with electrical insulation equivalent to, or of higher rating, than insulation on conductors being spliced.

- E. Prepare cables and wires. by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated.
- F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten wire-binding connector screws firmly.
- H. Provide flexible conduit for motor connections, and for other electrical equipment connections where subject to movement and vibration.
- I. Provide liquid-tight metallic flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:
 - Exterior location.
 - Moist or humid atmosphere where condensate can be expected to accumulate.
 - Corrosive atmosphere.
 - Subjected to water spray.
 - Subjected to dripping oil, grease, or water.
- J. Refer to basic materials and methods section for identification of electrical power supply conductor terminations with markers approved as to types, colors, letter and marker sizes, by Designer. Affix markers at each point of termination, as close as possible to each point of connection.

END OF SECTION 16070

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of raceways is indicated by drawings and application. Provide raceway as required by the application. Use EMT for interior of building, as permitted by the codes, except imbedded in masonry. Type ENT, AC cable, and MC cable conduit is not permitted to be used. Use schedule 40 PVC or RMC as directed under slab or encased. Use RMC where exposed to damage. Provide a code size grounding conductor in all nonmetallic conduit. Install an insulated code size grounding conductor in all metallic raceway systems and connect/bond to all electrical system boxes, enclosures, frames and device grounds. Connect this conductor to all equipment frames, metallic boxes, device frames and other metallic components of the electrical distribution and utilization systems.

- B. Types of raceways in this section include the following:
 - Electrical metallic tubing.
 - Flexible metal conduit.
 - Liquid-tight flexible metal conduit.
 - Rigid metal conduit.
 - Rigid nonmetallic conduit.
 - Surface metal and nonmetallic raceways.
 - Cable trays.

PART 2 - PRODUCTS

2.01 METAL AND NONMETALLIC CONDUIT AND TUBING:

- A. General: Provide metal and nonmetallic conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with fire codes and applicable portions of NEC for raceways.

- B. Provide connectors, fittings, accessories and installation tools suitable for the product and application.

- C. Install conduit systems complying with manufacturers' published product information.
- D. Minimum conduit system shall be electrical metallic tubing except as otherwise noted.
- E. Minimum size conduit shall be 3/4 inch except for single receptacles or switch leg drops.

2.02 WIREWAYS:

- A. General: Provide electrical raceways of types, grades, sizes, weights (wall thicknesses), number of channels, for each type service indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as needed for complete system. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with applicable provisions of NEC for electrical raceways.

2.03 ELECTRICAL (50-V OR HIGHER) SURFACE MOUNTED RACEWAY

- A. Provide metal one-piece surface mounted raceway, Wiremold Company or approved equal. Raceway shall be permanently attached using 2-hole straps designed for use with the raceway. Area of raceway shall meet NEC requirements for the conductors installed. Raceway containing more than one circuit shall be equivalent in area to 3/4 inch conduit. Boxes and fittings shall be metal and shall be provided as required to meet the applications.
- B. Surface mounted raceway shall be used where raceways are exposed in finished areas such as offices, classrooms, assembly areas, conference room and other similar spaces. EMT conduit is acceptable in other areas.
- C. All raceway shall be installed plumb and level. Surface mounted raceways shall be used for runs to surface mounted receptacles.

2.04 POWER POLES

- A. Power poles shall be two-compartment aluminum construction. Pole shall extend to the structural ceiling and be attached to structure as required by the pole manufacturer. The communications compartment shall allow for a minimum of a

1-inch bending radius. Surface mounted faceplates shall be installed on pole as indicated on the contract documents. Wiremold 25DTP-4 or equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL RACEWAYS:

- A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.
- B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components with other work.
- C. Level and square raceway runs, and install at proper elevations/heights.
- D. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- E. Install flexible conduit for motor connections, and for other electrical equipment connections where subject to movement and vibration.
- F. Install liquid-tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:
 - Exterior location.
 - Moist or humid atmosphere where condensate can be expected to accumulate.
 - Subjected to water spray.
 - Subjected to dripping oil, grease, or water.
- G. Wherever possible, install horizontal raceway runs above water and steam piping.
- H. Provide secure fastening and support of conduit systems from the building structural system using materials manufactured for the intended application.
- I. Support conduit runs in accordance to seismic code requirements.

END OF SECTION 16110

SECTION 16120

WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of electrical wire and electrical cable work is indicated by drawings and schedules.
- B. Types of wire, cable and connectors in this section include, but are not limited to, the following and requirements of the service application:

- Copper conductors.
 - Fixture wires.
 - Switchboard wires.
 - Tap type connectors.
 - Split-bolt connectors.
 - Wire nuts.

- C. Applications for wire, cable and connectors required for project are as follows:

- Power distribution circuitry.
 - Lighting circuitry.
 - Appliance and equipment circuitry.
 - Motor-branch circuitry.
 - Control circuitry.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Wire and Cable:
Advance Wire and Cable, Inc.
General Cable Corp.
Rome Cable Corp.
Southwire
2. Connectors:
AMP, Inc.
Burndy Corp.
Ideal Industries, Inc.

2.02 WIRE, CABLE, AND CONNECTORS:

- A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.
- B. Wire: Provide factory-fabricated copper conductor, wire of sizes, ratings, materials, and types indicated for each service. Where type is not indicated, provide proper selection as determined by Installer to comply with project's installation requirements and NEC standards. Power wiring of different voltages shall not be allowed to be run in the same raceway, junction box, or wireway. Conductor colors for ungrounded conductors in 480Y/277 volt systems shall be brown, orange, and yellow. Conductor colors for ungrounded conductors in 208Y/120 volt systems shall be red, blue, and black.
- C. Connectors: Provide factory-fabricated, metal connectors of sizes, ratings, materials, types and classes as indicated for each service. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and NEC standards. All wire nuts shall be twist-on type. Non-twist-on type wire nuts shall not be allowed.

PART 3 - EXECUTION:

3.01 INSTALLATION:

- A. General: Install electrical cables, wires and connectors as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices as well as owner's requirements..

- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Pull conductors together where more than one is being installed in a raceway.
- D. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation.
- E. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- F. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- G. Keep conductor splices to minimum.
- H. Install splices and taps which have mechanical strength. Current and insulation rating shall be equivalent-or-better than conductor. All splices shall be compression type with cold shrink wrap and taped.
- I. Use splice and tap connectors which are compatible with conductor material.

3.02 FIELD QUALITY CONTROL:

- A. Prior to energization, test cable and wire for continuity of circuitry, and also for short circuits. Correct malfunctions when detected.
- B. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.
- C. Use THHN/THWN stranded for all field motor and control work. Use solid copper only for building branch wiring circuits at size No. 12 and No. 10. All other wiring shall be class and type approved for the applications.

END OF SECTION 16120

SECTION 16122

MEDIUM VOLTAGE WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of electrical wire and electrical cable work is indicated by drawings and schedules.
- B. Types of wire, cable and connectors in this section include, but are not limited to, the following and requirements of the service application:
 - Copper conductors.
 - Deadbreak separable splices.
 - Loadbreak elbows.
 - Cold shrinkable metallic shield kit.
- C. Applications for wire, cable and connectors required for project are as follows:
 - Medium voltage power distribution circuitry.
 - Appliance and equipment circuitry.
 - Motor-branch circuitry.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Wire and Cable:
 - Okonite
 - Keyrite
 - 2. Connectors:
 - 3M Corporation
 - Cooper Power Systems

2.02 MEDIUM VOLTAGE POWER CABLE

15KV POWER CABLE

- A. Primary voltage power cable shall be 15,000 volts; single conductor Class “B” stranded copper, ethylene propylene thermosetting type elastomer insulation (EPR), tape shielded and PVC jacketed. The cable shall be suitable for wet or dry location in conduit underground duct systems and direct burial. Contractor shall indicate if cable is compact or compressed stranded.
- B. The cable shall be rated 105 degrees C for normal operations, 140 degrees C for emergency overload operation, and 250 degrees C for short circuit conditions.
- C. The insulation system shall consist of a triple tandem extruded semi-conducting thermostat EPR strand screen, ethylene propylene rubber insulation, and a semiconducting thermoset EPR insulation screen. The insulation shall contain no polyethylene nor exceed 72 percent by weight of ethylene in the copolymer to limit the degree of susceptibility to treeing. (Any bid proposing an alternate to the specified cable must contain a statement from the manufacturer confirming strict compliance with the preceding underlined portion of the specifications. Otherwise, that bid cannot be considered.) The insulation thickness shall be 220 mils (133 percent insulation level.)
- D. The metallic shielding shall be a 5 mil bare copper tape with a 12 ½ percent nominal overlap.
- E. The overall jacket shall be polyvinylchloride of a minimum average thickness of 80 mils.
- F. The cable shall be manufactured and tested in complete and strict accordance with AEIC CS6-82 and applicable sections of ICEA CS6. (Paragraph F and D shall be reported with the bid).
- G. Cable shall have twenty-five (25) year warranty from date of shipment by seller to purchaser.

5KV POWER CABLE

- A. Primary voltage power cable shall be 15,000 volts; single conductor Class “B” stranded copper, ethylene propylene thermosetting type elastomer insulation (EPR), tape shielded and PVC jacketed. The cable shall be suitable for wet or dry location in conduit underground duct systems and direct burial. Contractor shall indicate if cable is compact or compressed stranded.

- B. The cable shall be rated 105 degrees C for normal operations, 140 degrees C for emergency overload operation, and 250 degrees C for short circuit conditions.
- C. The insulation system shall consist of a triple tandem extruded semi-conducting thermoset EPR strand screen, ethylene propylene rubber insulation, and a semiconducting thermoset EPR insulation screen. The insulation shall contain no polyethylene nor exceed 72 percent by weight of ethylene in the copolymer to limit the degree of susceptibility to treeing. (Any bid proposing an alternate to the specified cable must contain a statement from the manufacturer confirming strict compliance with the preceding underlined portion of the specifications. Otherwise, that bid cannot be considered). The insulation thickness shall be 115 mils (133 percent insulation level).
- D. The metallic shielding shall be 5 mil bare copper tape with a 12 ½ percent nominal overlap.
- E. The overall jacket shall be polyvinylchloride of a minimum average thickness of 80 mils.
- F. The cable shall be manufactured and tested in complete and strict accordance with AEIC CS6-82 and applicable sections of ICEA CS6. (Paragraph F and D shall be reported with the bid).
- G. Cable shall have twenty-five (25) year warranty from date of shipment by seller to purchaser.

2.03 15-KV TERMINATION

- A. Termination kits shall be capable of properly terminating a 15 KV single conductor polymeric-insulated cable. Kits shall meet Class I requirements and be design-proof tested per IEEE 48-1975 and be capable of passing a test sequence per draft and revisions of IEEE 404-1986. Kits as specified shall accommodate any common form of cable shielding/construction without the need for special adaptors or accessories, and shall accommodate a wide range of cable size and, also, be capable of being properly installed on out-of-round or out-of-tolerance cable as per relevant ICEA standards. Kits shall accommodate commercially available connectors.
- B. Terminations for single-conductor cable shall consist of cold-shrink stress control and outer non-tracking insulation tubes along with a high relative permittivity stress relief mastic for insulation shield cutback treatment with a cold shrink

- sealant for environmental sealing. Outdoor terminations shall include rain shields.
- C. Termination kits shall be manufactured by 3M Corporation, Cooper.
 - D. All loadbreak elbows shall be equipped with peroxide-cured EPDM insulation, copper top connector, tin plated copper loadbreak probe with an ablative arc-follower tip, stainless steel reinforced pulling eye, and capacitive test point. Provide amperages as indicated on drawing, Cooper RTE or approved equal.
 - E. Deadbreak separable splices shall be equipped with peroxide-cured EPDM insulation, capacitive test points, and shall meet IEEE Standard 386 for separable insulated connector systems. Provide splices as indicated on drawings. Cooper SSPL series or approved equal.
 - F. All 600A connector plugs and 200/600A loadbreak adapters shall be EPDM insulation only.

PART 3 - EXECUTION:

3.01 INSTALLATION:

- A. General: Install electrical cables, wires and connectors as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices as well as owner's requirements.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Pull conductors together where more than one is being installed in a raceway.
- D. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation.
- E. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- F. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- G. No conductor splices shall be made without Engineer's written approval.

- H. Install splices and taps which have mechanical strength. Current and insulation rating shall be equivalent-or-better than conductor. All splices shall be compression type with cold shrink wrap and taped.
- I. Use splice and tap connectors which are compatible with conductor material.

3.02 FIELD QUALITY CONTROL:

- A. Prior to energization, high pot test cables and connectors using a non-destructive high voltage insulation resistance tester. Provide written test reports for all cables and connectors tested and submit them to the engineer's or owner's representative prior to energizing. Correct malfunctions where detected.
- B. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION 16120

SECTION 16125

MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

- 1.01 The pad-mounted gear shall conform to the following specification.
- 1.02 The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked.

1.03 RATINGS

The ratings for the integrated pad-mounted gear shall be as designated below. (Select values from one of the columns shown in the table on page 2.)

Kv, Nominal	14.4
Kv, Maximum	17.0
Kv, BIL	95
Main Bus Continuous, Amperes	600
Three-Pole Interrupter Switches	
Continuous, Amperes	600
Load Dropping, Amperes	600
Fuses with Integral Load Interrupter	
Maximum, Amperes	200E
Load Dropping, Amperes	200
Short-Circuit Ratings	
Amperes Rms Symmetrical	14,000
Mva Three-Phase Symmetrical at Rated Nominal Voltage	350

The momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

1.04 CERTIFICATION OF RATINGS

- A. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.
- B. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

1.05 COMPLIANCE WITH STANDARDS AND CODES

The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

- A. All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
- B. Article 490-21(3) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
- C. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

1.06 ENCLOSURE DESIGN

- A. To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
- B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

PART 2 - CONSTRUCTION—ASSEMBLY

2.01 INSULATORS

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

- A. Operating experience of at least 15 years under similar conditions.

- B. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.
- C. Adequate strength for short-circuit stress established by test.
- D. Conformance with applicable ANSI standards.
- E. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.02 HIGH-VOLTAGE BUS

- A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.
- B. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.
- C. Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2"—13 galvanized steel bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot-pounds torque.
- D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.03 GROUND-CONNECTION PADS

- A. A ground-connection pad shall be provided in each compartment of the pad-mounted gear.
- B. The ground-connection pad shall be constructed of 3/8" thick steel, which shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.
- C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

PART 3 - CONSTRUCTION—ENCLOSURE INCLUDING OUTDOOR FINISH

3.01 ENCLOSURE

- A. The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.
- B. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.
- C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.
- D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
- E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
- F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.
- G. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which shall allow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
- H. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.
- I. Insulating interphase and end barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).
- J. Full-length steel barriers shall separate side-by-side compartments.
- K. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift the barriers out and insert them into the open gap when the switch is open. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

- L. Interrupter switches shall be provided with window panels to allow viewing of the switch position without removing the dual-purpose front barriers. Window panels shall be removable to facilitate phasing and shall be secured to the enclosure with stainless-steel or zinc-nickel-plated hardware.
- M. Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
- N. The enclosure shall be provided with an instruction manual holder.
- O. Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.
- P. Inner barrier panels that meet the Rural Electrification Association's requirements for "dead-front" and the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2) shall be provided—one for each door opening providing access to high voltage. These panels shall be secured in place with recessed pentahead bolts. When so secured, they shall guard against inadvertent contact with live parts.
- Q. A steel-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 12 inches.
- S. Polyurethane self-adhesive bumpers shall be placed on the left-hand door channel to prevent the right-hand door from abrading the paint, and on the center door divider to prevent the left-hand door from rubbing against the center door divider.

3.02 DOORS

- A. Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.
- B. Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.
- C. Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full

length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

- D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.
1. The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.
 2. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
 3. The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:
 - (a) It shall not be possible to unlatch the mechanism until the padlock is removed, and
 - (b) It shall not be possible to insert the padlock until the mechanism is completely latched closed.
- E. Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.
- F. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

3.03 FINISH

- A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.
- B. All exterior seams shall be filled and sanded smooth for neat appearance.
- C. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process

comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

- D. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:
1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
 - (a) Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
 - (b) Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.
 2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714.
 3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
 4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
 5. 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking.
 6. Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.
 7. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.

Certified test abstracts substantiating the above capabilities shall be furnished upon request.

- E. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.
 - F. A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.
 - G. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
 - H. The finish shall be olive green, Munsell 7GY3.29/1.5.
- 3.04 To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

PART 4 - BASIC COMPONENTS

4.01 INTERRUPTER SWITCHES

- A. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.
- B. Interrupter switches shall be operated by means of an externally accessible 3/4" hex switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4" deep-socket wrench or a 3/4" shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating-hub pocket.

- C. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access cover.
- D. Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.
- E. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.
- F. Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.
- G. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.
- H. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.
- I. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.
- J. Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on the terminals and ground pad in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.
- K. Key interlocks shall be provided to prevent paralleling the two source interrupter switches.
- L. Key interlocks shall be provided to guard against opening fuse-compartment door(s) unless all switches (series tap switch only, where furnished) are locked open.

- M. Base-mounted distribution-class surge arresters, metal-oxide type rated 10 kv shall be provided at all source switch terminals.
- N. Mounting provisions only for base-mounted distribution-class surge arresters rated 9 kv shall be provided at all source switch terminals.
- O. Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors and with viewing window in door in each switch compartment (except series tap switch, where furnished).

4.02 FUSES

A. Solid-Material Power Fuses

1. Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.
2. Fusible elements shall be non-aging and non-damageable so that it is unnecessary to replace un-blown companion fuses on suspicion of damage following a fuse operation.
3. Fusible elements for refill units or fuse units rated 10 amperes or larger shall be helically coiled to avoid mechanical damage due to stresses from current surges.
4. Fusible elements, that carry continuous current, shall be supported in air to help prevent damage from current surges.
5. Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.
6. Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
7. Solid-material power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
8. All arcing accompanying operation of solid-material power fuses shall be contained within the fuse, and all arc products and gases evolved shall be

effectively contained within the exhaust control device during fuse operation.

9. Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
- B. Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hookstick.
1. The integral load interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.
 2. The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.
 3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.
 4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
 5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
 6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
 7. The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
 8. Integral load interrupters for fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 13,000 amperes rms asymmetrical at 14.4 kv or 25 kv. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load interrupter remaining

operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

- D. Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.
- E. Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.
- F. A fuse storage compartment shall be provided in two source interrupter-switch compartments. Each fuse storage compartment shall provide space for storing three spare fuse holders or fuse units with end fittings for solid-material power fuses, or one spare electronic power fuse holder.

PART 5 - LABELING

5.01 HAZARD-ALERTING SIGNS

- A. All external doors shall be provided with "Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.
- B. The inside of each door shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
- C. Interrupter switch compartments shall be provided with "Danger" signs indicating that "Switches May Be Energized by Backfeed."
- D. Fuse compartments shall be provided with "Danger" signs indicating that "Fuses May Be Energized by Backfeed."
- E. Barriers used to prevent access to energized live parts shall be provided with "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" signs.

5.02 NAMEPLATES, RATINGS LABELS, AND CONNECTION DIAGRAMS

- A. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

- B. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).

- C. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

PART 6 - ACCESSORIES

6.01 End fittings and fuse units shall be furnished.

END OF SECTION 16125

SECTION 16127

UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of duct bank and electrical cable work as indicated by drawings and schedules.
- B. Underground manholes.
- C. Duct spacers and cable rack assemblies.
- D. Grounding.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. Use rigid steel, galvanized where exposed above ground or stubbed up poles. All 90 degree bends shall be long sweeping galvanized steel.
- B. All underground conduit runs shall be schedule 40PVC and shall be encased in concrete.
- C. Refer to the attached "Primary Duct Bank Detail" for a typical 15KV duct bank installation and concrete encasement requirements.

2.02 UNDERGROUND MANHOLES

- A. Furnish and install precast concrete manholes as indicated on the drawings and specified hereinafter. The products shall be similar and equal to those as manufactured by Oldcastle Precast, Inc. of Lebanon, Tennessee.
- B. Manholes shall be furnished 6'Wx12'Lx7'H. The sizes shall be clear inside dimensions of the hole. Provide two manhole openings 36" diameter. There shall be conduit duct windows to allow for the entry of the conduits in the installation of the duct as detailed. Concrete shall be rated at 5,000 pounds per square inch compression strength at 28 days. Provide reinforcing steel to support highway

truck traffic and conform to the Construction Materials Testing Institute Bridge Loading Specification No. H-20. Construction shall also conform to ANSI Code No. C857-78 and C858-78 pertaining to underground precast concrete utility structures. See attached typical manhole detail.

- C. Each manhole shall be equipped with Unistrut inserts in the side walls and pulling eyes in the side wall at the floor opposite each duct window opening.
- D. Covers and collars for manholes shall be level with the finished grade. Build up masonry wall between manhole top and manhole cover collar as required for leveling with finished grade.
- E. All cables in manholes shall be wrapped with fireproofing materials manufactured by 3M Company.

2.03 DUCT SPACERS AND CABLE RACKS

- A. A horizontal and vertical separation between the duct of 2 inches shall be maintained by installing high impact polystyrene duct spacers manufactured by Underground Devices Inc. Spacers shall be interlocked horizontally only. Along the length of the duct run spacers shall be staggered at least 6 inches vertically and shall be placed at an interval of 4 spacers per 20 feet.
- B. Cables shall be supported on walls by heavy duty non-metallic cable racks. The cable racks consist of stanchion that shall be attached to the manhole wall in accordance with the manufacturer's recommendations and adjustable arms that lock into the stanchion. Underground Devices Inc. Provide unless otherwise specified:
 - 1. At least two stanchions shall be installed on each manhole wall.
 - 2. Cable rack arm lengths shall be appropriate for the manhole size and amount of cable being installed.
 - 3. At least two spare arms shall be installed at each stanchion position.
- C. Cable rack stanchions and arms shall be made from 50% glass reinforced nylon. The stanchion shall be 36 inches long and incorporate multiple arm mounting holes. Holes or slots shall be provided in the arms for cable wire ties. All mounting hardware for stanchions shall be 316 stainless steel. Install per manufacturer's instructions.

2.04 GROUNDING

- A. Grounding shall be provided throughout the underground duct system and utility structures to establish a solid ground system.
- B. Install #4/0 soft drawn bare copper in the bottom of the duct bank trenches prior to the pouring of concrete backfill. Connect this #4/0 conductor to the ground loop in each manhole. In manholes, install a #4/0 bare copper grounding conductor around the interior face of the walls of the manhole and locate midway between the floor and ceiling of the manhole. Secure #4/0 ground conductor with anchor bolts and clamps on 18" centers.
- C. Install two copper clad 5/8" x 8' ground rods at each manhole separated minimum 10 feet apart. Connect ground rods to the grounding conductors in each manhole.
- D. Grounding connections in manholes shall be exothermic type. The ground shield on the 15-KV conductor insulation shall be brought out and connected to this grounding conductor in accordance with the conductor manufacturer's recommendations. Bond ground rods to ground loop in manhole with #4/0 bare copper.

PART 3 - EXECUTION:

3.01 INSTALLATION:

- A. Install duct banks as indicated on the attached drawing "Primary Duct Bank Detail".
- B. The hole to receive a manhole shall be dug to the proper depth to receive the manhole and cover plus 8 inches of crushed stone in bottom of hole. Manholes shall be set in place by the fabricator of the pre-cast manhole and inspected prior to backfilling.
- C. Manholes shall be set in place, backfilled, prior to installing underground duct banks. The excavation to receive the manhole shall be a minimum of 6" clear of manhole side in order to allow adequate backfilling and tamping of the earth fill along its side. The manholes shall be completely backfilled and sod and surface replaced prior to the excavation for underground duct lines.
- D. Conform to the manufacturer's recommendations. Ground rods shall be driven in place in the hole and conductors connected thereto prior to placing the manhole into position.
- E. Provide any shoring necessary for the installation of manholes.

- F. Grounds shall be provided to all equipment frames, housing, and secondary neutrals. Neutral conductors shall be grounded repeatedly wherever occurring near a grounding conductor.
- G. All ground connections in manholes shall be exothermic type. Ground connections exterior of manholes shall be exothermic type.

END OF SECTION 16120

SECTION 16130

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of electrical box and electrical fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings in this section include, but are not limited to, the following and the requirements of the application.

- Outlet boxes.
- Junction boxes.
- Pull boxes.
- Floor boxes.
- Conduit bodies.
- Bushings.
- Locknuts.
- Knockout closures.

PART 2 - PRODUCTS

2.01 FABRICATED MATERIALS:

- A. Interior Outlet Boxes: Provide galvanized flat rolled sheet steel interior outlet wiring boxes, of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts on back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
 - 1. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations. Choice of accessories is Installer's option.

- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering interior outlet boxes which may be incorporated in the work include, but are not limited to, the following:

Appleton Electric Co.
Crouse-Hinds Co.
RACO, Inc.
Steel City/Midland-Ross Corp.

- C. Weatherproof Outlet Boxes: Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit ends, cast-metal face plates with springhinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering weatherproof outlet boxes which may be incorporated in the work include, but are not limited to, the following:

Appleton Electric Co.
Crouse-Hinds Co.
O-Z/Gedney Co.

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

- F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering junction and pull boxes which may be incorporated in the work include, but are not limited to, the following:

Appleton Electric Co.
Crouse-Hinds Co.
O-Z/Gedney Co.
Spring City Elect Mfg Co.

- G. Floor Services Boxes

1. Large floor service boxes shall be a steel recessed floor box with four wiring compartments. Fully adjustable mounting hardware. Wiring

compartments shall be interconnected within the box with removable dividers. Each floor box shall use flush activation. The cover shall be suitable for the application, specifically a flush access hatch with carpet trim or flush furniture partition feed. The exact type of cover for each box will be determined by the owner in conjunction with the interior finishes. Boxes with no connections shall be equipped with the flush access hatch. The covers shall not be installed until the floor coverings or tile is installed. The boxes shall be protected from damage during construction. Covers shall be steel. Boxes shall be manufactured by Hubbell Incorporated, HBL series, or equal. 2.63" depth boxes shall be used in elevated applications, 4" depth boxes shall be used for slab-on-grade applications. Each box shall be equipped with two 20-amp duplex receptacles as specified in Section 16140. Install two brackets for mounting receptacles and two communications outlets with six (6) provision for snap-in connector modules unless indicated otherwise on plans.

2. Small floor service boxes shall be a steel recessed floor box with two wiring compartments. Fully adjustable mounting hardware. Each floor box shall use flush activation. The cover shall be suitable for the application, specifically a flush access hatch with carpet trim or flush furniture partition feed. The exact type of cover for each box will be determined by the owner in conjunction with the interior finishes. Boxes with no connections shall be equipped with the flush access hatch. The covers shall not be installed until the floor coverings or tile is installed. The boxes shall be protected from damage during construction. Covers shall be steel. Boxes shall be manufactured by Hubbell Incorporated, 3SFB series, or equal. Each box shall be equipped with one 20-amp duplex receptacle as specified in Section 16140. Install one bracket for mounting receptacle and one communications outlets with six (6) provision for snap-in connector modules unless indicated otherwise on plans.
3. Flush fire rated poke-through floor boxes, floor boxes shall be classified to maintain a two-hour fire rating in concrete floors. Floor box shall be equipped with four prewired 20-A, 120-V receptacles and shall contain category 6 communications inserts. Trim flange shall be die-cast aluminum with finish color to be chosen by owner. Unit shall mount in a 3-inch diameter core drilled hole.

- H. Available Manufacturers: Subject to compliance with requirements, manufacturers offering floor boxes which may be incorporated in the work include, but are not limited to, the following:
Hubbell Incorporated
Steel City/Midland-Ross Corp.
Wiremold Company
- I. Conduit Bodies: Provide galvanized cast-metal conduit bodies, of type, shapes and sizes, to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.
- J. EMT Fittings: Use steel compression connectors.
- K. Available Manufacturers: Subject to compliance with requirements, manufacturers offering conduit bodies which may be incorporated in the work include, but are not limited to, the following:

Appleton Electric Co.
Crouse-Hinds Co.
Thomas & Betts Co., Inc.
- L. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes to suit respective uses and installation.
- M. Available Manufacturers: Subject to compliance with requirements, manufacturers offering bushings, knockouts closures, locknuts, and connectors which may be incorporated in the work include, but are not limited to, the following:

O-Z/Gedney Co.
RACO, Inc.
Steel City/Midland-Ross Corp.
Thomas and Betts Co., Inc.

3.01 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

- A. General: Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
- C. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- D. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.
- E. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surface.
- F. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- G. Provide electrical connections for installed boxes.
- H. Use cast metal outlets and device boxes for all exposed work outside.
- I. Ground all metallic junction boxes by bonding to the system raceway grounding conductor. Ground the yoke or frame of all box-mounted devices.

END OF SECTION 16130

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - Receptacles.
 - Switches.
 - Wall plates.
 - Plugs.
 - Plug connectors.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - Bryant Electric Co.
 - Eagle Manufacturing
 - Harvey Hubbell Inc.
 - Pass and Seymour Inc.
 - Leviton Manufacturing

2.02 FABRICATED WIRING DEVICES:

- A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and complying with NEMA Stds pub No. WD 1. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and complying with NEC

and NEMA standards for wiring devices. Wiring devices other than those listed shall be of the type and rating required for service.

- B. Wiring device color shall be IVORY.
- C. Receptacles:
 - 1. General-Duty Duplex: 2 pole, 3 wire, 20 amp 125 volt grounding receptacle. Molded urea or nylon face, side wired, screw terminals, self grounding. Hubbell Cat. No. HBL5352, or equal by Bryant, P & S, Leviton, or Eagle.
 - 2. General-Duty Simplex: 2 pole, 3 wire, 30 amp 250 volt grounding receptacle. Black color molded urea or nylon face, side wired, screw terminals, self grounding. Hubbell Cat. No. HBL9330, or equal by Bryant, P & S, Leviton or Eagle.
 - 3. Special-Duty Combination: One boss 2 pole, 3 wire, 20 amp 125 volt, second boss 2 pole, 3 wire, 20 amp 250 volt, grounding receptacle. Molded urea or nylon face, side wired, screw terminals, self grounding. Bryant Cat. No. 5492-I, or equal by Hubbell, P & S, Leviton or Eagle.
 - 4. Special-Duty Isolated Ground: 2 pole, 3 wire, 20 amp 125 volt isolated ground receptacle. Orange color molded urea or nylon face, side wired, screw terminals. Hubbell Cat. No. 5362IG, or equal by Hubbell, P & S, Leviton, or Eagle.
 - 5. Special-Duty GFI Duplex: 2 pole, 3 wire, 20 amp, 125 volt grounding, ground fault, feed through, receptacle. Molded urea or nylon face, with wiring leads. Hubbell Cat. No. GF5362, or equal by Bryant, P & S, Leviton, or Eagle.
 - 6. Special-Duty Range: 3 pole, 3 wire, 50 amp, 125/250 volt, straight blade, flush receptacle. Black molded melamine or phenolic face, back wired, screw terminals. Hubbell Cat. No. HBL8430A, or equal by Bryant, P & S, Leviton, or Eagle.

D. Switches

1. Single Pole: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Hubbell Cat. No. 1221-I, or equal by Bryant, P & S, Leviton, or Eagle.
2. Double Pole: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Hubbell Cat. No. 1222-I or equal by Bryant, P & S, Leviton or Eagle.
3. Three Way: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Hubbell Cat. No. 1223-I, or equal by Bryant, P & S, Leviton or Eagle.
4. Four Way: General use snap switch rated 20 amp, 120/277 volt, (red face), side wired, screw terminals. Hubbell Cat. No. 1224-I, or equal by Bryant, P & S, Leviton, or Eagle.
5. Single Pole With 120/277 Volt Pilot Light: Special application snap switch rated 20 amp, (red face), clear handle with red pilot light, side wired, screw terminals. Hubbell Cat. No. 1221 PL, or equal by Bryant, Leviton, P & S., or Eagle.

E. Plugs and Connectors:

1. Plugs: Provide 15-amperes, 125-volts, 3-wire grounding, armored cap plugs, parallel blades with cord clamp, and 0.4" cord hole; match NEMA configuration with power sources.
2. Connectors: Provide 15-amperes, 125-volts, bakelite-bode armored connectors, 3-wire grounding, parallel blades, double wipe contact, with cord clamp, and 0.4" cord hole, match NEMA configuration to mating plug's.

2.03 WIRING DEVICE ACCESSORIES:

- A. Wall Plates: Provide single-switch and duplex outlet wall plates for wiring devices, of types, sizes, and with ganging and cutouts as indicated. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; plate color shall match wiring devices. Provide wall plates possessing the following additional construction features:
1. Receptacle Wall Plates: Molded high impact nylon, smooth finish. Bryant Series 88000, or equal by Hubbell, Leviton, P & S, or Eagle.

2. Switch Wall Plates: Molded high impact nylon, smooth finish. Bryant Series 88000, or equal by Hubbell, Leviton, P & S, or Eagle.
- B. Floor Service Outlets: Provide floor service outlets and fittings of types and ratings indicated. Floor box shall be constructed of 14 ga. galvanized steel with 5/32" steel reinforced hinged floor plate. Floor box shall have 90 cu. in. total capacity with two 24 cu. in. wiring compartments. Floor box shall be easily leveled and provide concealed service for power receptacles and communication connections. Hinged floor plate shall have a decorator top which may be covered with carpet or tile. Decorator top shall be painted color as selected by the Owner's Representative. Floor box shall be equal to Steel City Cat. No. 664. Concealed service top shall be equal to Steel City Cat. No. 644 CST.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES:

- A. Install wiring devices as indicated, in compliance 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 box 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. Install galvanized steel wall plates in unfinished spaces.
- E. Delay installation of wiring devices until wiring work is completed.
- F. Delay installation of wall plates until after painting work is completed.

3.02 PROTECTION OF WALL PLATES AND RECEPTACLES:

- A. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.03 GROUNDING:

- A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.04 TESTING:

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring of devices to demonstrated compliance with requirements.

END OF SECTION 16140

SECTION 16160

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of panelboard, load-center, and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include the following:
 - 1. Power-distribution panelboards.
 - 2. Lighting and appliance panelboards.
- C. Refer to other Electrical work sections for cable/wire, connectors and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of panelboard and enclosure):

General Electric Company
Siemens
Square D Company
Cutler-Hammer

2.02 PANELBOARDS:

- 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 number of unit panelboard devices as required for complete installation. Where more than one type of component meets indicated requirements, selection is Installer's option. Where types, sizes,

or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.

- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for copper conductors. Construct unit for connecting feeder at top or bottom of panel to suit application. Equip with copper bus bars, and full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide a bare uninsulated grounding bar suitable for bolting to enclosure. Provide panelboards fabricated by same manufacturer as enclosures, and which mate properly with enclosures. Provide an additional isolated ground bar for panels serving isolated ground outlets.
- C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangement shown; with anti-turn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top or bottom of panel as arrangement requires; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty molded case circuit breakers; provide suitable lugs on neutral bus for each outgoing feeder required; provide bare uninsulated grounding bar suitable for bolting to enclosure; and provide panelboards fabricated by same manufacturer as enclosures, and which mate properly with enclosure. Provide panels for 208Y/120-Volt or 480Y/277-Volt service as determined for the use. Provide an additional isolated ground bar for panels serving isolated ground outlets.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Design enclosure for recessed or surface mounting as indicated. Provide enclosures fabricated by same manufacturer as panelboards, and which mate properly with panelboards to be enclosed. Provide panels for 208Y/120-Volt or 480Y/277-Volt

service as determined by the use. Wet location panelboards shall be NEMA 4 enclosures.

- E. Panelboard Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit breakers, ground-fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated. Provide extra gutter space; split-bus; contactor space; and circuit breaker arrangement to accommodate the energy management system described in other specifications. Provide suitable enclosure space to accommodate time clock; relays; contactors and control items as shown on the drawings. The separate space shall be under a separate door located at the top of the panel with locking provisions.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS:

- A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- D. Provide electrical connections within enclosures.
- E. Fill out panelboard's circuit directory card upon completion of installation work. Directory shall be type written.
- F. Provide a minimum of 6-empty 3/4" conduits stubbed out above ceiling from all recessed panelboards.

END OF SECTION

SECTION 16161

SWITCHBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Provide service and distribution switchboards as indicated on the Drawings.
- B. Refer to other Electrical work sections for fuses, cable/wire, connectors, electrical raceway, and ground fault protection work required in conjunction with switchboard; not work of this section.

1.02 QUALITY ASSURANCE

- A. Manufacturer: For each material type required for the work of this section, provide primary materials which are the product of one manufacturer. Provide secondary or accessory materials that are acceptable to the manufacturers of the primary materials.
- B. Performance Requirements: Provide switchboards manufactured in accordance with Article 384 of the National Electrical Code and applicable portions of the NEMA PB2, U.L. 891 and NFPA 70, the National Electrical Code.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of switchboard):
 - Siemens
 - General Electric Company
 - Square D Company
 - Cutler-Hammer

2.02 SWITCHBOARDS:

- A. Switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and U.L. 891 standards, with the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. Switchboard shall include all protective devices and equipment as listed on drawings with necessary interconnections, instrumentation and control wiring. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide switchboards for 208Y/120-Volt or 480Y/277-Volt service as determined by the use. Wet location panelboards shall be NEMA 3R enclosures. If indicated on plans, switchboard shall be suitable for use as service equipment and be labeled in accordance with U.L. requirements.

- B. Bus Requirements: The bus shall be silver-plated copper and of sufficient size to limit the temperature rise to 65°C, based on U.L. tests. The bus shall be braced as indicated and supported to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having the indicated available short circuit current. Refer to plans for available short circuit current. Provide a full capacity neutral where a neutral is indicated on the drawings. The through bus on the end section shall be extended and pre-drilled to allow the addition of future sections with standard splice plates. Through bus shall be non-tapered. Ground bus and grounding conductor lug shall be furnished. Ground bus shall extend the entire length of the switchboard and shall be firmly secured to each vertical section.

- C. Incoming Service:
 - 1. Underground Service: To isolate incoming underground service conductors, an underground cable pull or auxiliary section shall be used. This section shall be of the bussed type and shall be sealable per local utility requirements. Screw-type mechanical lugs to terminate and copper cable shall be furnished as detailed on the plans.

 - 2. Overhead Service: Cable entry: Screw-type mechanical lugs to terminate and copper cable shall be furnished as detailed on the plans. Where necessary provide top cable pull box that shall be sealable per local utility requirements.

 - 3. Service Section: The service section shall be designed for the system parameters indicated, and shall have user metering as indicated, and shall have a main protective device indicated.

D. Distribution Sections:

1. Switchboard Type: Panel-Mounted, Front Accessible

- a. Individual sections shall be front accessible, not less than 20" deep, and the rear of all sections shall align. Incoming line termination, main device connection and all bolts used to join current-carrying parts shall be installed so as to permit servicing from the front only so that no rear access is required. The branch devices shall be front removable and panel mounted with line and load side connections front accessible.

E. Main Protective Device:

1. Molded case circuit breaker:

- a. Molded case circuit breaker shall be of the quick-make, quick-break, trip-free, heavy duty type. It shall be a 600-volt breaker with the number of poles, a trip current rating and an interrupting capacity as indicated on plans.

F. Branch Protective Devices: All molded case circuit breakers and fusible switches used as a protective device in a branch circuit will meet the requirements of the appropriate paragraph below.

1. Molded Case Circuit Breakers: Molded case circuit breakers shall be of quick-make, quick-break, trip-free thermal magnetic type, with interrupting capacity, frame, trip and voltage ratings, either 2-pole or 3-pole, as indicated on the plans. All breakers shall be removable from the front of the switchboard without disturbing adjacent units. The switchboard shall have prepared space (provisions) for future units as shown on the plans.

G. Switchboard Accessories:

1. Metering Equipment: Provide a G.E. MULTILIN PQM II-T20CA with multi-net-FE, multi-function, high accuracy digital power metering instrumentation module equipped with an LCD display. The power metering module shall provide simultaneous measurements for current, voltage, and power parameters. Power meter shall be equipped with a communications port for connection to customer's future SCADA network.

2. Ground Fault Protection: Provide as indicated on plans and in Section 16450.
3. Finish: The complete switchboard shall be phosphatized and finished with light gray. ANSI 61 paint.
4. Each switchboard section shall have a nameplate permanently affixed to it, listing the following information: Name of manufacturer, system voltage, ampacity, type, manufacturer's shop order number and date.
5. Each section of switchboard shall bear a U.L. listing mark, where qualified, and a short circuit rating label.
6. Front, side, rear and top of each switchboard section will have a DANGER label in accordance with NEMA Standard PB-2.

PART 3 - EXECUTION

3.01 INSTALLATION OF SWITCHBOARDS:

- A. General: Install switchboards where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of switchboards with cable and raceway installation work.
- C. Anchor enclosures firmly to floors and structural surfaces, ensuring that they are permanently and mechanically secure.
- D. Provide electrical connections within enclosures.
- E. Fill out switchboard's circuit directory card upon completion of installation work. Directory shall be type written.
- F. Torque all made connections per manufacturer's specifications and check torque of all factory connections before energization.

END OF SECTION 16161

SECTION 16170

MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of motor and circuit disconnect switch work is indicated by drawings, schedules, and code requirements.
- B. Types of motor and circuit disconnect switches in this section including the following:

- Equipment disconnects.
- Appliance disconnects.
- Motor-circuit disconnects.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

- General Electric Co.
- Siemens
- Square D Company
- Cutler-Hammer

2.02 FABRICATED SWITCHES:

- A. General-Duty Disconnect Switches: Provide surface-mounted, general-duty type, sheet steel enclosed switches, of types, sizes, and electrical characteristics indicated; rated 240 volts, 200 amperes and below, 60 hertz, with 3-blades, 3-poles; incorporating spring assisted, quick-make, quick-break switches which are so constructed that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose position is easily recognizable, and is capable of being padlocked in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten

type switch contacts, and stamped enclosure knockouts. Provide type enclosure suitable for the application. Use NEMA 3R for all outdoor applications.

- B. Heavy-Duty Safety Switches: Provide surface-mounted, heavy-duty type, sheet steel enclosed safety switches, of types, sizes and electrical characteristics indicated; fusible type, rated 600 volts, 400 amperes and below, 60 hertz, 3-blades, 4-poles, solid neutral; incorporating quick-make, quick-break type switches; so construct that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose position is easily recognizable, and is padlockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips. Provide NEMA type 3R enclosure for outdoor.
- C. Fuses: Provide fuses for safety switches, as recommended by switch manufacturer, of classes, types, and ratings needed to fulfill electrical requirements for service indicated. Provide fuses to match equipment label requirements when fuse information is furnished as part of the equipment label.
- D. Provide electrical interlock kits for all disconnects serving variable frequency drives.

PART 3 - EXECUTION

3.01 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

- A. Install motor and circuit disconnect switches where required by code, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- D. Mount disconnect switches securely. Use stainless steel or silicon bronze fasteners for mounting outdoor switches.

- E. Where building walls or equipment frames do not provide suitable mounting surface, provide galvanized unistrut frames or racks which will securely support the disconnect switch. Indoor frames may be painted unistrut frames.

END OF SECTION 16170

SECTION 16180

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective device work is indicated by drawings, schedules, and code requirements.
- B. Types of overcurrent protective devices in this section include the following:
 - Circuit breakers.
 - Fuses.
- C. Provide overcurrent protection for all electrical work.
- D. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than one unit of each.

PART - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Circuit Breakers:
 - General Electric Co.
 - Siemens
 - Square D Co.
 - Cutler-Hammer
 - 2. Fuses:
 - Bussmann Mfg Co.
 - Littelfuse Co.

2.02 CIRCUIT BREAKERS:

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated or required, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers amperes rated as indicated on the drawings, 600-Volts for 480-Volt system and 240-Volts for 208-Volt system, 60 HZ, 3-pole or single-pole as indicated with RMS symmetrical interrupting ratings as required by the application and location within the distribution system. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip button on cover for mechanically tripping circuit breakers. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 C. Provide with mechanical screw type removable connector lugs, AL/CU rated.

2.03 FUSES:

- A. General: Except as otherwise indicated, provide fuses of types, sizes and ratings and electrical characteristics indicated or required, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Class L Fuses: Provide NEMA Class L fuses in current ratings indicated or required, for service entrances and main and feeder circuits.
- C. Class J (K-5) Fuses: Provide NEMA Class J (K-5), dual-element types, with time delay of 10 seconds at 500% of rating, for use with switches.
- D. Where equipment nameplate requires a specific fuse, the required fuse shall be furnished.
- E. Provide indicator type fuses where such fuses are available.

3.01 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

- A. Install overcurrent protective devices as indicated or required, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation and application of overcurrent protective devices.
- B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.
- C. Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cables.
- D. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of devices.
- E. Install fuses, if any, in fused circuit breakers and fused disconnect switches.

3.02 ADJUST AND CLEAN:

- A. Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

3.03 FIELD QUALITY CONTROL:

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION 16180

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL:

1.01 DESCRIPTION OF WORK:

- A. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Electrical work sections.
- B. Types of supports, anchors, sleeves and seals specified in this section include but are not limited to the following:
 - Clevis hangers.
 - Riser clamps.
 - C-clamps.
 - I-beam clamps.
 - One-hole conduit straps.
 - Two-hole conduit straps.
 - Round steel rods.
 - Lead expansion anchors.
 - Toggle bolts.
 - Wall and floor seals.
- C. Furnish and install supports, anchors, sleeves and seals for factory-fabricated equipment as required to properly and securely mount the equipment.
- D. Furnish and install supports, braces, anchors and fasteners to meet seismic code requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES:

- A. General: Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer's option.

- B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod; approx. 54 pounds per 100 units.
 2. Riser Clamps: For supporting 5" rigid metal conduit; black steel; with 2 bolts and nuts, and 4" ears; approx. 510 pounds per 100 units.
 3. Reducing Couplings: Steel rod reducing coupling, 1/2" X 5/8"; black steel; approx. 16 pounds per 100 units.
 4. C-Clamps: Black malleable iron; 1/2" rod size; approx. 70 pounds per 100 units.
 5. I-Beam Clamps: Black steel, 1-1/4" X 3/16" stock; 3/8" cross bolt; flange width 2"; approx. 52 pounds per 100 units.
- C. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approx. 7 pounds per 100 units.
1. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
 2. Hexagon Nuts: For 1/2" rod size; galvanized steel; approx. 4 pounds per 100 units.
 3. Round Steel Rod: Black steel; 1/2" dia.; approx. 67 pounds per 100 feet.
 4. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approx. 200 pounds per 100 units.
- D. Anchors: Provide anchors of types, sizes and materials indicated; and having the following construction features:
1. Lead Expansion Anchors: 1/2"; approx. 38 pounds per 100 units.
 2. Toggle Bolts: Springhead; 3/16" X 4"; approx. 5 pounds per 100 units.

- E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering anchors which may be incorporated in the work include, but are not limited to, the following:
- Ackerman Johnson Fastening Systems Inc.
 - Ideal Industries, Inc.
 - Star Expansion Co.
 - U.S. Expansion Bolt Co.
- F. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated; and having the following construction features:
1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws. Floor sleeves and seals shall match the fire rating of the assembly being penetrated.
- G. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable iron casting with hot dip galvanized finish.
- H. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 16-gauge hot dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish (provide finish coat of paint in field to match surroundings), and with the following fittings which mate and match with U-channel:
- Fixture hangers.
 - Channel hangers.
 - End caps.
 - Beam clamps.
 - Wiring stud.
 - Thinwall conduit clamps.
 - Rigid conduit clamps.
 - Conduit hangers.
 - U-bolts.

- I. Available Manufacturers: Subject to compliance with requirements, manufacturers offering channel systems which may be incorporated in the work include, but are not limited to, the following:

Greenfield Mfg Co., Inc.
Midland-Ross Corp.
Unistrut Div; GTE Products Corp.

2.02 FABRICATED SUPPORTING DEVICES:

- A. Pipe Sleeves: Provide pipe sleeves, suitable for the application, of one of the following:
1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6", 14 gauge.
 2. Steel-Pipe: Fabricate from schedule 40 galvanized steel pipe; remove burrs.
 3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
 4. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- B. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:
1. Lead and Oakum: Caulked between sleeve and pipe.
- C. Fire Barriers: Provide galvanized steel conduit sleeves through all fire wall, floor ceiling or barrier penetration. Seal sleeve with an approved expanding fire/smoke material. The wall penetration and seal assembly shall equal the fire rating of the barrier penetrated. Refer to Architectural plans for the location and type of fire barrier construction.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES:

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA, NEC, MSS, and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with maximum spacings indicated.
- D. Tighten sleeve seal nuts until sealing grommets have expanded to form watertight seal.
- E. Install all supporting devices to meet seismic requirements.

END OF SECTION 16190

SECTION 16289

TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide 3-phase, 4-wire transient voltage surge suppression (TVSS) or surge protection devices (SPD) as indicated on the panel board schedules and on the riser diagram.
- B. As a minimum provide TVSS for all service entrance panels and switchboards as well as all distribution panels 600Amps and above.

1.02 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to this section.

1.03 DESCRIPTION

- A. General: Transient voltage surge suppression (TVSS) or surge protection device (SPD) is the description and equipment required for the protection of all AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

1.04 REFERENCE STANDARDS AND PUBLICATIONS

- A. General: The latest edition of the following standards and publications shall comply to the work of this section:

ANSI/IEEE C84.1-1989, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz)

ANSI/IEEE C62.41-1991, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

ANSI/IEEE C62.45-1992, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

Underwriters Laboratories UL 1449 Second Edition, Standard for Safety - Transient Voltage Surge Suppressors

Underwriters Laboratories, UL 1283, Standard for Safety - Electromagnetic Interference Filters

National Fire Protection Association, NFPA 780 - National Electrical Code

IEEE Standard 142-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

ANSI/IEEE Standard 141-1999, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)

IEEE Standard 1100-1999, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)

FIPS Pub 94, Federal Information Processing Standards Publication - Guideline on Electrical Power for ADP Installations

National Electrical Manufacturer's Association LS-1, 1992 (NEMA MIL Standard 220A Method of Insertion-loss Measurement)

1.05 MANUFACTURER QUALIFICATIONS

- A. In order to establish a level of quality for these Construction Documents, Eaton's Innovative Technology shall be the basis of design.
- B. All products submitted shall comply with the specifications of the Eaton's Innovative Technology model type specified herein. Manufacturers requesting product approval must meet or exceed the written specification contained herein.
- C. The registered service mark (brand) must be owned by the Manufacturer. No private label accepted.
- D. Manufacturer shall be ISO 9001 certified: Quality Systems – Model for Quality Assurance in Design, development, Production, Installation, and Servicing.

- E. The Manufacturer must be regularly engaged in the manufacture of surge suppression products for the specified categories for no less than ten (10) years.
- F. All surge protective devices for service entrance, distribution, and branch circuit protection within a facility shall be provided by a single manufacturer.

1.06 WARRANTY

- A. The TVSS and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of twenty (20) years from the date of substantial completion of service and activation of the system to which the suppressor is attached.
- B. Any TVSS that shows evidence of failure or incorrect operation during the warranty period shall be replaced free of charge. Since “Acts of Nature” or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section.
- C. Exclusions and prorating will not be allowed. Warranties extended in excess of the manufacturer’s standard warranty are not acceptable for the purpose of the specification.

1.07 COMPLIANCE REQUIREMENTS

- A. A TVSS shall be listed in accordance with UL 1449 Second Edition, Standards for Safety, Transient Voltage Surge Suppressors and UL 1283, Standard for Safety, Electromagnetic Interference Filters.
- B. ANSI/IEEE C62.41-1991 Measured Limiting Voltage (Let-Thru) shall be reported with measurements taken from zero reference per NEMA LS-1.
- C. SPD’s listed for 120/208V or 120/240V sub panels shall be UL 1283 listed, and must be a true sine wave tracking unit with EMI/RFI filtering. ANSI/IEEE C62.41-1991 Measured Limiting Voltage for sine wave tracking shall not exceed for A1 Ring Wave: L-N 60V; L-G 100V; L-L 70V & N-G 70V (Measurements taken from zero reference per NEMA LS-1; 180 degree phase Angle).
- D. TVSS shall have a response time of equal or less than 1 nanosecond, and be of non-deteriorating design.

1. Repetitive surge withstanding capabilities for ANSI/IEEE Category 3 shall be no less than 18,000 pulse life for main switchgear 300ka and higher, and no less than 18,000 for distribution and sub panels.

1.08 SUBMITTALS

- A. Submit product data and shop drawings with complete description of material components.
- B. Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.
- C. Drawings, with dimensions, indicating TVSS mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.
- D. All submittals for approved equals must be made ten (10) days prior to bid date.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The TVSS shall protect all modes and there shall be seven discrete suppression circuits; 3 modes connected Line to Ground, 3 modes connected Line to Neutral, and 1 mode connected Neutral to Ground for 3-phase, 4-wire, plus ground voltage system. Line to Neutral ground is not an acceptable substitute for Line to Ground. Line to Neutral to Line and Line to Ground to Line (in combination) will be acceptable for Line to Line protection.
- B. Each TVSS must be in a Powered Steel NEMA Type 4 enclosure (IP66), and be of a no-power consuming design, except for indicator light.
- C. TVSS unit must not be affected by humidity, altitude, external EMI or RFI and must not generate EMI or RFI.

The TVSS shall be equal to Eaton's Innovative Technology based on Voltage & Amperage, and Repetitive Surge Withstanding Capabilities as well as let-through voltage; and, 20 year warranty.

Note to Engineer: Select applicable Voltage & Amperage below and delete off other rows.

Area to be Protected	Sine Wave Tracking	Protector Model #	Warranty
A. Main Power			
(277/480) ≤1600A		PTX160-3Y201	20 Years
(120/208) ≤1600A		PTX160-3Y101	20 Years
(277/480) ≤3000A		PTX300-3Y201	20 Years
(120/208) ≤3000A		PTX300-3Y101	20 Years
(277/480) ≤4000A		PTX400-3Y201	20 Years
(120/208) ≤4000A		PTX400-3Y101	20 Years
B. Distribution Panels			
120/208V ≤800A		PTX080-3Y101	20 Years
277/480V ≤800A		PTX080-3Y201	20 Years
C. Critical Sub-Panels (Computers, Process Controllers, PLC's, etc.)			
120/240V ≤400A	YES	PTE048-1S101	20 Years
120/208V ≤400A	YES	PTE048-3Y101	20 Years
277/480V ≤400A	YES	PTE048-3Y201	20 Years

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The installing contractor shall install the parallel TVSS with short and straight conductors as practically possible.
- B. The contractor shall follow the TVSS manufacturer's recommended installation practice as found in the equipment installation instructions (to be included in package with each unit).
- C. The installation shall apply to all applicable codes.
- D. All conductors associated with TVSS devices shall be installed in conduit. Minimum conductor size shall be #8 AWG copper.

END OF SECTION 16289

SECTION 16450

GROUNDING AND GROUND-FAULT PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of grounding and ground-fault protection work is as directed by the NEC and additional grounding as indicated by the contract documents.
- B. Types of grounding and ground-fault protection in this section include but are not limited to the following:
 - 1. Grounding:
 - Underground metal piping.
 - Underground metal water piping.
 - Underground metal structures.
 - Grounding electrodes.
 - Grounding rods.
 - Separately derived systems.
 - Service equipment.
 - Enclosures.
 - Systems.
 - Equipment.
 - Isolated ground systems.
 - 2. Ground-Fault Protection:
 - Ground-fault circuit interrupters.
 - Ground-fault sensing and relaying equipment.
- C. Provide an equipment grounding conductor in all feeder wiring runs. Provide ground bus in all panels, switchboards and equipment enclosures. Bond ground conductor in all metallic enclosures.

PART 2 - PRODUCTS

2.01 GROUNDING:

- A. Materials and Components: Except as otherwise indicated, provide each electrical grounding system indicated, with assembly of materials including, but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation. Where more than one type meets indicated requirements, selection is Installer's option. Where materials or components are otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.
- B. Metallic Raceway: Where existing metallic raceway provides a grounding path, the raceway couplings, connection, jumpers, bonds and installation methods shall meet all requirements to provide a continuous ground return path.
- C. Equipment grounding conductor: Where specified or required by the application, provide code size equipment grounding conductors throughout the raceway system. Bond the equipment grounding conductor at all metal enclosures, equipment frames, housings, racks, etc. entered.
- D. Electrical Bonding Jumpers:
 - 1. Bonding Jumper Braid: Copper braided tape, constructed of 30-gauge bare copper wires and properly sized for indicated applications.
 - 2. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gauge bare copper wire; 3/4" wide, 9/16"-2" long; 48,250 CM. Protect braid with copper bolt hole ends with holes sized for 3/8" dia. bolts.
- E. Electrical Grounding Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
- F. Ground Rods and Plates:
 - 1. Ground Rods: Steel with copper welded exterior, 5/8" dia. X 8 feet long.
 - 2. Electrical Grounding Connections Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, thermoweld process, bonding straps, as recommended by accessories manufacturers for type services indicated.

2.02 GROUND-FAULT PROTECTION DEVICES:

- A. General: Except as otherwise indicated, provide ground-fault protection devices and components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.
- B. Circuit Interrupters/Circuit-Breakers: Provide where required 1" wide module bolt-on panel board circuit breakers, with integral ground-fault circuit interrupters, UL-rated Class A, Group 1; 20-amperes ratings, 1-pole construction, 120-volts, 60 Hz, 22000 AIC. Provide with solid-state ground-fault sensing and signaling, with 5 milliamperes ground-fault sensitivity, plus or minus 1 milliampere. Equip with PUSH-TO-TEST capability. Provide modules which fit panelboards in which they are located.
- C. Ground-fault Sensing and Relaying Equipment: Provide ground-fault sensing and relaying equipment for 480 V, 60 Hz, grounded system consisting of current sensor to encircle and monitor circuit's phase and neutral conductors, relaying equipment to provide desired ground-fault current sensitivity and time-current response characteristics, monitor panel, and low voltage power circuit-breaker, equipped to function in conjunction with other elements of GFP system, and constructed with the following features:
 - 1. Current Sensors: Provide zero sequence current sensors for feeder and branch devices and ground return sensors for main service device; inputs compatible to relay. Construct sensor frame so it can be opened to permit removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up, relay, and circuit protection device operation.
 - 2. Ground-Fault Relay: Provide solid-state ground-fault relay, which requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF currents from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 0.5 seconds and which precludes tampering with setting after installation.

3. Circuit Breaker: Provide molded case circuit breaker of ratings indicated. Construct with thermal and magnetic elements for conventional overload and fault current protection; and with GF trip mechanism capable of being activated by GF relay causing opening of circuit when ground fault of required magnitude occurs.
 4. Monitor Panel: Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system can not be left in an inactive or OFF state. Provide indicator lamps and TEST and RETEST control switches.
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering ground-fault sensing and relaying equipment which may be incorporated in the work include, but are not limited to, the following:

General Electric Co.
Siemens
Pringle Electrical Mfg Co.
Square D Co.
Cutler-Hammer

PART 3 - EXECUTION

3.01 INSTALLATION OF GROUNDING AND GROUND-FAULT PROTECTION SYSTEMS:

- A. Install electrical grounding systems and ground-fault protection devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding and ground-fault protection devices comply with requirements. Comply with requirements of NEC, NESC, and NEMA standards for installation of grounding and ground-fault protection systems and devices. Provide ground fault system where code required.
- B. Coordinate with other electrical work as necessary to interface installation of grounding system and ground-fault protection devices with other work.
- C. Weld cable connections to ground rods and coat with protective asphaltic paint.
- D. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass water meter.

- E. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- F. Install ground-fault protection devices complying with electrical winding polarities indicated.
- G. Fasten ground-fault sensing devices without mechanical stresses, twisting or misalignment being exerted by clamps, supports, bus bars or cables.
- H. Install ground-fault sensing windows symmetrically around power conductor bus bars or cable. Maintain clearances between conductors and ground-fault sensor body recommended by device manufacturer.
- I. Set field-adjustable GFP devices for pickup and time sensitivity ranges as indicated, after installation of devices.
- J. Where indicated on the drawings, provide additional isolated ground system. Isolated ground systems shall provide electrical isolation from outlet or device continuous to service equipment neutral/ground bonding point.

3.02 FIELD QUALITY CONTROL:

- A. Upon completion of installation of ground-fault protection devices and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. Upon completion of installation of electrical grounding system, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional ground rods. Then retest to demonstrate compliance.
- C. Perform resistance-to-ground tests of electrical grounding system one year following time of substantial completion and submit written report indicating results. Where resistance is greater than 3 ohms, chemically treat soil to reduce resistance to 3 ohms or less. Then retest to demonstrate compliance.

3.03 PERSONNEL TRAINING:

- A. Building Maintenance Personnel Training: Train Owner's building maintenance personnel in procedures for testing and determining resistance-to-ground values of

grounding system. Also instruct maintenance personnel in preparation and application of chemical solution for earth surrounding grounding rods for reducing ohmic resistance to required levels.

END OF SECTION 16450

SECTION 16460

PAD MOUNTED TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers specified in this section include the following:
 - 1. ENVIROTEMP FR3 filled pad mounted transformer.
 - 2. Forced air ENVIROTEMP FR3 filled pad mounted transformer.

1.02 QUALITY ASSURANCE:

- A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
- B. NEMA Compliance: Comply with applicable portions of NEMA Std Pub Nos. TR 1 and TR 27 pertaining to power/distribution transformers.
- C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/distribution transformers.
- D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- E. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers".
- F. UL Labels: Provide distribution transformers which have been UL-listed and labeled.

1.03 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data including rated KVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and certification of transformer performance efficiency at indicated loads, percentage regulation at 100% and 80% power factor, no-load and full-load

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losses in watts, % impedance at 75 degrees C hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data.

- B. Shop Drawings: Submit manufacturer's drawings indicating above data, dimensions, and weight loadings for transformer installations, showing layout, mountings and supports, spatial relationship to associated equipment, and transformer connections to electrical equipment.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
 - Siemens
 - General Electric Company.
 - Square D Company
 - Cooper Power Systems

2.02 POWER/DISTRIBUTION TRANSFORMERS:

- A. General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Forced Air Pad Mounted Transformers
 - 1. General:
 - a. Transformers shall be compartment style, self-cooled, tamperproof, and copper windings.

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- b. Enclosure shall be designed for outdoor pad mounted installation.
 - c. The average temperature rise of the transformer windings shall not exceed 65 degree C when the transformer is operated at full name plate rating. The transformers shall be capable of carrying 100% of name plate KVA rating in a 40 degree C max. 30 degree C average ambient as defined by ANSI C57.12.00.
2. Ratings:
- a. Transformers as identified on the drawings shall be KVA, rated as indicated on the drawings, OA; Primary voltage, 13.2 KV volts, delta; Secondary voltage 480Y/277-V or 208Y/120-V, as identified on the drawings, wye, 4-wire, 60HZ with two 2-1/2% full-capacity above normal and two 2-1/2% full-capacity below normal primary taps. Impedance shall be ANSI C-57-12 standard impedance. Primary and secondary BIL shall be 95 KV and 30 KV respectively.
 - b. Coils shall be wound with copper.
3. Construction:
- a. Provide full height, air filled, incoming and outgoing terminal compartments with hinged doors, separated by a steel barrier. Construction of unit shall be dead-front. Equip primary section with six 200-ampere bushing wells in accordance with ANSI Standard C119.1. Low voltage bushings shall be tinned, spade-type with 9/16" holes spaced on 1^{3/4}" centers, six holes per blade and have vertical bus supports for each bushing. Provisions for grounding shall be provided in both high and low voltage sections.
 - b. Enclosure of unit shall conform with ANSI Standard C57.12.28-1988 for tamper resistance and coating.
 - c. The high voltage terminations and equipment shall be dead front and conform to ANSI C57.12.26 requirements.
 - d. The bases shall be constructed to permit rolling or skidding in any direction, and shall be equipped with jacking pads designed to be flush with the transformer enclosure.

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- e. Transformer shall be UL classified for installation per Article 450-23 of the National Electric code.
 - f. The core shall be visibly grounded to the frame by means of a flexible grounding strap.
 - g. Provide lifting eyes and padlocking provisions.
 - h. Transformer fluid shall be minimum 30NC flame point, Envirotemp FR3 fire-resistant fluid.
 - i. Transformer shall be factory mutual rated.
4. Provide accessories as follows:
- a. Transformer shall be equipped with oil-immersed current limiting fuse, sized by transformer manufacturer to particular transformer. Provide one complete set of spare fuses for owner. Provide on-off internal load break switch, with handle located in primary compartment.
 - b. Provide 3, dead-front 9/10 KV M.O.V.E. surge arrestors for each transformer.
 - c. 1" drain valve with sampling device.
 - d. Dial type thermometer.
 - e. Magnetic liquid-level gauge.
 - f. Pressure vacuum gauge.
 - g. Pressure relief valve.
 - h. Equip transformer with pressure relief device rated ____ SCFM at 15 PSI. Transformer tank shall be able to withstand internal pressure of 12 PSI without rupture.
 - i. Mounting provisions for low-voltage current transformers and potential transformers.
 - j. Unit shall be equipped with forced air cooling. Fans shall be

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single stage, with power provided from secondary of transformer to self-contained control cabinet. Fans to be low noise, maintenance free, with guards. Cooling shall be automatically activated when top coolant temperature reaches 65NC.

C. Pad Mounted Transformers

1. General:

- a. Transformers shall be compartment style, self-cooled, tamperproof, loop feed, and copper windings.
- b. Enclosure shall be designed for outdoor pad mounted installation.
- c. The average temperature rise of the transformer windings shall not exceed 65 degree C when the transformer is operated at full name plate rating. The transformers shall be capable of carrying 100% of name plate KVA rating in a 40 degree C max. 30 degree C average ambient as defined by ANSI C57.12.00.

2. Ratings:

- a. Transformers as identified on the drawings shall be KVA, rated as indicated on the drawings, OA; Primary voltage, 13.2 KV volts, delta; Secondary voltage 480Y/277-V or 208Y/120-V, as identified on the drawings, wye, 4-wire, 60HZ with two 2-1/2% full-capacity above normal and two 2-1/2% full-capacity below normal primary taps. Impedance shall be ANSI C-57-12 standard impedance. Primary and secondary BIL shall be 95 KV and 30 KV respectively.
- b. Coils shall be wound with copper.

3. Construction:

- a. Provide full height, air filled, incoming and outgoing terminal compartments with hinged doors, separated by a steel barrier. Construction of unit shall be dead-front. Equip primary section with six 200-ampere bushing wells in accordance with ANSI Standard C119.1. Low voltage bushings shall be tinned, spade-type with 9/16" holes spaced on 1¾" centers, six holes per blade and have vertical bus supports for each bushing. Provisions for

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- grounding shall be provided in both high and low voltage sections.
 - b. Enclosure of unit shall conform with ANSI Standard C57.12.28-1988 for tamper resistance and coating.
 - c. The high voltage terminations and equipment shall be dead front and conform to ANSI C57.12.26 requirements.
 - d. The bases shall be constructed to permit rolling or skidding in any direction, and shall be equipped with jacking pads designed to be flush with the transformer enclosure.
 - e. Transformer shall be UL classified for installation per Article 450-23 of the National Electric code.
 - f. The core shall be visibly grounded to the frame by means of a flexible grounding strap.
 - g. Provide lifting eyes and padlocking provisions.
 - h. Transformer fluid shall be minimum 30NC flame point, Envirotemp FR3 fire-resistant fluid.
 - ii. Transformer shall be factory mutual rated.
4. Provide accessories as follows:
- a. Transformer shall be equipped with oil-immersed current limiting fuse, sized by transformer manufacturer to particular transformer. Provide one complete set of spare fuses for owner. Provide on-off internal load break switch, with handle located in primary compartment.
 - b. Provide 3, dead-front 9/10 KV M.O.V.E. surge arrestors for each transformer.
 - c. 1" drain valve with sampling device.
 - d. Dial type thermometer.
 - e. Magnetic liquid-level gauge.

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- f. Pressure vacuum gauge.
- g. Pressure relief valve.
- h. Equip transformer with pressure relief device rated ____ SCFM at 15 PSI. Transformer tank shall be able to withstand internal pressure of 12 PSI without rupture.
- i. Mounting provisions for low-voltage current transformers and potential transformers.

5. Standards and Tests:

- a. The transformer shall comply with all applicable portions of ANSI C57.12.00 and ANSI C57.12.26.
- b. Testing shall be done in accordance with ANSI C57.12.90 and shall include, as a minimum, the following tests: Provide Test reports.

Ratio

Polarity

Phase Rotation

No-Load Loss

Excitation Current

Impedance Voltage

Load Loss

Applied Potential

Induced Potential

- D. Finish: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.
- E. Manufacturers: Unit shall be similar and equal to R.T.E./Cooper Power pad mounted transformer similar and equal equipment by Westinghouse, McGraw Edison, and General Electric are approved

PART 3 - EXECUTION

3.01 INSTALLATION OF TRANSFORMERS:

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards,

and in accordance with recognized industry practices to ensure that products fulfill requirements.

- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.
- D. Connect transformer units to electrical wiring system; comply with requirements of other Electrical Work sections.

3.02 GROUNDING:

- A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground. Provide a separately derived grounding point for each transformer. Extend grounding conductor to an earth electrode and building steel. Where available, connect to a cold water main.

3.03 TESTING:

- A. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting. Test voltage and connect tap setting for an acceptable no load voltage level.

END OF SECTION 16460

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SECTION 16461

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. Copper-wound transformer optimized for light loading, meeting US Department of Energy proposed Candidate Standard Level (CSL) 3 efficiency, extremely low no load losses, with optional integrated efficiency & power quality meter.
- B. Load Mix: Transformer shall be UL listed to feed a mix of equipment load profiles such as computers without derating or significant degradation of efficiency.

1.02 QUALITY ASSURANCE:

- A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
- B. NEMA Compliance: Comply with applicable portions of NEMA Std Pub Nos. TR 1 and TR 27 pertaining to power/distribution transformers.
- C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/distribution transformers.
- D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- E. ANSI/NEMA Compliance: Comply with NEMA Std ST 20; "Dry-Type Transformers for General Applications".
- F. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers".
- G. UL Labels: Provide distribution transformers which have been UL-listed and labelled.

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1.03 SUBMITTALS:

- A. Submit product data including the following:
1. Copy of ISO 14001 Certification of manufacturing operation.
 2. Copy of ISO 9001 Certification of manufacturing operation.
 3. Insulation system impregnant data sheet as published by supplier.
 4. Construction Details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, unit weight
 5. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight
 6. Inrush Current (typical 3 cycle recovery)
 7. Short Circuit Current data: Primary (Sym. O/P S/C) & Secondary (L-N/G S/C)
 8. Efficiency Data
 - a. No load and full load losses per NEMA ST20
 - b. Linear load Efficiency data @ 1/6 load
 - c. Linear load efficiency data @ 1/4, 1/2, 3/4 & full load
 - d. Linear Load Efficiency @ 35% loading tested per NEMA TP-2.
 - e. Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.
 9. Copy of Factory ISO 9001 documentation describing nonlinear load test program
 - a. Meter and CT details including model, accuracy, serial numbers and calibration information.

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10. Copy of Linear & Nonlinear load test report for a representative 75kVA transformer
 11. 25 year Product Warranty Certificate
 12. Packaging method for shipment (meeting specification requirements) including representative picture
 13. UL and other applicable agency certifications
- B. Description of manufacturer's factory nonlinear load test program.
1. In light of the significant degradation of transformer performance when feeding nonlinear load compared to linear load, it is mandatory that the manufacturer test the transformers under nonlinear load representative of real world load mix. Transformers that have not been subject to testing under nonlinear load will not be considered for this project due to the uncertainty related to their real world performance.
 2. Given the lack of a standard for testing transformers under nonlinear load, the manufacturer must have a nonlinear Load Test Program operating in the production environment that is audited and documented per quality standard ISO 9001.
 3. The nonlinear load bank shall consist of a phase-neutral loading with a k7 profile, representative of a mix of typical commercial equipment.
 4. Meters and CTs shall both be revenue class accurate. CTs shall be operated within their approved accuracy loading range. Dual meters shall gather simultaneous primary and secondary energy and harmonic data. Meter and CT details including model, accuracy, serial numbers and calibration information.
 5. Efficiency: Measurements shall be taken at multiple load levels and plotted to show compliance with specification and correlation to the designed efficiency curve.
 6. Efficiency shall be determined purely by measurements using method and instrumentation per NEMA TP-2 Standard. Other methods are not acceptable.

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7. Harmonic data including current and Voltage THD at the different load levels shall be included with the test report.
- C. Shop Drawings: Submit manufacturer's drawings indicating above data, dimensions, and weight loadings for transformer installations, showing layout, mountings and supports, spatial relationship to associated equipment, and transformer connections to electrical equipment.

1.04 WARRANTY

- A. Transformer shall carry a 25-year pro-rated warranty, which shall be standard for the product line.

1.05 COMMERCIAL PRODUCT

- A. Transformer shall be a standard item in the manufacturer's catalog.

1.06 INTERNATIONAL STANDARDS ORGANIZATION REGISTRATION OF
MANUFACTURING PLANT

- A. Registration to current ISO standard is required.
 - B. Independent annual audits are conducted.
 - C. Product shall be manufactured in registered facility
 - D. ISO 9001:2000 Registered – Quality Management System
 - E. ISO 14001:2004 Registered – Environmental Management System
1. Transformer manufacturing results in potentially significant emissions of volatile compounds and other waste. ISO 14001 registration means:
 - a. That a facility has had an independent environmental impact assessment of raw material sourcing and all manufacturing processes,
 - b. Has implemented an independent annually audited program that minimizes environmental impact during manufacturing process and includes a strictly monitored continuous improvement program.

PART 2 - PRODUCTS

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2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
- B. Powersmiths International Corp.
- C. Substitutions are permitted, subject to meeting all the requirements of this specification AND having written approval by engineer 10 days prior to bid closing. Substitutions after bid closing are not acceptable.

2.02 TRANSFORMER SPECIFICATION

- A. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.
- B. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be U.L. and CSA Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.
- C. Insulation System:
 - 1. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy
 - 2. Class: 220 degrees C
 - 3. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
 - 4. Epoxy co-polymer
 - 5. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)

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6. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
 7. Chemical Resistance: Must have documented excellent performance rating by supplier
 8. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
 9. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life
- D. Operating Temperature Rise: 130 degree C in a 40 degree C maximum ambient
- E. Noise levels:
1. Per NEMA ST-20
 2. Production Test every unit. Data to be available upon request.
- F. UL Listed & Labeled K-Rating: K-7 or higher
- G. Maximum No Load Losses
1. Transformers are energized 24 hours a day for their entire life, potentially 40 years or more. These losses are incurred whether the transformer is loaded or not, and cost the user many times the purchase price of the transformer even at current energy rates.
 2. No load losses shall not exceed: 15kVA: 50W, 30kVA: 90W, 45kVA: 120W, 75kVA: 170W, 112.5kVA: 250W, 150kVA: 310W, 225kVA: 430W, 300kVA: 530W, 500kVA: 800W
- H. Efficiency at 15% loading
1. Data shows that transformers are typically very lightly loaded for extended periods of time, therefore to minimize operating cost under real world loading conditions, efficiency at 1/6 loading shall be maximized.
 2. Efficiency at 1/6 load shall meet or exceed: 15kVA: 97.3%, 30kVA: 97.6%, 45kVA: 97.9%, 75kVA: 98.2%, 112.5kVA: 98.4%, 150kVA: 98.5%, 225kVA: 98.6%, 300kVA: 98.7%, 500kVA: 98.8%, 750kVA: 98.9%

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- I. DOE 10 CFR Part 430 CSL 3 Efficiency requirement, tested per NEMA TP-2:
 - 1. Shall meet or exceed: 15kVA: 97.6%, 30kVA: 98.1%, 45kVA: 98.3%, 75kVA: 98.6%, 112.5kVA: 98.8%, 150kVA: 98.9%, 225kVA: 98.9%, 300kVA: 99.0%, 500kVA: 99.1%, 750kVA: 99.2%
- J. Efficiency under k-7 nonlinear load at 50% of nameplate rating:
 - 1. 15kVA: 97.3%, 30kVA: 97.7%, 45kVA: 97.9%, 75kVA: 98.4%, 112.5kVA: 98.7%, 150kVA: 98.8%, 225kVA: 98.8%, 300kVA: 98.8%, 500kVA: 98.9%, 750kVA: 98.9%
- K. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2% full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5% full capacity tap above and below nominal primary voltage.
- L. Impedance: Between 3.5% and 5.8% unless otherwise noted.
- M. Enclosure type: NEMA 2, drip-proof [optional NEMA 3R]
- N. Maximum Footprint for 130 degree C rise model in a NEMA 1 enclosure:
 - 1. 17" Wide x 17" Deep x 27" High for 15kva.
 - 2. 26" Wide x 18" Deep x 30" High for 30kVA, 45kVA
 - 3. 33" Wide x 22" Deep x 40" High for 75kVA, 112.5kVA
 - 4. 38" Wide x 28" Deep x 52" High for 150kVA
 - 5. 38" Wide x 32" Deep x 52" High for 225kVA, 300kVA
 - 6. 52" Wide x 38" Deep x 61" High for 500kVA
 - 7. 63" Wide x 46" Deep x 67" High for 750kVA
- O. OPTIONS
 - 1. Demonstrate compliance by providing factory production test report for every unit on this project upon shipment to customer or customer representative.

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2. Lug Kit: Supply with standard screw-type lugs

PART 3 - EXECUTION

3.01 INSTALLATION OF TRANSFORMERS:

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.
- D. Connect transformer units to electrical wiring system; comply with requirements of other Electrical Work sections.

3.02 GROUNDING:

- A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground. Provide a separately derived grounding point for each transformer. Extend grounding conductor to an earth electrode and building steel. Where available, connect to a cold water main.

3.03 TESTING:

- A. Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting. Test voltage and connect tap setting for an acceptable no load voltage level.

END OF SECTION 16461

SECTION 16465

SF6 GAS FILLED PAD MOUNTED SWITCHGEAR

PART 1 - GENERAL

1.01 The switchgear shall be in accordance with the one-line diagram, and shall conform to the following specification.

1.02 The switchgear shall consist of a gas-tight tank containing SF 6 gas, load-interrupter switches and resettable fault interrupters with visible open gaps and integral visible grounds, and a microprocessor-based overcurrent control. Load-interrupter switch terminals shall be equipped with bushings rated 600 amperes continuous, and fault-interrupter terminals shall be equipped with bushing wells rated 200 amperes continuous or bushings rated 600 amperes continuous (as specified) to provide for elbow connection. Manual operating mechanisms and viewing windows shall be located on the opposite side of the tank from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

1.03 RATINGS

A. The ratings for the integrated switchgear shall be as designated below.

Frequency, Hz.....	60
Short-Circuit Rating Amperes, RMS Symmetrical	25,000
kV, Maximum.....	15.5
kV, BIL	95
Main Bus Continuous, Amperes.....	600
Three-Pole Load-Interrupter Switches Continuous, Amperes.....	600
Load Dropping, Amperes	600

Fault-Closing, Duty-Cycle Three-Time, Amperes RMS Symmetrical	25,000
Three-Time, Amperes, Peak	65,000
10-Time, Amperes RMS Symmetrical	12,500
10-Time, Amperes, Peak.....	32,500
Fault Interrupters	
Continuous, Amperes.....	600
Load Dropping, Amperes.....	600
Fault Interrupting, Duty-Cycle	
Three-Time, Amperes RMS Symmetrical	25,000
Ten-Time, Amperes RMS Symmetrical	12,500
Fault-Closing, Duty-Cycle	
Three-Time, Amperes RMS Symmetrical	25,000
Three-Time, Amperes, Peak	65,000
10-Time, Amperes RMS Symmetrical	12,500
10-Time, Amperes, Peak.....	32,500

1.04 CERTIFICATION OF RATINGS

- A. The manufacturer of the switchgear shall be completely and solely responsible for the performance of the load-interrupter switch and fault interrupter as well as the complete integrated assembly as rated.
- B. The manufacturer shall furnish, upon request, certification of ratings of the load-interrupter switch, fault interrupter, and the integrated switchgear assembly

consisting of switches and fault interrupters in combination with the gas-tight tank.

1.05 COMPLIANCE WITH STANDARDS AND CODES

- A. The switchgear shall conform to or exceed the applicable requirements of the following standards and codes:
 - 1. The applicable portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
 - 2. The applicable portions of ANSI C37.71, ANSI C37.72, ANSI C37.73, IEC 56, and IEC 265-1 (Class A), which specify test procedures and sequences for the load-interrupter switches, fault interrupters, and the complete switchgear assembly.
 - 3. For gear rated 25-kA short circuit, the applicable portions of IEC 298, Appendix AA covering arc resistance, through 25 kA for 15 cycles.

PART 2 - CONSTRUCTION

2.01 SF 6 -GAS INSULATION

- A. The SF 6 gas shall conform to ASTM D2472.
- B. The switchgear shall be filled with SF 6 gas to a pressure of 7 psig at 68° F.
- C. The gas-tight tank shall be evacuated prior to filling with SF 6 gas to minimize moisture in the tank.
- D. The switchgear shall withstand system voltage at a gas pressure of 0 psig at 68° F.
- E. A gas-fill valve shall be provided.
- F. A temperature-compensated pressure gauge shall be provided that is color coded to show the operating range. The gauge shall be mounted inside the gas-tight tank (visible through a large viewing window) to provide consistent pressure readings regardless of the temperature or altitude at the installation site.

2.02 GAS-TIGHT TANK

- A. The tank shall be submersible and able to withstand up to 10 feet of water over the base.
- B. The tank shall be of welded construction and shall be made of Type 304 stainless steel.
- C. A means of lifting the tank shall be provided.

2.03 VIEWING WINDOWS

- A. Each load-interrupter switch shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the switch-blade position (open, closed, and grounded) while shining a flashlight on the blades.
- B. Each fault interrupter shall be provided with a large viewing window at least 6 inches by 12 inches to allow visual verification of the disconnect-blade position (open, closed, and grounded) while shining a flashlight on the blades.
- C. Viewing windows shall be located on the opposite side of the gear from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.
- D. A cover shall be provided for each viewing window to prevent operating personnel from viewing the flash which may occur during switching operations.

2.04 HIGH-VOLTAGE BUS

- A. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the switchgear.
- B. Before installation of aluminum bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.05 PROVISIONS FOR GROUNDING

- A. One ground-connection pad shall be provided on the gas-tight tank of the switchgear.

- B. The ground-connection pad shall be constructed of stainless steel and welded to the gas-tight tank, and shall have a short-circuit rating equal to that of the switchgear.

2.06 TERMINATIONS

- A. For gear rated 25-kA short circuit, terminals for load-interrupter switches shall have 600-ampere bushings, and terminals for fault interrupters shall have 600-ampere bushing wells.
- B. Bushings and bushing wells shall be located on one side of the gear to reduce the required operating clearance.
- C. Bushings rated 600 amperes continuous shall be provided without a threaded stud.
- D. Terminals for fault interrupters shall be equipped with 600-ampere bushings.

2.07 BUSHINGS AND BUSHING WELLS

- A. Bushings and bushing wells shall conform to ANSI/IEEE Standard 386 (ANSI Standard C119.2).
- B. Bushings and bushing wells shall include a semiconductive coating.
- C. Bushings and bushing wells shall be mounted in such a way that the semiconductive coating is solidly grounded to the gas-tight tank.

PART 3 - BASIC COMPONENTS

3.01 LOAD-INTERRUPTER SWITCHES

- A. The three-phase, gang-operated load-interrupter switches shall have a three-time and ten-time duty-cycle fault-closing rating as specified under "Ratings." This rating defines the ability to close the switch the designated number of times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Certified test abstracts establishing such ratings shall be furnished upon request.

- B. The switch shall be provided with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment.
- C. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.
- D. The switch shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap.
- E. The open gaps of the switch shall be sized to allow cable testing through a feedthru bushing or the back of the elbow.

3.02 FAULT INTERRUPTERS

- A. Fault interrupters shall have a three-time and ten-time duty-cycle fault-closing and fault interrupting rating as specified under "Ratings." This rating defines the fault inter-rupter's ability to close the designated number of times against a three-phase fault with asymmetrical (peak) current in at least one phase equal to the rated value and clear the resulting fault current, with the interrupter remaining operable and able to carry and interrupt rated current. Certified test abstracts establishing such ratings shall be furnished upon request.
- B. The fault interrupter shall be provided with a disconnect with an integral ground position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to ground the equipment.
- C. The ground position shall have a three-time and ten-time duty-cycle fault-closing rating.
- D. The disconnect shall be provided with an open position that is readily visible through the viewing window to eliminate the need for cable handling and exposure to high voltage to establish a visible gap.
- E. The fault interrupter, including its three-position disconnect, shall be a single integrated design so that operation between the closed and open positions or the open and grounded positions is accomplished with a single, intuitive movement.
- F. The open gaps of the disconnect shall be sized to allow cable testing through a feed-through bushing or the back of the elbow.

- G. An internal indicator shall be provided for each fault interrupter to show when it is in the tripped condition. The indicator shall be clearly visible through the viewing window.

3.03 OPERATING MECHANISMS

- A. Load-interrupter switches and fault interrupters shall be operated by means of a quick- make, quick-break mechanism.
- B. The manual handle shall charge the operating mechanism for opening, closing, and grounding of the switches and fault interrupters.
- C. A single, integrated operating mechanism shall fully operate each fault interrupter or load interrupter switch in a continuous movement, so that additional operations are not required to establish open or ground positions.
- D. Operating mechanisms shall be equipped with an operation selector to prevent inadvertent operation from the closed position directly to the grounded position, or from the grounded position directly to the closed position. The operation selector shall require physical movement to the proper position to permit the next operation.
- E. Operating shafts shall be padlockable in any position to prevent operation.
- F. The operation selector shall be padlockable to prevent operation to the grounded position.
- G. The operating mechanism shall indicate switch position which shall be clearly visible from the normal operating position.

3.04 OVERCURRENT CONTROL

- A. A microprocessor-based overcurrent control shall be provided to initiate fault interruption.
- B. The control shall be mounted in a watertight enclosure and shall be removable in the field without taking the gear out of service.

- C. Control settings shall be field programmable using a personal computer connected via a data port to the control. The data port shall be accessible from the exterior of the enclosure.
- D. Power and sensing for the control shall be supplied by integral current transformers.
- E. The minimum total clearing time (from initiation of the fault to total clearing) for fault interruption shall be 40 milliseconds (2.4 cycles) at 60 hertz or 44 milliseconds (2.2 cycles) at 50 hertz.
- F. The control shall feature time-current characteristic (TCC) curves including standard E-speed, K-speed, coordinating-speed tap, and coordinating-speed main curves. Coordinating-speed tap curves shall optimize coordination with load-side weak-link/backup current-limiting fuse combinations, and coordinating-speed main curves shall optimize coordination with tap-interrupter curves.
- G. The standard E-speed curve shall have phase-overcurrent settings ranging from 25E through 400E. The coordinating-speed tap curve shall have phase-overcurrent and independent ground-overcurrent settings ranging from 50 amperes through 400 amperes. The coordinating-speed main curve shall have phase-overcurrent and independent ground-overcurrent settings ranging from 100 amperes through 800 amperes.
- H. The control shall have instantaneous-trip (1 kA through 8 kA) and definite-time delay (32 ms through 96 ms) settings to allow tailoring of the coordinating-speed tap and coordinating-speed main curves to the application.
- I. Event records shall be easily extractable from the control using a personal computer connected to the data port.
- J. The control shall store sufficient energy to operate the motor operators for the interrupter switches without impacting the accuracy or coordination under fault conditions.

3.05 VOLTAGE INDICATION

- A. Voltage indication with provisions for low-voltage phasing

1. Voltage indication with provisions for low-voltage phasing for each load-interrupter switch and fault interrupter, shall be provided by means of capacitive taps on the bushings. There shall be no need for cable handling and exposure to high voltage to test the cables for voltage and phasing. This feature shall include a flashing LCD display to indicate the presence of voltage for each phase, and a solar panel to supply power for testing of the complete voltage-indication circuit and phasing circuit.
2. The voltage-indication feature shall be mounted on the covers for the viewing windows on the opposite side of the gear from the bushings and bushing wells so that operating personnel shall not be required to perform any routine operations in close proximity to high-voltage elbows and cables.

3.06 LOW-VOLTAGE ENCLOSURE AND COMPONENTS

- A. The low-voltage enclosure shall have a minimum space of 16" high x 26" wide x 11" deep for a user-specified RTU and communications device.
- B. The low-voltage enclosure shall be a separate, grounded structure. It shall be mounted on the outside of the pad-mounted enclosure for the pad-mounted switchgear style. It shall be mounted to a vault wall for the vault-mounted switchgear style. It shall be mounted on a customer supplied pad above grade level for the UnderCover switchgear style.
- C. All low-voltage components, including the batteries, shall operate over the temperature range of -40 deg. C to +65 deg. C.
- D. To guard against unauthorized or inadvertent entry, the low-voltage enclosure shall not have any externally accessible hardware.
- E. The low-voltage enclosure shall include appropriate vents to prevent gas and moisture buildup. Vents shall be screened and filtered to prevent entry of insects and to minimize entry of dust into the enclosure.
- F. All low-voltage components, including motor operator controls, RTUs, communication devices, batteries, and battery charger, shall be located in a grounded, steel-enclosed compartment separate from medium voltage to provide isolation, and shall allow complete accessibility for test and/or maintenance without exposure to medium voltage.

- G. Low-voltage wiring, except for short length, such as connections connectors to terminal blocks, shall be shielded for isolation from medium voltage.
- H. For submersible applications, all motor operator wiring between the switchgear tank and the low-voltage enclosures shall be submersible.
- I. For submersible applications, all current and voltage sensing wiring between the switchgear tank and the low-voltage enclosure shall be submersible.
- J. The low-voltage enclosure shall be made of 14-gauge mild steel.
- K. Control cabling between the tank and the low-voltage enclosure that is 15 feet or greater in length shall be furnished with a braided shield to protect electronic components from damage under surge and transient conditions.
- L. Single-point grounding methods shall be used on cabling between the tank and the low-voltage enclosure to protect electronic components from damage under surge and transient conditions.
- M. Low voltage enclosure shall be large enough to accommodate motor operators in the event that they will be installed at a future date.

3.07 OPTIONAL FEATURES

- A. Three-phase current sensing.
- B. Three-phase voltage sensing.
- C. Portable remote control for motor operator. This device plugs into an adapter on the face of the motor control board and allows the user to activate the motor operator from a maximum distance of 50 feet from the gear tank.
- D. Gear shall be Remote-Supervisory ready for integration into campus SCADA system.

PART 4 - SWITCHGEAR STYLE

4.01 PAD-MOUNTED STYLE

- A. o guard against corrosion due to extremely harsh environmental conditions, the gas-tight tank shall be made of Type 304 stainless steel.

- C. Enclosure
 - 1. The switchgear shall be provided with a pad-mounted enclosure suitable for installation of the gear on a concrete pad.
 - 2. The pad-mounted enclosure shall be separable from the switchgear to allow clear access to the bushings and bushing wells for cable termination.
 - 3. The basic material shall be 14-gauge hot-rolled, pickled, and oiled steel sheet.
 - 4. The enclosure shall be provided with removable front and back panels, and hinged lift-up roof sections for access to the operating and termination compartments. Each roof section shall have a retainer to hold it in the open position.
 - 5. Lift-up roof sections shall overlap the panels and shall have provisions for pad-locking that incorporate a means to protect the padlock shackle from tampering.
 - 6. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
 - 7. Panel openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between panels and panel openings to guard against water entry.
 - 8. For bushings rated 600 amperes continuous, the termination compartment shall be of an adequate depth to accommodate encapsulated surge arresters mounted on 600-ampere elbows having 200-ampere interfaces.
 - 9. For bushing wells rated 200 amperes continuous, the termination compartment shall be of an adequate depth to accommodate 200-ampere elbows mounted on feed-thru inserts.
 - 10. An instruction manual holder shall be provided.

11. Non-removable lifting tabs shall be provided.

D. Enclosure Finish

1. All exterior welded seams shall be filled and sanded smooth for neat appearance.
2. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard under film propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling, before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.
3. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the manufacturer's finishing system shall satisfactorily pass the following tests:
 - a. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
 - (1) Under film corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
 - (2) Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.
 - b. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714.
 - c. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659,

and no more than 10% reduction of gloss as evaluated per ASTM D 523.

- d. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
- e. 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking. (vi) Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.
- f. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.

Certified test abstracts substantiating the above capabilities shall be furnished upon request.

- 4. The finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
- 5. The finish shall be olive green, Munsell 7GY3.29/1.5.

PART 5 - LABELING

5.01 HAZARD-ALERTING SIGNS

- A. The exterior of the pad-mounted enclosure (if furnished) shall be provided with “Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death” signs.
- B. Each unit of switchgear shall be provided with a “Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death” sign. The text shall further indicate that operating personnel must know and obey the employer’s work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
- C. Each unit of switchgear shall be provided with a “Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death” sign.

5.02 NAMEPLATES, RATINGS LABELS, AND CONNECTION DIAGRAMS

- A. Each unit of switchgear shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.
- B. Each unit of switchgear shall be provided with a ratings label indicating the following: voltage rating; main bus continuous rating; short-circuit rating; fault-interrupter ratings including interrupting and duty-cycle fault-closing; and load-interrupter switch ratings including duty-cycle fault-closing and short-time.

PART 6 - ACCESSORIES

- 6.01 A shotgun clamp stick (6-5/2 , 8-5/2) in length shall be provided complete with a canvas storage bag.
- 6.02 An adapter cable for connecting an overcurrent control to a user-furnished personal computer (having a 25-pin or 9-pin serial communication port) in the field shall be provided.
- 6.03 An adapter cable for connecting an overcurrent control removed from its enclosure to a user-furnished personal computer (having a 25-pin or 9-pin serial communication port) in the shop shall be provided.

END OF SECTION 16465

SECTION 16510

INTERIOR BUILDING LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of interior lighting fixture work is indicated by drawings and schedules.
- B. Types of luminaires and controls in this section include the following:
 - High-intensity-discharge (HID).
 - Fluorescent.
 - Incandescent.
 - Dimming Controls
- C. Applications of interior lighting fixtures required for project include the following:
 - General lighting.
 - Supplementary lighting.
 - Emergency lighting.
- D. UL Compliance: Provide interior lighting fixtures which have been UL-listed and labeled.
- E. CBM Labels: Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
- F. Provide ballast meeting applicable energy codes with a temperature rating suitable for the application.
- G. Provide barriers to isolate fixtures from insulation installations.

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, manufacturers specified below and as shown on the drawings within the lighting fixture schedule.

2.02 INTERIOR LUMINAIRES:

- A. Luminaires shall consist of complete units including the lighting fixture, ballast, lamps, and associated components required for a complete and operating unit with the options, finishes and photometry specified.
- B. Recessed/Indirect Luminaire: A recessed/indirect luminaire shall consist of a steel enclosure with a curved reflector and center mounted light shield. The curved reflectors shall have a power coat finish of high reflectance white, and shall provide symmetric light distribution. The center lamp shield shall be a perforated with a white finish, and shall have a white acrylic diffuser behind. The shield shall swing down to allow access to the lamps. The ballast compartment shall be center mounted and shall enclose the ballast and wiring in an all-steel enclosure, and shall have tool-less entry. A top-mounted wiring access cover shall allow the luminaire to be wired without need to access the ballast compartment from below.
 - 1. Recessed/Indirect luminaires in 2'x4' size shall use 32-watt T8 lamps, unless indicated otherwise. Fixture shall be capable of installing up to three (3) lamps behind the shield, but shall be provided sockets and ballasts for the quantity of lamps indicated on the plans. Luminaire efficiency factor (LEF) shall be 67% minimum.
 - 2. Recessed/Indirect luminaires in 2'x2' size shall use 40-watt long compact fluorescent lamps. Fixture shall be capable of installing up to three (3) lamps behind the shield, but shall be provided sockets and ballasts for the quantity of lamps indicated on the plans.
- C. Parabolic Troffer: shall consist of a steel enclosure with 8"x8" parabolic louvered cells. Louver finish shall be low iridescent diffuse silver.

1. 2'x4' size shall have 18 cells and be provided with three 4' T8 lamps, unless indicated otherwise. Luminaire efficiency factor (LEF) shall be a 64% minimum.
2. 2'x2' size shall be the same style of construction as the 2'x4' luminaires, and shall have 9 cells. Provide with two 31-watt T8 U-lamps.

2.03 LAMPS

- A. General: Provide lamps to match the requirements of the luminaire and ballast in which they are installed. Subject to compliance with these specifications, provide fluorescent lamp from one of the following manufacturers:

General Electric
Phillips
Sylvania

- B. Standard T8 fluorescent lamps shall be medium bi-pin lamps suitable for instant start or rapid start ballasts. Lamps shall be in lengths as required for the fixture installation and shall be 3500 degree Kelvin color temperature, 86 color rendering index minimum, 20,000 hour rated average life. Mean rating for a 4-foot, standard output lamp shall be 2800 lumens. All T8 style fluorescent lamps shall be low Mercury and Toxicity Characteristic Leaching Procedure (TCLP) compliant, and shall have green endcaps to demonstrate compliance.
- C. Compact fluorescent shall be suitable for the luminaire in which they are installed and shall be 82 CRI minimum. Four-pin lamps shall be used except below 13-watts, and in luminaires that require two-pin lamps.

2.04 BALLASTS

- A. Non-dimming fluorescent ballasts shall be high frequency electronic integrated circuit providing normal light output from the lamps. Lamp operational frequency shall be greater than 42 kHz. Total harmonic distortion (THD) shall be less than 10%. Power factor shall be no less than 98%. Crest factor shall be less than 1.7. Audible noise rating shall be better than Class A. Lamps shall be operated in a instant start, parallel configuration. Ballasts shall meet all applicable ANSI and IEEE standards, including ANSI/IEEE C62.41, CAT. A. Ballasts shall carry a five year warranty. Ballasts shall be capable of operating 2', 3' or 4' lamps. Ballast shall contain auto restart circuitry in order to restart lamps without resetting power. Ballast shall provide independent lamp operation for

instant start ballasts allowing remaining lamps to maintain full light output when one or more lamps fail. Ballast shall be Advance Centium T8, no substitutions.

- B. Compact fluorescent ballasts shall be high frequency electronic integrated circuit providing normal light output from the lamps. Lamp operational frequency shall be greater than 42 kHz. Total harmonic distortion shall be less than 20%. Power factor shall be greater than 98%. Crest factor shall be less than 1.7. Audible noise rate shall be Class A or better. Ballasts shall meet all applicable ANSI and IEEE standards, including ANSI/IEEE C62.41, CAT A. Ballasts shall carry a five year warrantee.
- C. Incandescent lamps shall be size, style wattage and type suitable for the application and as indicted.
- D. Fluorescent Emergency Ballast shall consist of a high-temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry contained in one metal case. A solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware shall be provided. The emergency ballast shall be capable of operating two fluorescent lamps at 1350 lumens initial light output in the emergency mode for a minimum of 90 minutes. The emergency ballast shall have 4 Watts of input power, a 24 Watt-hour battery capacity, and exceed emergency standards set forth by the current NEC. The emergency ballast shall be UL Listed for installation inside, on top of, or remote from the fixture and warranted for a full five years from date of purchase. Bodine # B50 or approved equal.
- E. Compact Fluorescent Emergency Ballast shall consist of a high-temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry contained in one metal case. A solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware shall be provided. The emergency ballast shall be capable of operating one compact fluorescent lamp at 1000 lumens initial light output in the emergency mode for a minimum of 90 minutes. The emergency ballast shall have 3.5 Watts of input power, a 19.2 Watt-hour battery capacity, and exceed emergency standards set forth by the current NEC. The emergency ballast shall be UL Listed for installation inside, on top of, or remote from the fixture and warranted for a full five years from date of purchase. Bodine # B84C or approved equal.
- F. Dimmable Fluorescent Ballast, non-addressable: Ballasts for dimming fluorescent lamps fo presentation areas shall dim the lamps from 100% to 1% relative light output without flicker. THD shall be less than 10%, power factor greater than

0.95, ballast factor greater than .85, and have inrush current limited to 7 amps for 120-volt systems. Lutron Hi-lume series.

2.05 ADDRESSABLE BALLAST SYSTEM

- A. Addressable Fluorescent Ballast: Addressable ballasts shall communicate digitally with other ballasts to form a dedicated network for lighting control and monitoring. The ballast shall be dimmable from 100% to 10% relative light output. Each ballast shall be capable of integrating a daylight sensor, occupancy sensor, or infrared controller into the control network. Lutron EcoSystem series.
- B. Digital Bus Supply: A digital bus supply shall be installed for each addressable zone. The bus shall provide power to the communications bus and shall be capable of being integrated with other digital bus supplies to for larger networks.
- C. Occupancy sensors: Dual technology occupancy sensors shall be installed where indicated. Sensor shall be selected to provide coverage over the entire area. Provide ceiling mounted sensor unless shown otherwise. Lutron LOS series.
- D. Daylight sensor: Where indicated, provide daylight sensors for light harvesting control. Through programming, the sensor shall dim selected fixtures based on the available daylight. Sensor shall also contain an infrared receiver for EcoSystem programming. Lutron #C-SR-M1-WH.
- E. Infrared Receiver: used for wireless control of the system. Provide ceiling mounted units where indicated and required for programming. Lutron C-R-M1-WH.
- F. A control module shall be supplied where an addressable fluorescent ballast is not available due to voltage, lamping, dimming requirements, or other issues. The module shall provide an addressable control point and shall control a 3-wire ballast, 10% eco-system unless indicated otherwise. Lutron C5-BMF-2A or equal.
- G. Control wiring shall be provided between all components per the manufacturers written instructions and recommendations. Control wiring shall be installed in a dedicated conduit system separate from the power wiring.
- H. The system shall be programmed to provide correct operation of ballasts with inputs for hand-operated control and automatic sensors. Programming shall be complete at the time of substantial completion.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES:

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.
- C. Fasten fixtures securely to indicated structural support; and check to ensure that solid pendant fixtures are plumb.
- D. Coordinate lighting fixture installation with the mechanical, plumbing and sprinkler installation work. Develop a reflected ceiling arrangement plan in cooperation with the installers of the mechanical, plumbing, and sprinkler work. Adjust lighting fixture locations to solve conflict problems with other installation work. Notify the designer of pending conflict problems and recommend adjustments prior to installing the lighting fixtures.
- E. The lighting fixture vendor shall be responsible for coordinating all fixture types with mounting requirements and ceiling types. Provide for adjustments, exchanges and accessories required to match fixture to ceiling type.

3.02 ADJUST AND CLEAN:

- A. Clean interior lighting fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during remainder of construction period.
- C. Maintain a protective seal over lighting fixture diffusers during the remaining construction period.

3.03 FIELD QUALITY CONTROL:

- A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. Replace defective and burned out lamps at the time of Substantial Completion.

3.04 GROUNDING:

- A. Provide tight equipment grounding connections for each interior lighting fixture installation.

END OF SECTION 16510

SECTION 16520

EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of exterior lighting fixture work is indicated by drawings and schedules.
- B. Types of exterior lighting fixtures in this section include the following:
 - High-intensity-discharge (HID).
 - Metal halide.
- C. Applications of exterior lighting fixtures required for project include the following:
 - Outdoor area lighting.
 - Outdoor supplementary lighting.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products of manufacturers listed on the drawings within the lighting fixture schedule.

2.02 EXTERIOR LIGHTING FIXTURES:

- A. General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring.
- B. Fluorescent-Lamp Ballasts: Provide fluorescent-lamp ballasts, capable of operating lamp types indicated; with high power factor, rapid-start, and low-noise features; Type 1, sound rated A, and with internal thermal protection.
- C. High-Intensity-Discharge-Lamp Ballasts: Provide HID lamp ballasts, capable of operating lamp types and ratings indicated; reactor type, high power factor, core and coil assembly encapsulated in non-melt resin; install capacitor outside ballast

encapsulation for easy field replacement; and enclose assembly in drawn aluminum alloy housing(s) unless otherwise specified.

- D. High-Intensity-Discharge-Lamp Ballasts: Provide HID lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly matches lamps to power line by providing appropriate voltages and impedances for which lamps are designed.
- E. Comply with additional fixture requirements contained in Lighting Fixture Schedule shown on drawings.

2.03 LUMINAIRES:

- A. Provide corrosion-resistant, aluminum luminaires, of sizes, types and styles indicated on the drawings.

2.04 EXTERIOR LIGHTING CONTROL

- A. Provide photocell, timeclock and contactors as indicated on plans. Time clock shall be digital microprocessor-based with battery backup. All contactors shall be full size standard NEMA. Miniature size contactors will not be allowed.

PART 3 - EXECUTION

3.01 INSTALLATION OF EXTERIOR LIGHTING FIXTURES:

- A. Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of exterior lighting fixtures with other work.
- C. Fasten fixtures securely to indicated structural supports; and check to ensure that solid pendant fixtures are plumb.

- D. Install roadway and parking area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that lighting units fulfill requirements.
- E. Coordinate with other electrical work as necessary to properly interface installation of roadway and parking area lighting with other work.
- F. Use belt slings or rope (not chain or cable) to raise and set finished poles and standards to protect finishes.
- G. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.
- H. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling where indicated.

3.02 ADJUST AND CLEAN:

- A. Clean exterior lighting fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during remainder of construction period.

3.03 GROUNDING:

- A. Provide tight equipment grounding connections for each roadway and parking area lighting unit installation.
- B. Provide tight equipment grounding connections for each exterior lighting fixture installation.
- C. Exterior lighting branch circuits shall be equipped with a code size equipment grounding conductor. The equipment grounding conductor shall bond to the pole base, pole, luminaire housing, and ballast frame to insure a complete ground return path for all outdoor lighting system components.

3.04 FIELD QUALITY CONTROL:

- A. Upon completion of installation of exterior lighting fixtures, and after energizing branch supply circuitry, apply electrical energy to lighting fixtures to demonstrate

capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

- B. Replace defective and burned-out lamps at the time of Substantial Completion.
- C. Furnish stock or replacement lamps amounting to 10% (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space.

END OF SECTION 16520

SECTION 16526

EXTERIOR ATHLETIC LIGHTING

1PART - LIGHTING PERFORMANCE

The lighting systems manufacturer shall supply equipment to meet or exceed the following performance criteria:

1 .1 Requirements

- A. The following establish the design and performance requirements for the lighting system.
- B. Initial Light Levels, established after 100 hours of system operation, are computed only to verify that the computer-generated design is in accordance with Illuminating Engineering Society (IES) recommendations (RP6-88), and are not computed in order to establish actual measurements. The following criteria must be utilized and substantiated by required documentation:
 - 1. **100-Hour Lamp Lumen Output** (as shown on the lamp manufacturer's specification sheet)
 - 2. **Ballast Factor** (wattage output of ballast when operating hot in the fixture, as shown on the ballast manufacturer's specification sheet: if ballast is rated cold, output must be derated by 0.95)
 - 3. **Lamp Tilt Factor** (.90 for axially mounted lamps; 1.0 for horizontally mounted lamps)
 - 4. **Initial Light Level = Lamp Manufacturers 100 Hr Lamp Lumens Output x Ballast Factor x Lamp Tilt Factor**
- C. Targeted Light Levels (Maintained Footcandles) shall be determined utilizing the following formula and considering the following criteria:
 - 1. **Initial Light Levels X 0.80 LLF (Light Loss Factor)**
 - 2. The lumen output for each luminaire, as denoted by a numeric value, must be clearly shown on the computer-generated design. Failure to do so shall be grounds for rejections of bid.

3. Actual field measurements shall be taken after 100 hours of system operation. To attain 100 hours of operation, lamps shall be cycled eleven hours on and one hour off (per IES LM-54-91).
 4. Specified light levels shall be an average of all the measurement readings in the given area of play.
- D. Average initial horizontal light level measured 36" above the playing surface will meet or exceed _____ FC _____ LUX.
- E. Average maintained horizontal light level measured 36" above the playing surface will meet or exceed _____ FC _____ LUX.
- F. The uniformity of the playing field shall be determined by comparing the maximum reading to the minimum reading. The maximum to minimum ratio shall not exceed: _____.
- G. The areas to be included as Primary Playing Area, (PPA) requiring equal illumination, are in distances of _____' beyond the field boundary (per IES Lm-5-96).
- H. Initial spill light readings shall not exceed the following values at a distance of _____' from the boundary of playing area in any direction:
1. Average Initial **horizontal** light level measured 36" above grade _____ FC _____ LUX.
 2. *Average Initial **vertical** light level measured 36" above grade _____ FC _____ LUX.
- I. To compare actual performance of the lighting installation with the computer-generated design, measurements shall be taken in the field on a grid with points spaced _____' X _____', totaling _____ (per IES RP6-88).
- J. The entire lighting system shall not exceed _____kW.
- K. The lighting system shall have an ETL, UL, or CSA listing. This listing shall be based upon ETL or UL testing and evaluation of the compatibility of components for use in combination in this application, as well as the individual components being ETL or UL listed or recognized.

*NOTE: **Maximum Spill** - The maximum illuminance calculated at a point when the light meter at that point is aimed successively at each light source or group of light sources.

1.2 WARRANTY

- A. The sports lighting system materials and workmanship are warranted to be free from manufactured defects for five years from time of shipment from the manufacturer's facility to the site. Excluded from this five-year warranty are lamp, fuses, and any labor charges.

1.3 SHOP DRAWINGS

- A. Submit shop drawings for all equipment specified, including luminaire assemblies, electrical components and computer-generated designs verifying initial and targeted light levels.

PART II - PRODUCTS

2.1 SPECIFIED MANUFACTURER

- A. The sports lighting system and specifications shall be from Cooper Lighting, Universal Sports Lighting.

2.2 LUMINAIRE

- A. The luminaire shall consist of an integral, pre-wired and pre-assembled ballast housing and general purposed optical assembly. The luminaire shall feature horizontal lamp optics utilizing standard BT-56 Mogul base lamps with optional internal glare/spill light control louvers. The luminaire shall comply with all appropriated NEMA and ANSI specifications.
- B. In order to ensure proper heat dissipation and properly balance the luminaire load on the crossarm, the luminaire shall feature an isolated ballast compartment design with transverse crossarm mounting. The integral ballast housing shall be of die-cast aluminum and isolate the core and coil on one side and capacitors on the other for coolest operation. The optical assembly shall also be completely separate from the ballast housing for maximum thermal management. The die-cast aluminum housing shall be uniformly painted inside and out with a polyester powder coat finish. The ballast housing shall be accessible by the removal of a formed aluminum ballast cover. Cover fastener hardware shall be captive to prevent loss during installation and maintenance. All external hardware shall be stainless steel or polymer coated for corrosion resistance.
- C. The luminaire shall have a cast-in horizontal aiming protractor and feature single bolt mounting to the crossarm or service platform without the use of an additional crossarm adapter or special mounting plate for ease of installation.

- D. The luminaire shall be rated for 55 degree C maximum ambient temperature operations for up to 1650 watts, and shall reliably start and operate the lamp in ambient temperatures down to -20 degrees C for the life of the rated lamp. Capacitor temperatures shall not exceed 68 degrees C in a 55 degree C ambient environment operating a maximum 1650 watt lamp.
- E. The ballast shall be capable of starting and operating one 1000/1500/1650 watt metal halide lamp from a nominal 120/208/240/277/347/480 volt, 60 Hz power source, or a 220,230,240 volt 50Hz power source.
- F. The ballast shall be in full compliance with lamp/ballast specifications available from the lamp manufacturer. The ballast must protect itself against normal lamp failure modes and be capable of operation with the lamp in an open circuit condition for six months without accelerate loss of ballast life.
- G. The ballast output shall not vary more than +/- 5% from rated wattage when operated hot in the fixture (with nominal line and lamp voltage). Rated wattage for the ballast, supplied by the ballast manufacturer, shall be determined when the ballast is operating hot in the supplied luminaire, not cold on the bench.
- H. For ease of installation and maintenance, the luminaires shall be supplied with a pre-installed STOOW-A cord with molded integral UL/CSA certified water-tight connector plug for connection to the pre-wired, galvanized steel mounting structure. Mating parts shall be mechanically keyed to prevent miss mating. Pins extended from the male device shall be recessed for protection. A molded rubber collar shall circle the base of each male pin to form a cork-like seal with each female socket. Pins and sockets shall be machined from solid bar stock to provide maximum moisture resistance. The grounding pins shall be extended for maximum safety. SO cable shall be rated at 600 volts and 105 degree C. All electrical components shall be UL recognized (UL #53429).
- I. The general-purpose optical assembly shall consist of a one piece spun aluminum reflector that is symmetrically parabolic in shape. It shall be uniformly finished inside and out with a corrosion resistant anodized finish for maximum optical performance and lumen maintenance. The reflector shall be held in place by two stainless steel mounting arms and die-cast aluminum socket castings. The socket casting and reflector shall be sealed with post baked, high temperature, silicone gaskets.
- J. The stainless steel mounting arms shall feature separate vertical aiming pivot bolts for permanent fixed aiming, and separate re-lamping hinge bolts so that the vertical aiming pivot point is never adjusted during re-lamping to prevent miss-aiming. The separate re-lamping hinge bolts shall allow easy rear re-lamping from service platforms or catwalks. An aluminum extrusion shall be used to provide positive stop repositioning without the use of friction or pin based re-

positioning stops. Vertical aiming degree markers shall be mounted on both sides of the optical for ease of aiming in any direction. A fixed mounted external aiming site shall also be supplied on the luminaire.

- K. The optical shall use an impact and thermal-resistant tempered glass lens. The lens shall be mounted in a stainless steel hinged doorframe with a permanent hinge and stainless steel latches. The lens door shall be sealed with a post baked, high temperature silicone gasket to protect the internal reflective surfaces from the photometric degradation caused by the entry of dirt and contaminants.
- L. The optical shall utilize internal glare control louvers for cutoff to lamp and lamp image without the increase in Effective Projected Area wind loading caused by external visors or louvers. The optical shall also include a thermal resistant vibrations lamp support with a fiberglass protective sleeve.
- M. The luminaire shall be vibration tested to a 3G force for 100,000 cycles in three planes, and shall be wind tunnel tested to 125 mph with a 1.3 Gust Factor.

2.3 LAMP

- A. The lamp shall be metal halide, manufactured to current industry standards, and commercially available at common sources of supply. Lamp construction shall be such that it is capable of operation in the luminaire without special retaining devices.

2.4 DISCONNECT SWITCH/FUSE ENCLOSURE

- A. Power disconnect enclosure shall be NEMA 3 rated and ETL or UL/CSA listed. It shall be hot-dipped galvanized per ASTM A123. It shall be equipped with a manual UL/CSA certified power disconnect switch and fuse holder. Enclosure door shall have stainless steel hinges and a waterproof gasketed seal. Enclosure shall be pre-wired complete, ready for installation.
- B. Enclosure shall be mounted on the pole at approximately 10' above grade.

2.5 SEOPRENE DROP CABLE

- A. The electrical supply cable shall be of the multiple conductor type and designed for suspension applications in high abrasion and extreme environment applications with a 600 volt, 105 degree C UL/CSA classification. Cable to be furnished with appropriate suspension device.

2.6 POWER DISTRIBUTION BOX

- A. Power distribution box shall be NEMA 3R rated and hot-dipped galvanized. It shall contain power distribution blocks and grounding lugs rated for 600 volts. Box shall be mounted on mounting structure assemblies.

PLEASE CHOOSE ON "2.7" BELOW

2.7 STEEL POLES - ANCHOR BOLT FOUNDATION

- A. The sports lighting system shall include a steel pole with an anchor bolt foundation.
- B. The fabricator shall have been involved in the production of high mast steel structures for a period of no less than three years in order to ensure adequate experience, knowledge, equipment, and capability.
- C. Pole shaft and foundation shall be designed to withstand an Isotach wind velocity of _____ mph times a 1.3 gust factor, including the total effective projected area (EPA) and weight of the luminaires and assembly, as based upon the 50-Year Mean Recurrence Interval Isotach Chart.
- D. Upon award of contract, lighting system manufacturer shall provide complete calculations verifying that the lighting pole meets the wind load requirements specified herein.
- E. Each section of the pole shaft shall be of a single ply of steel with no welded splices, and having only one longitudinal seam weld. Each slip joint shall be assembled in the field by slipping the upper section over the lower section by a minimum lap of 1.5 times the largest inside diameter of the upper section. The pole cross section shall be rounded or sixteen-sided with a four inch corner radius. The pole shaft sections shall be high strength steel meeting the requirements of ASTM A595 Grade A or B or ASTM A572 Grade 65.
- F. The base plate shall be of steel meeting the requirements of ASTM A36 or ASTM A572 Grade 42. It shall be integrally welded to the pole shaft with either 100% penetration, free of cracking and under cutting, and shall be ultrasonically tested, or a telescopic welded joint and magnetic particle tested.
- G. Poles shall be hot-dipped galvanized in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- H. The anchor bolt material shall meet the requirements of ASTM A615 Grade 75 with a minimum yield strength of 75,000 psi, elongation of 10% minimum in 8",

and charpy impact values of 15 ft/lb at -20 degrees F, or the anchor bolt material shall be AASHTO M314 Grade 55 with supplemental requirement S1.

- I. Anchor bolts shall be hot-dipped galvanized to ASTM A153 for a minimum of 12" on the threaded end. Each anchor bolt shall be supplied with the two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the anchor bolts.
- J. Steps shall be 3/4" - 10 UNC x 6-1/2" long. They shall be secured to the step lug (welded to the pole shaft) with a 3/4" - 10 UNC square nut and a 3/4" - UNC hex nut. Step spacing shall be on 15" staggered centered, beginning at approximately 12' - 15' above grade.
- K. Safety climbing device shall consist of 1/4" stainless steel safety cable, attached with a cable terminator even with the first step up from pole base and to the service base with an impact attenuator, and having an intermediate cable guide. The safety climbing device should be used with an OSHA approved body harness with D-rings, 6' lanyard, and detachable sleeve with quick stop locking device.

2.7 STEEL POLES - FLANGE FOUNDATION

- A. The sports lighting system shall include a steel pole with a flange foundation.
- B. The fabricator shall have been involved in the production of high mast steel structures for a period of no less than three years in order to ensure adequate experience, knowledge, equipment, and capability.
- C. Pole shaft and foundation shall be designed to withstand an Isotach wind velocity of _____ mph times a 1.3 gust factor, including the total effective projected area (EPA) and weight of the luminaires and assembly, as based upon the 50-Year Mean Recurrence Interval Isotach Chart.
- D. Upon award of contract, lighting system manufacturer shall provide complete calculations verifying that the lighting pole meets the wind load requirements specified herein.
- E. Each section of the pole shaft shall be of a single ply of steel with no welded splices, and having only one longitudinal seam weld. Each slip joint shall be assembled in the field by slipping the upper section over the lower section by a minimum lap of 1.5 times the largest inside diameter of the upper section. The pole cross section shall be rounded or sixteen-sided with a four inch corner radius. The pole shaft sections shall be high strength steel meeting the requirements of ASTM A595 Grade A or B or KASTM A572 Grade 65.

- F. The base plate shall be of steel meeting the requirements of ASTM A36 or ASTM A572 Grade 47. It shall be integrally welded to the pole shaft with either 100% penetrations, free of cracking and under cutting, and shall be ultrasonically tested, or a telescopic welded joint and magnetic particle tested.
- G. Poles shall be hot-dipped galvanized in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip; no double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- H. The flange foundation shall project approximately one foot out of the ground, have a top plate to match the pole's base plate, and be hot-dipped galvanized to guard against corrosion. It shall be made of high strength steel meeting the requirements of ASTM A572, Grade 65. The tip plate shall meet or exceed the requirements of ASTM A36. It shall be integrally welded to the steel tube with either a telescopic welded joint or a full penetration butt weld with a backup bar.
- I. Steps shall be 3/4" - 10 UNC x 6-1/2" long. They shall be secured to the step lug (welded to the pole shaft) with a 3/4" - 10 UNC square nut and a 3/4" - UNC hex nut. Step spacing shall be on 15" staggered centers, beginning at approximately 12' - 15' above grade.
- J. Safety climbing device shall consist of 1/4" stainless steel safety cable, attached with a cable terminator even with the first step up from pole base and to the service basket with an impact attenuator, and having an intermediate cable guide. The safety climbing device should be used with an OSHA approved body harness with D-rings, 6' lanyard, and detachable sleeve with quick stop locking device.

2.7 STEEL POLES - DIRECT EMBEDDED

- A. The sports lighting system shall include a steel pole that is direct embedded.
- B. The fabricator shall have been involved in the production of high mast steel structures for a period of no less than three years in order to ensure adequate experience, knowledge, equipment and capability.
- C. Pole shaft and foundation shall be designed to withstand an Isotach wind velocity of _____ mph times a 1.3 gust factor, including the total effective projected area (EPA) and weight of the luminaires and assembly, as based upon the 50-Year Mean Recurrence Interval Isotach Chart.
- D. Upon award of contract, lighting system manufacturer shall provide complete calculations verifying that the lighting pole meets the wind load requirements specified herein.

- E. Each section of the pole shaft shall be of a single ply of steel with no welded splices, and having only one longitudinal seam weld. Each slip joint shall be assembled in the field by inside diameter of the upper section. The pole cross section shall be rounded or sixteen-sided with a four inch corner radius. The pole shaft sections shall be high strength steel meeting the requirements of the ASTM A595 Grade A or B or KASTM A572 Grade 65.
- F. Poles shall be hot-dipped galvanized in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- G. Steps shall be 3/4" - 10 UNC x 6-1/2" long. They shall be secured to the step lug (welded to the pole shaft) with a 3/4" - 10 UNC square nut and a 3/4" - UNC hex nut. Step spacing shall be on 15" staggered centers, beginning at approximately 12' - 15' above grade.
- H. Safety climbing device shall consist of 1/4" stainless steel safety cable, attached with a cable terminator even with the first step up from poles base and to the service basket with an impact attenuator, and having an intermediate cable guide. The safety climbing device should be used with an OSHA approved body harness with D-rings, 6' lanyard, and detachable sleeve with quick stop locking device.

2.7 STEEL TOWERS - ANCHOR BOLT FOUNDATION

- A. The sports lighting system shall include a three-sided steel tower with an anchor bolt foundation.
- B. The fabricator shall have been involved in the production of high mast steel structures for a period of no less than three years in order to ensure adequate experience, knowledge, equipment, and capability.
- C. Tower and foundation shall be designed to withstand an Isotach wind velocity of _____ mph times a 1.3 gust factor, including the total effective projected area (EPA) and weight of the luminaries and assembly, as based upon the 50-Year Mean Recurrence Interval Isotach Chart.
- D. Tower and foundation design shall account for ice load per the latest revision of ANSI/EIA-222.
- E. Tower shall be constructed of the following materials:
 - 1. Steel pipe legs (ASTM A618, Grade III) and solid rod legs (ASTM A572, Grade 50) having a minimum yield strength of 50 ksi.

2. Solid rod braces (C-1008) having a minimum yield strength of 33 ksi.
 3. Angle braces up to 3" x 3" x 1/4" through 4" x 4" x 3/8" (ASTM A36 Modified) having a minimum yield strength of 50 ksi.
 4. Angle braces up to 3" x 3" x 1/4" through 4" x 4" x 3/8" (ASTM A36 Modified) having a minimum yield strength of 50 ksi.
 5. Angle braces of 5" x 5" x 5/16" or more (ASTM A572, Grade 50).
 6. Tower bolts shall be ASTM A325.
- F. Each structural member shall be identified by a part number, and any parts with the same part number must be interchangeable. This shall allow tower sections to be installed at any 120 degree rotation without changing the tower structurally. Match marking requirements of tower sections by the tower manufacturer, for proper assembly, shall not be acceptable.
- G. Tubular leg members shall maintain an open interior diameter through the flange plate at least as large as the inside diameter of the pipe and shall be electrically welded internally and externally.
- H. Flanged leg connections shall utilize a minimum of four bolts per leg.
- I. The tower base plates shall be of steel, meeting the requirements of ASTM A36.
- J. Anchor bolts shall meet or exceed ASTM A193 Grade B7 and ASTM A320 Grade 1.7.
- K. Anchor bolts shall be hot-dipped galvanized to ASTM A153 for a minimum of 12" on the threaded end. Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the anchor bolts.
- L. Poles/Tower shall be hot-dipped galvanized in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip; no double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- M. All welds shall be in accordance with the American Welding Society (AWS) D1.1-84 Gas Metal Arc process and performed by AWS-certified welders.
- N. Ladder shall be a minimum of 1' - 1-1/2" in width, with rungs 5/8" in diameter and spaced 15" o.c. Side rails shall be 1-1/2" x 1/4" bar. Where ladder sections are joined, splice plates and 1/2" x 1-1/2" bolts shall be used.

- O. Safety climbing device shall consist of 3/8" diameter 1 x 7 galvanized or stainless steel safety cable, attached at the bottom ladder rung with a bracket and compression spring and at the service basket with an impact attenuator, and having an intermediate cable guide. The safety climbing device should be used with an OSHA approved body harness with D-rings, 6' lanyard, and detachable sleeve with quick stop locking device.
- P. Tower design, fabrication and galvanizing quality shall be maintained through in-house control. Subcontracting of any of these responsibilities to companies other than the primary tower vendor shall be cause for rejection of the tower.

2.7 POLES - CONCRETE

- A. The following covers design, fabrication, and installation of pre-stressed concrete poles for sports lighting.
- B. Poles shall be designed to conform to the design criteria of the American Association of State Highway and Transportation Officials (AASHTO).
- C. Pole shall be a single continuous structure. Sectional poles to be field-assembled shall not be allowed.
- D. Poles shall be designed and constructed so that all wiring and grounding facilities are concealed within the pole. Any handholds, wire inlets and outlets inserts for pole steps, thru-bolt holes, and ground wire shall be cast into the pole during manufacturing. It is intended that no field drilling of the poles be required.
- E. Poles shall be designed considering the application of both dead load and wind load. The moment at any point along the length is to be the sum of moments resulting from dead loads and wind loads. The wind force is to be computed by multiplying the specified wind pressure by the effective projected area (EPA) of the individual components involved.
- F. Poles shall be designed to withstand a constant wind speed of _____ mpg times a gust factor of 1/3, as base upon the 50-Year Mean Recurrence Interval Isotach Chart.
- G. No deviations in ole design will be permitted without prior written approval of the engineer. Requests for any deviation must be submitted in writing at least seven (7) days prior to the bid date so that adequate time is available for evaluation and proper addendum. All such requests must be submitted with conclusive engineering and descriptive data to prove that the resulting structures and all components will meet or exceed the requirements herein.

- H. Upon award of contract, lighting system manufacturer shall provide complete calculations verifying that the lighting pole meets the wind load requirements specified herein.
- I. Pole fabrication shall adhere to the following:
1. The concrete mix shall be designed to achieve a minimum twenty-eight day compressive strength of 7,000 psi. Cement shall conform with ASTM C150. Maximum aggregate size shall be 3/4". Any water reducers, retarders or accelerating admixtures shall conform to ASTM C494. Water shall be free from foreign material in amounts harmful to concrete and embedded steel.
 2. **Reinforcing Steel** - Steel reinforcements shall conform to the requirements of ASTM A615 for Grade 60 rebar.
 3. **Pre-stressing Steel** - Pre-stressing steel reinforcement shall conform to un-coated 7- wire, stress relieved strand (including low relaxation) ASTM A416.
 4. **Spiral Reinforcement** - Steel spiral reinforcement shall conform to the requirements of ASTM A82 and shall be not less than 0.2031" in diameter (5 gauge). The pitch of the spiral steel shall not be greater than 6".
 5. **Hardware** - All structural steel shall conform to ASTM A123. Zinc alloy AC41A for inserts, handhole frames, and covers shall conform to ASTM B240. All nuts, bolts, washers, and other fasteners must either be hot-dipped galvanized or stainless steel to resist corrosion.
- J. All manufacturing tolerances, details of reinforcement, and finishes shall be in accordance with "Guide Specification for Pre-stressed Concrete Poles" as published in the JOURNAL OF THE PRE-STRESSED CONCRETE INSTITUTE.
- K. All poles must be pre-stressed to ensure a minimum 28-day compression strength of 7,000 psi.
- L. Forms shall be designed to provide a maximum continuous taper of 1/4" inches per foot of length, and provide a minimum of 3/4" concrete cover over all reinforcing steel.
- M. Pole shall have a smooth natural form finish, soft gray in color.
- N. The manufacturer shall have a minimum of three years experience in the design and production of concrete.

- O. Each concrete sports lighting pole shall include the following:
1. No. 6 stranded copper ground wire cast in the pole and attached to prestressing steel by appropriate connectors. Wire to be terminated at the top of the pole and at the bottom of the pole at approximately 18" below grade in a copper tank ground which provides a 1/2" tapped insert at the pole face for attachment to the lightning rod at the top of the pole and ground rod below grade. Provision for grounding of the safety climbing cable shall be provided by bonding one or more of the inserts used to install the safety cable eye bolts.
 2. Lightning rod (1/2" x 24") to be attached to the pole.
 3. As imprint or name plate cast into the wall of the pole approximately 4' - 5' above the ground to identify the manufacturer, year of manufacture, customer or job, and overall length.
 4. A minimum 2" conduit raceway centered 18" below grade.
 5. 3" x 8" minimum reinforced handhole frame and flush metal cover 24" above grade.
 6. A 1-1/2" coupling for wire inlet/outlet opposite handhole at fixture level.
 7. 5/16" diameter galvanized stranded safety climbing cable for servicing luminaires, nylon body harness with D-rings, detachable quick-strip latch, and 6' lanyard.
 8. 5/8" x 7" long step bolts complete with locking nuts on 15" staggered centers beginning at approximately 12' - 15' above grade.
 9. Each pole shall be capped at top and plugged at bottom.

2.8 SERVICE PLATFORMS

- A. Service platforms design shall comply with all OSHA safety and structural requirements. Service platforms shall be one piece units, factory assembled, shipped ready for installation. No field assembly of service baskets shall be allowed.
- B. The service platforms shall be made of rectangular tubular members. The vertical center support shall measure 4" x 6". Horizontal members shall be made from 2" x 4" steel tubing and be mounted through the vertical support. No support member will be dependent upon a weld for its structural integrity. All tubing components shall conform to ASTM designation A36. The assembly shall be manufactured as a one-piece modular unit for ease of installation and shall bolt

directly to the pole with high strength ASTM A325 connection bolts. The floor shall be 3# expanded metal grating with a hinged and framed door allowing access. The door shall be capable of closing prior to uncoupling safety climbing device.

- C. Service basket members shall be internally hard wired with 16 AWG stranded copper wire encased by a synthetic rubber molding and rated for 90 degree C and 600 volts. Wiring shall be UL/CSA certified for enclosed applications. The wire shall terminate at each luminaire location on the service basket with a ½" NPT receptacle threaded into the underside of the horizontal tubular member. Receptacles shall be epoxied for durability and moisture resistance. Wiring shall originate in UL/CSA certified compression-type terminal blocks. Block is to be mounted in a NEMA rated UL/CSA certified, gasketed enclosure. Each set of wires shall be marked and identified by luminaire location. The pole top mounting bracket shall have internal drip shielding for wire entrance.
- D. Welding shall be in accordance with the American Welding Society (AWS) structural Welding Code D1.1 Section 1 - 8, and shall be performed by welders certified in accordance with the AWS Code.
- E. The service basket shall be hot-dipped galvanized. Galvanizing to be in accordance with the requirements of ASTM A123. Each component must be completely coated in a single dip; no double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- F. All service basket materials shall be produced in the United States of America. They shall be of the ASTM type.

2.9 CROSSARMS

- A. The crossarm shall be made of rectangular tubular members to allow for internal wiring of fixtures. The vertical center support shall measure 4" x 6". Horizontal members shall be made from 2" x 4" steel tubing and be mounted through vertical supports. No support member shall be dependent upon a weld for its structural integrity.
- B. All tubing components shall conform to ASTM designation A36 and shall be pre-drilled for mounting luminaires. The assembly shall be manufactured as a one-piece modular unit for ease of installation and shall bolt directly to the pole with high strength ASTM A325 connecting bolts.
- C. Welding shall be accordance with American Welding Society (AWS) structural Welding Code D1.1 Sections 1 - 8, and shall be performed by welders certified in accordance with AWS Code.

- D. Crossarms shall be hot-dipped galvanized. Galvanizing to be in accordance with the requirements of ASTM A123. Each component must be completely galvanized in a single dip. No double dipping will be allowed. All miscellaneous hardware shall be galvanized per ASTM A153.
- E. All crossarm materials shall be produced in the United States of America. They shall be of the ASTM type.

2.10 SUBSTITUTE PRODUCTS

- A. Luminaires, poles lighting assemblies, and electrical components not in compliance with specification criteria must be submitted to the owner seven (7) days prior to bid opening for evaluation and approval. Substitute equipment must be equal to or exceed the requirements specified herein.
- B. Lighting manufacturers submitting products other than those in compliance with specifications shall submit photo metric data showing equal or better footcandles levels, uniformity levels, and electrical consumption, while using the same design criteria and formulations.
- C. Information shall be included on the following: ballast and ballast housing, all materials and electrical components of the luminaire, pre-wiring, pre-aiming, and luminaire construction. Omission of information or failure to provide proper and concise data shall be ground for rejection of bid.
- D. Photometric reports must be submitted as outlined in Section 1.5. Failure to provide this information shall be cause for rejection of bid.
- E. Lighting system manufacturer shall provide statement of warranty for all substitute equipment provided.
- F. Lighting system manufacturer shall submit a written itemized statement of exceptions and discrepancies to specification.

PART III

3.1 MEASUREMENT PROCEDURES AND EVALUATION (per IES RPG-88, pp 88-89)

- A. All luminaries shall be operating and properly aimed.
- B. HID lamps shall have been in operation for 50 to 100 hours prior to testing. If the lamps and/or luminaires have been in operation for more than 100 hours, the approximate operating hours should be recorded.

- C. For HID lamps, the system shall be operating for at least 30 minutes prior to testing.
- D. Testing shall be done when the air and sky are clear and extraneous light is at a minimum.
- E. Care shall be taken that test personnel do not cast shadows or reflected light from clothing or measurement instruments.
- F. The photometer shall be of good quality and accuracy, recently calibrated or its accuracy otherwise verified.
- G. The measurement record shall include the following information:
 - 1. Name of the installation.
 - 2. Date and time of the measurements.
 - 3. Description of the lighting system, including luminaire and lamp type and quantities, mounting heights, and other pertinent details.
 - 4. Age of the lighting system and number of operating hours since the last lamp change.
 - 5. Type, make and serial number of the photometer.
- H. A variation between computer-predicted performance and the site-measured results is to be expected. However, the actual results shall be within 10% of the predicted results.

3.2 ON-SITE ASSISTANCE

- A. At the request of the owner or contractor, the manufacturer shall provide a representative during the installation of the lighting system to instruct the installing contractor and to ensure that poles and luminaire assemblies are properly oriented according to manufacturer requirements.

PART IV - DELIVERY

4.1 REQUIREMENTS

- A. All material shall be delivered to the site undamaged and stored in an area safe from damage of all nature.
- B. Damaged material shall be rejected.

- C. The contractor shall be responsible for receiving the sports lighting system and poles at the site, and shall provide all equipment and labor required to unload the materials. Poles shall be stored as recommended by the manufacturer.

END OF SECTION 16526

SECTION 16722

FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of fire alarm and detection system work shall be as described in this specification, as shown on the drawings and as required by code requirements. The contractor and equipment supplier shall review all project plans and specifications completely and be familiar with the requirements of the system. All required components to cause operation of the system as specified shall be supplied and installed.
- B. The system described in this specifications shall use digital transmissions between the CPU/transponder and the peripheral devices. Systems using non-digital technology as the principal means of supervision shall not be considered as meeting the requirements of this specification. Analog supervision of signaling devices and non-digital devices such and tamper switches and flow switches is acceptable.
- C. The system shall conform to all applicable sections of the NFPA including, but not limited to sections 72-A, B, C, D, E, F and the Life Safety Code section 101. The system shall also comply with the National Electric Code (NEC), Standard Building Code, local codes, UL wiring criteria, Americans with Disabilities Act (ADA) and directions of the Fire Marshal.

1.02 QUALITY ASSURANCE

- A. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
- B. The equipment and installation supervision furnished under this specification is to be provided by a supplier who has been engaged in production of this type (software driven) of equipment for at least ten (10) years, and has a fully-equipped service organization within fifty (50) miles of the installation.

- C. All control equipment is to be listed under U.L. category UOJZ as a single control unit. Partial listing shall not be accepted. The system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.

1.03 SYSTEM OPERATION

- A. Each component of the fire alarm system shall be supervised for improper operation including open or short circuits by the fire alarm panel. The fire alarm panel shall also supervise itself for low battery voltage and loss of normal building power. Upon any of the above conditions, the trouble indicator on the fire alarm panel shall indicate the improper status by both an audible and visual signal. The audible indication shall continue until the condition is acknowledged by an operator at the fire alarm panel. Visual indication shall continue until the trouble condition is corrected.
- B. Upon confirmation of an alarm from any initiation device, the following functions shall be performed without delay:
 - 1. All alarm signaling devices shall sound until silenced by an operator at the fire alarm panel or after ten (10) minutes of operation. Silencing signals shall not prevent the signals from sounding on a subsequent alarm.
 - 2. Display an alarm status on the alphanumeric display of the fire alarm panel and sound an audible signal at the panel. Signal shall sound until alarm is acknowledged by an operator.
 - 3. Shut down all required air handling units. All smoke dampers shall be closed and the smoke removal system shall be activated.
 - 4. Transmit a signal to the local fire department having responsibility by the most expedient method acceptable to the local authority having jurisdiction unless directed by a specific method within these specifications or drawings.
 - 5. Cause doors held open electrically to close without time delay.

1.04 POWER REQUIREMENTS

- A. The control panel shall receive 120 VAC power via a dedicated fused disconnect circuit.

- B. 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 five (5) minutes of alarm indication at the end of this period or as required.
- C. Circuits requiring system operating power shall be 24VDC and individually fused at the control panel.

1.05 SUPERVISION AND WIRING

- A. All pull stations, smoke detectors, heat detectors, remote control modules (RCM), and remote monitoring modules (RMM) shall be supervised using digital messages between the Fire Alarm Panel and the device. Each device shall be individually addressed and shall have a parity checksum test that must be passed before any digital message is considered valid. Any loss of correct communications with any device shall be indicated as a trouble condition on the Fire Alarm Panel.
- B. Monitor and signaling devices (speakers, strobes, and tamper switches, flow switches, etc.) shall be supervised by means of a class "B" circuit. This includes circuits from the Fire Alarm Panel, remote control modules and remote monitoring modules. Any faults in this circuit shall be indicated as a trouble condition on the Fire Alarm Panel.
- C. All digital communications wiring shall be as recommend by the manufacturer with a minimum size of #18 shielded AWG. All data wiring shall be shielded will a foil wrap and contain an integral drain wire. The system shall allow for "T" taps in the data wiring. Contractor shall verify that maximum run lengths are not exceeded and shall provide and install repeaters as necessary.
- D. Power, signal and other class "B" circuit wiring shall be sized as recommended by the manufacturer with a minimum size of #14 AWG. Provide end-of-line resistors where necessary and required; Ohmic values as required by the manufacturer.

1.06 PRODUCTS

- A. FIRE ALARM CONTROL PANEL MODEL [4110, 4100, 4120] with a MINIMUM OF [250, 500, 1000] ACTIVE POINTS - expandable to (1000), capable of supporting alarm initiating appliances and alarm indicating appliances as required in this specification.

The control panel shall be software programmable via the front panel for input/output functions and shall contain a historical event log.

Control panel status and custom labels shall be displayed by an alphanumeric LCD display (80 characters). Front panel switches shall provide control and programming. Displayed information indicates which zones are in alarm, supervisory, or trouble and also indicates additional panel status such as auxiliary output per zone, low battery, ground fault, and other pertinent information.

System Walk Test operation that shall allow the system to be tested by a single person.

Remote Digital Access Retrieval and Programming System RDARPS: The New Panel shall contain a Remote Digital Access Retrieval and Programming System(RDARPS) for connection to the campus 2120 CPU system with communication software package. This shall consist of a password/call back telephone interface system for remote monitoring and programming. When connection is made by a remote access system, a password shall be given. If the password entered is valid, the system shall hang up and call a specific phone number matched to that password. At that time, system status information may be retrieved and certain control functions may be implemented. Listing of all summary reports specified elsewhere shall be possible. System reset, alarm acknowledge or signal silence shall not be possible from the remote location. The Fire Alarm System may be monitored continuously for all system status changes including but not limited to alarm and trouble conditions. Once access has been obtained, an additional second level system password may be entered allowing on line programming of the system software. The entire system program shall be capable of being retrieved, saved, modified and re-installed at a later time. A master password shall be required to program matched phone numbers and passwords. Twenty-six password buffers shall be available for these functions. The fire alarm supplier shall have on line an access system capable of the above functions.

Provide a distributive processing network fire control loop system control panel. This system shall be an expansion of the existing peer to peer network loop system.

B. Voice Fire Alarm Panel

The system shall incorporate one-way voice communication and tone generating capabilities.

A central audio control module shall be provided where required for the necessary alarm message/tone generation, main and remote microphone connections, music inputs, and mixer/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure should a problem occur (eg. main microphone trouble, tone trouble, etc.). Audio outputs shall have individual gain control.

A hand-held, push-to-talk microphone shall be provided, recessed within a protective panel-mounted enclosure. The microphone shall be a noise-cancelling communication type with a frequency range of 200 Hz to 4000 Hz and shall be equipped with a self-winding five foot coiled cable. An LED indicator shall be provided to indicate the microphone push-to-talk button has been pressed and speaker circuits are ready for transmission. The microphone shall be supervised for disconnection.

An audio control switch module shall be furnished to provide manual access to audio operations for authorized personnel. The module shall include an "ALL Circuits" switch, "Aux Tone 1" switch, "Aux Tone 2" switch, tone generator stop switch, and "Audio Trouble Reset" switch. These switches and associated LED indicators shall be supervised for disarrangement or failure.

Audio power amplifiers shall be furnished with a self-contained filtered 24VDC power supply, transformer, and amplifier monitor circuits. The amplifiers shall provide a 25 Volt RMS output with a frequency response of 120 Hz to 12,000 Hz. Provide sufficient amplification to operate all system speakers simultaneously.

The speaker circuits shall be capable of supplying 25 Volt RMS audio power from the system amplifiers. Supervision for open, short, or ground fault conditions shall be provided. Individual and distinct trouble indications shall be provided for each fault. Provide [one circuit for each zone or area of distinct communication] or [the circuits identified in the schedule on the electrical plans]. Digitized tones, minimum of [8], for alarm (slow whoop) and auxiliary requirements (wail, horn, chime, etc.) shall be provided.

A pre-recorded digitized voice message capability is to be provided for automatic transmission to building occupants during alarm conditions. The automatic message player shall not rely on a tape or other mechanical means of transmitting the evacuation message. Systems that use tape players must provide, as a minimum, a backup tape player designed to automatically operate (within 2 seconds) if the primary tape player jams or otherwise fails to operate. A standard evacuation message shall be provided under this contract, however, the message player must be capable of transmitting a custom message of up to five (5) minutes

long. A self-contained speaker will provide testing of the message(s) without disturbing the occupants of the facility.

A remote microphone/annunciator command location where shown on the electrical plans shall be provided to duplicate the manual voice transmission capability of the main fire alarm control panel.

Automatic Voice Evacuation Sequence

1. The audio alarm signal shall consist of an alarm tone for a maximum of 15 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume. The alarm tones shall sound alternately until the alarm silence switch at the fire alarm control panel has been operated.
2. All audio alarm operations (speaker circuit selection and alarm tone/voice message timing variations) shall be activated by the system software so that any required future changes to the evacuation sequence can be facilitated by authorized personnel without any component rewiring.

Manual Voice Paging Sequence

1. The system shall be configured to allow selective voice paging, minimum [1] circuit per floor. Upon activation of any speaker manual control switch, two (2) attention getting beeps shall sound over the speakers indicating an impending voice message will occur.
2. If any speaker manual control switches are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the preselected speakers.
3. Facility for total building evacuation and paging shall be provided to allow for activation of all speakers. This shall be accomplished by the means of an "All Circuit" switch.

C. REMOTE ANNUNCIATOR(S) MODEL 4606-9101

Where shown on the electrical plans, provide and install a Serial Annunciator. The serial annunciator shall provide an alphanumeric, 80 Character Liquid Crystal Display (LCD) that provides clear language information as to the 4100 point status (alarm, trouble, etc.), type of alarm (smoke detector, pull station, etc.),

number of alarms on the system, and a custom location label. The annunciator(s) shall have a [beige enamel] finish. The annunciator shall communicate to the control panel over one twisted, shielded pair of wire and operating power shall be 24VDC and be fused at the control panel. Point-wired annunciators will not be considered as equal. Status information of each device may be individually displayed to investigate specific point detail. Four programmable control switches with associated LEDs are available for custom control functions. Manual Control Switches shall function and be the same as those on the 4100 Control Panel.

- D. ADDRESSABLE MANUAL PULL STATION - Model 4099-9001 Addressable pull stations will contain electronics that communicate the station's status (alarm, normal) to the control panel over two wires which also provide power to the pull station. The address will be set on each station. Pull stations shall be single action.
- E. TrueAlarm Sensors and Addressable Sensor Bases CEILING, DUCT, AND HEAT SENSORS - Model 4098-9714 addressable smoke sensors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel. Each sensor shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location. Each sensor shall be scanned by the control panel for its type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.
- F. ADDRESSABLE TRUEALARM HEAT SENSOR - Model 4098-9733 Addressable temperature sensors shall sense within a temperature range of 32EF to 158EF. The control panel will be capable of sensing either a set point of 135EF, or a rate-of-rise of [15EF] [20EF] per minute for fire sensing. For utility sensing, a set point may be chosen within the stated range and the control panel programming will be capable of using that information to determine specific response such as warning of failure of local temperature controls.
- G. ADDRESSABLE ZONE MODULES - Zone Modules shall only be used for monitoring of water flow, valve tamper, and for control HVAC systems.
 - 1. Model 4090-9001 Individual Addressable Module (IAM) shall be used to monitor devices like sprinkler , kitchen hood and Halon Systems. Only [1] contact per Monitor Module shall be permitted.

2. Model 4090-9002 Control Addressable Module (CAM) shall be provided with Form C contacts for interfacing HVAC devices, elevator/sprinkler control to an addressable signaling line circuit for non-supervised control.

H. ADDRESSABLE DUCT HOUSINGS

1. Model 4098-9756 True Alarm Duct Housing with a programmable relay for HVAC Control. This programmable relay shall be programmed to operate the air handling unit and shall not require [1] of the [CPU] addresses.

I. ADDRESSABLE SENSOR BASES

1. Each 4098-9792 sensor base shall contain a LED that will flash each time it is scanned by the control panel (once every 4 seconds). When the control panel determines that a sensor is in the alarm or a trouble condition, the control panel shall command the LED on that sensor's base to turn on steady indicating the abnormal condition. Sensors which do not provide a visible indication of an abnormal condition at the sensor location shall not be acceptable.
2. Sensor bases, as shown on the plans, shall be provided with a relay driver output that is to be controlled either automatically or manually from the control panel. This programmable output shall not require [1] of the [CPU] addresses.

J. Audio Visual Xenon Strobe / Horn - Model 4903-9417 Wall Mount Audio Visual Unit. All strobes shall be synchronized and shall be 15-cd minimum. Horns shall be rated 91-db at 10'-0".

K. Visual Only Xenon Strobe - Model 4904-9331 Wall Mount. Visual Only Xenon Strobe Unit. Strobes shall be synchronized and shall be 15-cd minimum. Strobe units shall mount to the same backbox as the audio/visual combination unit.

L. Water Flow / Tamper / PIV Switch - If these devices are in the Mechanical Specifications, the SPRINKLER CONTRACTOR shall furnish and install these devices. The ELECTRICAL CONTRACTOR shall make the electrical connections.

M. Door Holders - Model 2088-9608 Wall Mount 24VDC type Door Holders unless the door holders are specified to be furnished under another section. In this case

the OTHER CONTRACTOR shall furnish and install the devices. The ELECTRICAL CONTRACTOR shall make the electrical connections.

N. GRAPHICS COMMAND CENTER AT ELECTRICAL SHOP

1. Expand the existing 4190 Color Graphics System (CGS) to include all system events and automatically and manually display customer specified graphic representations and condition of zone for this project. The system shall be U.L listed to Standard 864 as supplemental equipment to all compatible Fire Alarm Control Panels connected. The system shall include screens which will represent each wing of each floor. Travel keys shall be available to allow selection of further system detail. Travel keys shall be user defined for selection of the next or previous screen as desired. Multiple levels of screen selection shall be available to allow for direct selection of the desired screen without accessing intermediate screens. The CGS shall include user-prompting messages, which minimize operator time, reduce training requirements, and eliminate typing errors where keyboard response is required. From the mouse, the operator shall be able to:
 - a. Silence audible and extinguish visible appliances in the affected area.
 - b. Perform manual operation of system(s) control points.
 - c. View the most detailed level of graphic display and return in onestep.
 - d. Request the "HELP" menu.
 - e. Acknowledge all alarm and return-to-normal conditions.
 - f. Select the individual message screens.
 - g. Set system time and date.
 - h. Reset system alarm points.
 - i. Perform editing functions.
 - j. Perform operator log-in/log-off sequence.

- k. Display list menus.

1.07 EXECUTION AND INSTALLATION

- A. Provide 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 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.

All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.

Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.

“Wire nut” type connectors shall not be used anywhere in the fire alarm system wiring. All wiring connections will be made with the use of compression type, barrier, terminals, Ideal Industries #89-608 or approved equal and sized to fit the wiring configuration.

The fire alarm panel shall be programmed with a specific description for each device, including device type, room name, and room number using the owner’s final room numbering scheme, which may differ from the architectural plans.

1.08 SYSTEM TESTING

- A. The completed system shall be fully tested by the contractor and the manufacturer's NICET CERTIFIED technical representative in the presence of the owner's representative. Upon completion of a successful test, the contractor shall so verify in writing to the owner, architect, and general contractor.
- B. The following test shall be performed by the Fire Alarm Manufacturer's authorized representative. Each and every device shall be tested for its intended function. Verify that each device is located in its appropriate location. Written verification of this test shall be provided to the owner, architect, and general contractor. This test shall be performed in accordance with NFPA 72 National Fire Alarm Code 1993.
- C. The fire alarm supplier shall own and maintain a smoke detector analyzer for on

site sensitivity testing of smoke detectors per NFPA. The analyzer shall be made available to the owner for such tests.

1.09 SYSTEM SERVICE SUPPORT

- A. The system's supplier must employ factory trained technicians and maintain a service organization within 50 miles of the job site. This organization must have a minimum of 10 years experience selling and servicing fire alarm systems.

1.10 SYSTEM TRAINING

- A. Personalized instructions to the owner's representative shall be provided by a factory-trained representative of the equipment supplier.

1.11 WARRANTY

- A. The equipment and wiring shall be warranted to be free from electrical and mechanical defects for a period of one (1) year commencing with start-up and owners beneficial use of any portion of the system. Warranty shall include all labor/travel time and parts.

END OF SECTION 16722

INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.
- B. Division 16 Basic Materials and Methods sections apply to work of this section.
- C. The contractor and equipment supplier shall review all project plans and specifications completely and be familiar with the requirements of the system.

1.2 DESCRIPTION OF WORK:

- A. The University of Tennessee currently has in place a Cardax "FT" access and intrusion detection control system as their standard "head-end" and controller/communicator. All local control panels and associated I/O, and card reader interface modules shall be manufactured by Cardax. All products and work provided under this section will be completely compatible in all aspects of system architecture, software, programming, data protocols, operating voltages, and input/output characteristics.
- B. Extent of intrusion and detection and access system work is indicated herein, and by the contract drawings and schedules. All work and provisions under this specification section shall be considered as an expansion of the existing system.
- C. Types of detection in this section include motion detection sensors, door position switches, and acoustic glass break detection.
- D. Access control system will include proximity, wiegand, and magnetic stripe entrance readers, continuous duty electric door strikes, exit request detectors and push buttons, magnetic door locks, and various interfaces and interlocks to the IDS.
- E. At a minimum, each building on the UTK Campus, which is served by a fire alarm system, shall have in place components listed herein so as to communicate alarm, trouble, and supervisory conditions to the central alarm receiving system. These 3 inputs from the building fire alarm system shall be received at the central receiving system as separate and distinct signals. Minimum equipment package

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shall be as follows:

6000 8R Controller	1ea.
Communications surge arrester	1ea.
AC primary surge arrester	1ea.
12VDC power supply w/battery	1ea.
Cabinet to house above	1ea.
Provisions for connection to UT LAN	Lot

1.3 QUALITY ASSURANCE:

- A. Manufacturer: Firms regularly engaged in manufacture of intrusion detection and access systems, of types, sizes, and electrical characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with intrusion detection and access control systems installation work similar to that required for project. The installer shall be an authorized factory representative of the supplied equipment, and employ full time, factory trained technicians. Installer shall submit proof of current registration with the Tennessee Alarm Contractors Board.
- C. NEC Compliance: Comply with NEC as applicable to construction and installation of intrusion and detection system components and accessories.
- D. UL Compliance and Labeling: Provide intrusion and detection system components which are UL-listed and labeled.
- E. All required components to cause operation of the system as specified shall be supplied and installed.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on all equipment, and cable, including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals.
- B. Shop Drawings for systems provided under this section of the specification shall contain but not be limited to the following:
 - 1. Specification data sheets on each individual system component.

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2. Complete wiring diagrams for all devices and control panels.
 3. Conduit layouts on project floor plans, including wire and cable types and counts in each conduit run.
 4. Theory of operation and event matrix.
 5. Battery calculations that substantiate requirement for a minimum standby operation of all IDS and access control systems and devices for a minimum of 8 hours standby and 10 minutes of alarm. Also demonstrate ability of power supply/battery chargers to fully recharge battery sets in 12 hours or less.
 6. Voltage drop calculations for any voltage outputs to ensure proper operating voltage at the device.
- C. Provide complete sets of as-built drawings to the owner including any deviations from the submittal data and shop drawings, complete programming, installation, operation, and maintenance information including all access codes and user data bases.
- D. Based upon submittal information, the Designer and representatives of the University of Tennessee shall be the sole authorities to determine equipment compatibility and compliance with the specifications.
- E. Regardless of any other submittal requirements, 2 complete sets of all shop drawings, submittal books, and As-built documents drawings will be delivered directly to the Facility Services, Electrical Maintenance office.

1.5 GENERAL PROVISIONS

- A. All wiring shall be in conduit, 3/4" minimum, except for flexible device drops. Maximum conduit fill shall be 40%.
- B. Each detection device will be wired, annunciated, and programmed as a separate and distinct input zone.
- C. All communication or I/O wiring of any type leaving or entering the building will be protected with surge arresters specified herein.
- D. All AC inputs to power supplies and system components will be equipped with surge arresters specified herein.
- E. All cabinets shall be keyed alike. The University standard lock set is the C420A
- F. All accessible fasteners shall be tamper-proof "snake bite" type.
- G. All new doors and frames shall be factory prepped for electric strikes, mortise locks, door and bolt position switches, and magnetic locks. The Security Contractor shall carefully coordinate all aspects of this work with the door supplier to assure complete compatibility and alignment.
- H. Control panel and all associated control and "head end" equipment, and power supplies shall be housed in a NEMA 1 steel cabinet sized to accommodate the equipment. Cabinet shall include screen protected air vents at the cabinet top and bottom. Plywood backboards (3/4" BC) shall be permitted. All backboards shall

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be painted to match the cabinet interior. Cabinet shall be Hoffman Data Com D Box or approved equal. Free standing cabinets shall be Hoffman "Proline" Server cabinet or approved equal.

PART 2 - PRODUCTS

2.1 LOCAL CONTROL PANEL COMPONENTS.

- A. Local processor/control panel shall be a Cardax Model 6000. Provide quantities as shown on the drawings, at a minimum, provision shall be capable to handle all devices, functions, and I/O zones as shown plus 10% for future use.
- B. Local card reader control board shall be Cardax 6000 8R. Module shall be capable of connecting 4 wiegand/magnetic stripe, 8 proximity reader heads, and shall have 16 programmable inputs and 8 programmable outputs.
- C. Local I/O board shall be Cardax. Module shall be capable of 8 programmable inputs with input parameters of various EOL values, sensitivity ranges, and timing functions. Module shall also have 4 programmable relay outputs.
- D. Contractor shall provide desktop computer, software, and installation of a local workstation.

2.2 Peripheral Devices

- A. Card reader shall be Mercury Security Corp. SRI-10/20.
- B. LCD display, keypad shall be Cardax remote arming terminal.
- C. Wall mounted motion detectors shall feature dual detection using microwave and passive infrared technologies. Each detector shall be adjusted and aimed to the individual mounting location to ensure immunity to false alarm from air currents, rotating machinery, etc. Motion detector shall be a Detection Systems DS860 or approved equal. Provide all associated mounting hardware.
- D. Ceiling mounted motion detector shall have equal characteristics as the wall mounted unit, but shall feature 360 degree coverage. Ceiling mounted motion detector shall be a Detection Systems DS9360 or approved equal.
- E. Request to exit motion detector shall be a Detection Systems DS150 or approved equal and shall be mounted as per details shown on the plans and specifications.
- F. Magnetic door locks shall feature dual voltage operation, and an integral door position switch. Magnetic lock shall be Locknetics 390+ or 320+ depending on frame style and as shown on the drawings. Magnetic locks shall be mounted as shown in the specification details.
- G. Over-head door contacts shall feature a 2' stainless steel armored cable, cast aluminum body and shall have SPDT contacts. Door contact shall be a Sentrol

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- 2327A or approved equal.
- H. Door contacts shall be selected as to door type and construction. Door contacts shall be Sentrol 1078CTW, 1070W, 1047T, or 1037W or approved equal.
 - I. Cabinet tamper switches shall be mounted on all cabinets and shall indicate door movement of 3/4" or more. Tamper switch shall be GRI, TSC20 or approved equal.
 - J. Frame mounted electric solenoid locks shall be rated for continuous duty as required, and shall come with integral door position switches. Electric strike shall be Von Duprin 6112 or approved equal.
 - K. Environmental monitoring systems shall be Winland, Enviro Alert, EA-200/400 or approved equal. Monitor shall be supplied with required probes for humidity, hi/lo temperature, water, etc.
 - L. Money clip switches shall be mounted in all cash boxes. Coordinate locations and wiring entrances with building owner. Switch shall be Ademco 264 or approved equal.
 - M. Panic switches and associated wiring shall be mounted as concealed as possible under counter space and desks. Careful consideration in location shall be used to ensure ease of switch operation and avoidance of false activation. Panic switch shall be Amseco HUSK-20 or approved equal.
 - N. Acoustic glass break detectors shall be ceiling mounted so as to cover as much glass space as possible. Detectors shall have adjustment capabilities so that they can be tuned to each area of coverage. Contractor shall test and adjust each detector with a manufacturers approved and calibrated electronic tester. Acoustic glass break detector shall be Sentrol ShatterPro III. Tester shall be Sentrol 5709C or approved equal.
 - O. Wireless panic and status receivers shall be Dx format, single channel, programmable units with 32 channels and form C output contacts. Wireless receiver shall be Linear DXR 701 equipped with pendant transmitters DXT61A (qty. as specified) or approved equal.
 - P. Power supply/battery chargers shall be provided as indicated on the drawings and as per Contractors load and standby calculations. Units will be sized with a minimum of 40% extra output capacity above load calculations. Each power circuit serving control equipment or field devices will be individually fused. "Pig-tail" type fuse holders are not acceptable. Power supplies shall be Altronix SMP10PM24(12) or SMP5 as required. Fuse holders shall be Altronix PD8 or approved equal.
 - Q. Voltage driven sirens shall be enclosed in a tamper proof, steel cabinet with hinged cover and integral tamper switch. Siren package shall be Revere Industries RV-R2200SSPD or approved equal.
 - R. Surge Arrester shall be Innovative Technology HT12030A for primary AC circuits feeding all control equipment and Ditek 2MHLP series for I/O circuits or approved equal. All circuits that enter or leave the building for any reason or are

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connected to exterior equipment, shall be equipped with surge arresting devices.

2.3 SYSTEM OPERATION:

- A. Provide a complete intrusion detection and access control system to be installed, connected, tested and left in first-class operating condition. These intrusion detection and access control systems shall be designed and submitted with shop drawing and supporting data to document system proposed. Full and seamless integration of the systems shall be included under this contract and accomplished by use of outputs and data interconnections of each control system.
- B. The security alarm system shall monitor the integrity of all alarm initiating circuits, and shall be provided with automatically charged batteries to maintain system operation for 8 hours in the normal supervisory mode plus have sufficient capacity to operate in the alarm mode for 10 minutes at the conclusion of this supervisory time period. Batteries shall be supervised for connection to the system and a low voltage threshold. The automatic battery charger shall be capable of charging fully the discharged system batteries to 100% in 12 hours.
- C. Location of the control panel, alarm initiating devices, and audio/visual devices shall be as shown on the plans.

2.4 INTRUSION DETECTION SYSTEM:

- A. The system shall be comprised of the number of partitions shown on the drawings. Each alarm initiating device shall be wired and programmed as a separate and distinct zone.
- B. The system shall be armed, disarmed, reset, monitored and altered by the use of local card readers keypads or remotely by the UTK central alarm receiving system operator. Keypads and readers shall be supplied as indicated on the drawings.
- C. Actuation of any zone shall cause the following to occur.
 - 1. Activate the built in digital communicator for use on the campus proprietary network, or seize the protected premises telephone line and automatically report the alarm to the central receiving system.
 - 2. Activate any programmed output functions such as sirens, and lock or unlock electrically held doors.
 - 3. Indicate the alarm condition at the local keypad or annunciator.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. The University's staff technicians and designer's representative shall perform an inspection of the installation after written notice from the contractor that the installation is complete and ready for connection to the central alarm receiving system.
- B. Contractor shall be responsible for provision and installation of all system components, conduit and wiring. Contractor shall mount, connect, power and test all devices and alarm zone wiring. Control equipment shall be mounted and terminated but shall not be powered before inspection by the University staff technicians. System programming shall be by the University staff technicians. Contractor shall provide technicians familiar with all aspects of the installation and as-built drawings during all phases of the final connections and system certification.
- C. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- D. Wiring color code shall be maintained throughout the installation.
- E. All installation will be in strict accordance with the Contract Documents, Manufacturers installation and wiring recommendations, and the standards of the University of Tennessee.
- F. All aspects of the installation including device coverage patterns, adjustments, balancing, and programming will be closely coordinated with the University alarm room and their staff, alarm maintenance technicians

3.2 TESTING:

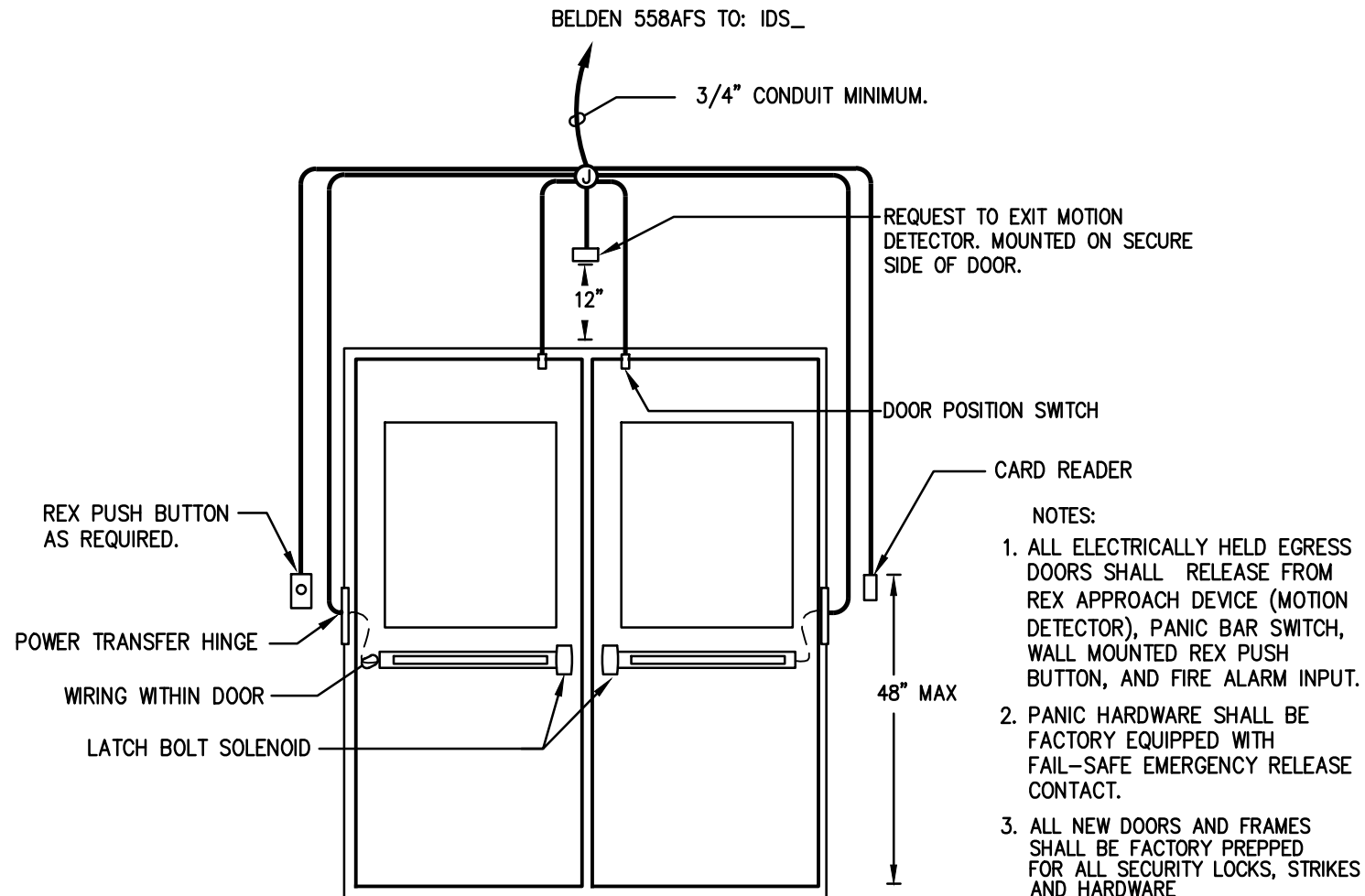
- A. Immediately after approval of shop drawings and submittals the contractor shall submit for approval, test plans for all equipment, remote reporting, outputs and functions. Plan shall include cause/effect matrix for each type of device, manufacturers recommended testing method for each type of device, and test forms showing every device, order of tests, pass/fail results and notations for the device.
- B. Contractor shall supply 2 technicians with appropriate means of communications for all phases of testing.
- C. All testing will be witnessed by the designer and will be assisted by the University's alarm maintenance technicians.

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3.3 SYSTEM GUARANTEE:

- A. The selected vendor shall maintain a service branch within 50 miles of the job site. The selected vendor shall maintain a 24 hour per day service department manned at all times, seven (7) days per week, including holidays.
- B. All equipment and wiring shall be guaranteed against defects in materials and workmanship for a one year period from the start up and beneficial use of the system. Warranty service for the equipment shall be provided by the system supplier's factory trained representative during normal working hours, Monday through Friday, excluding holidays. Emergency service provided at times other than as stipulated above shall be available from the same source at additional cost to the owner.

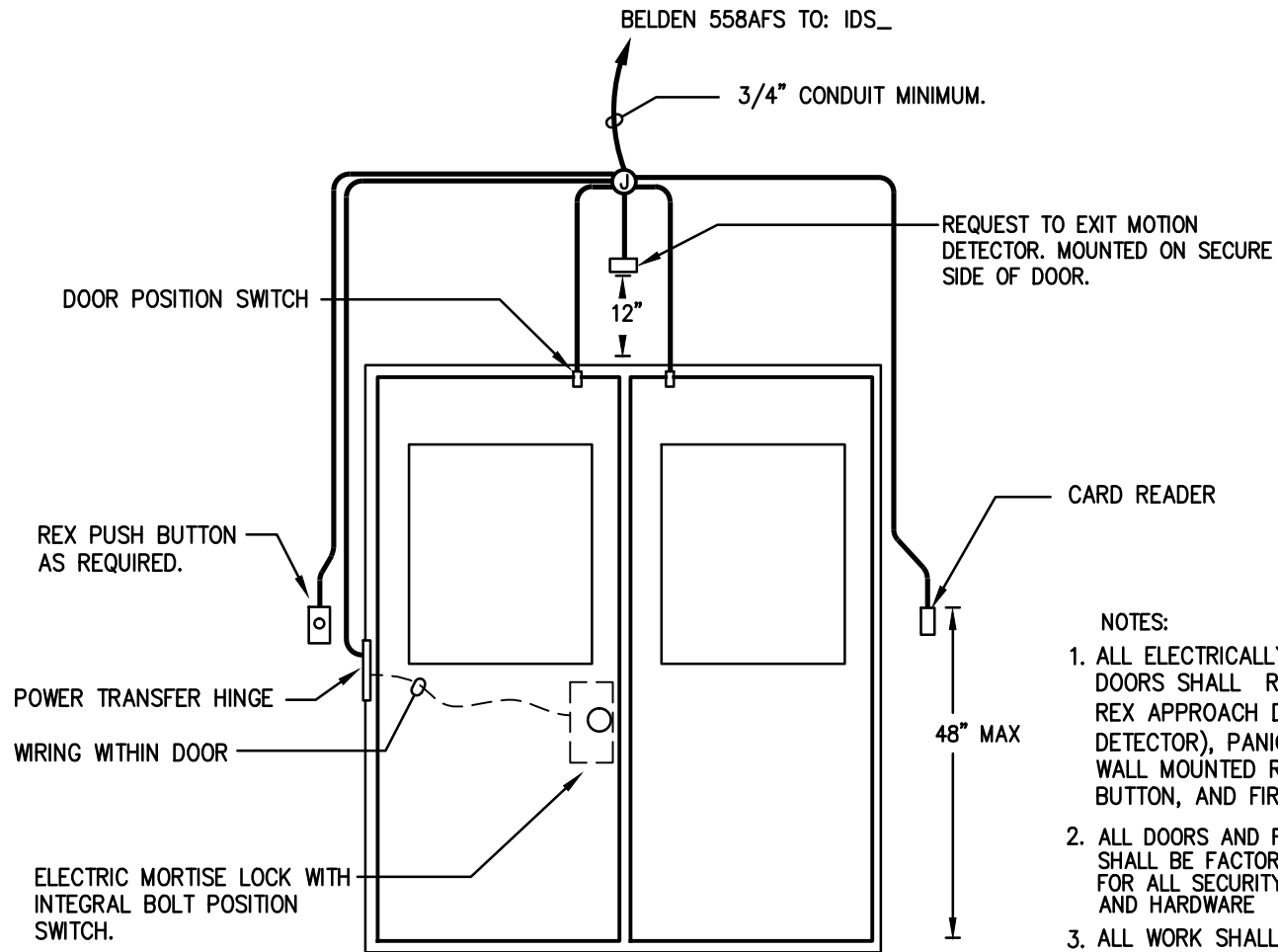
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- NOTES:
1. ALL ELECTRICALLY HELD EGRESS DOORS SHALL RELEASE FROM REX APPROACH DEVICE (MOTION DETECTOR), PANIC BAR SWITCH, WALL MOUNTED REX PUSH BUTTON, AND FIRE ALARM INPUT.
 2. PANIC HARDWARE SHALL BE FACTORY EQUIPPED WITH FAIL-SAFE EMERGENCY RELEASE CONTACT.
 3. ALL NEW DOORS AND FRAMES SHALL BE FACTORY PREPPED FOR ALL SECURITY LOCKS, STRIKES AND HARDWARE
 4. ALL WORK SHALL BE IN COMPLIANCE WITH IBC 2006, NFPA 101 2006.
 5. ALL CONDUIT AND WIRING SHALL BE CONCEALED IN WALL OR ABOVE CEILING LEVEL.
 6. CONTRACTOR SHALL SUPPLY ALL REQUIRED ACCESSORY EQUIPMENT SUCH AS POWER TRANSFER HINGES, POWER SUPPLIES, RELAYS, ETC.

TYPICAL DOOR SECURITY HARDWARE DETAIL C

NO SCALE



- NOTES:
1. ALL ELECTRICALLY HELD EGRESS DOORS SHALL RELEASE FROM REX APPROACH DEVICE (MOTION DETECTOR), PANIC BAR SWITCH, WALL MOUNTED REX PUSH BUTTON, AND FIRE ALARM INPUT.
 2. ALL DOORS AND FRAMES SHALL BE FACTORY PREPPED FOR ALL SECURITY LOCKS, STRIKES AND HARDWARE
 3. ALL WORK SHALL BE IN COMPLIANCE WITH IBC 2006, NFPA 101 2006.
 4. ALL CONDUIT AND WIRING SHALL BE CONCEALED IN WALL OR ABOVE CEILING LEVEL.
 5. CONTRACTOR SHALL SUPPLY ALL REQUIRED ACCESSORY EQUIPMENT SUCH AS POWER TRANSFER HINGES, POWER SUPPLIES, RELAYS, ETC.

TYPICAL DOOR SECURITY HARDWARE DETAIL B

SCALE: NONE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.
- B. Division 16 Basic Materials and Methods sections apply to work of this section.
- C. The contractor and equipment supplier shall review all project plans and specifications completely and be familiar with the requirements of the system.

1.2 DESCRIPTION OF WORK:

- A. Furnish and install a complete Closed Circuit Television (CCTV) system as describe herein and as shown on the electrical plans, to be wired, connected, tested and left in first-class operating condition.
- B. Coordinate and install required ancillary functions where shown on the electrical plans.

1.3 QUALITY ASSURANCE:

- A. Manufacturer: Firms regularly engaged in manufacture of CCTV equipment and recording devices, of types, sizes, and electrical characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with CCTV systems installation work similar to that required for this project. The installer shall be an authorized factory representative of the supplied equipment, and employ full time, factory trained technicians. Installer shall submit proof of current registration with the Tennessee Alarm Contractors Board.
- C. NEC Compliance: Comply with NEC as applicable to construction and installation of CCTV system components and accessories.
- D. UL Compliance and Labeling: Provide components which are UL-listed and labeled where required.

- E. Supply all required components to cause operation of the system as specified shall be supplied and installed.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on all equipment, and cable, including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals.
- B. Shop Drawings for systems provided under this section of the specification shall contain but not be limited to the following:
 - 1. Specification data sheets on each individual system component.
 - 2. Complete wiring diagrams for all devices and control panels.
 - 3. Conduit layouts on project floor plans, including wire and cable types and counts in each conduit run.
 - 4. Theory of operation and event matrix.
 - 5. Battery calculations that substantiate requirement for a minimum standby operation of all CCTV systems and devices for a minimum of 4 hours. Also demonstrate ability of power supply/battery chargers to fully recharge battery sets in 12 hours or less.
 - 6. Voltage drop calculations for any voltage outputs to ensure proper operating voltage at the device.
 - 7. Test plans for all devices.
 - 8. Training session plans including certifications of trainer, material to be covered, and tentative daily schedule.
- C. Provide complete sets of as-built drawings to the owner including any deviations from the submittal data and shop drawings, complete programming, installation, operation, and maintenance information including all access codes and user data bases.
- D. Based upon submittal information, the Designer and representatives of the University of Tennessee shall be the sole authorities to determine equipment compatibility and compliance with the specifications.
- E. Regardless of any other submittal requirements, 1 complete set of all shop drawings, submittal books, and As-built documents and drawings shall be delivered directly to the Facility Services Electrical Services Office, Facility Services Engineering Office, and Facilities Planning Office.

1.5 GENERAL PROVISIONS

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- A. All wiring shall be in conduit, 3/4" minimum, except for flexible device drops. Maximum conduit fill shall be 40%.
- B. Each detection devices shall be wired, annunciated, and programmed as a separate and distinct input.
- C. All wiring of any type leaving or entering the building shall be protected with surge arresters specified herein.
- D. All AC inputs to power supplies and system components shall be equipped with surge arresters specified herein.
- E. All cabinets shall be keyed alike. The University standard lock set is the C420A
- F. Control panel and all associated control and "head end" equipment, and power supplies shall be housed in a NEMA 1, steel cabinet sized to accommodate the equipment. Cabinet shall include screen protected air vents at the cabinet top and bottom. Plywood backboards (3/4" BC) shall be permitted. All backboards shall be painted to match the cabinet interior.

PART 2 - PRODUCTS

2.0 Digital Video Recorder

DVR ('s) shall be provided and sized as shown in the specifications and drawings, or at a minimum, shall accommodate all cameras shown on the drawings plus a minimum of 2 spare video inputs. Digital video recorder shall be Pelco DVR5100 Series or approved equal, with the following features as a minimum. All units supplied shall be Pelco "Endura" enabled and 100% compatible.

2.1 Digital Video Recorder (input channels as required).

- A. DVR shall incorporate the following features.
 - 4, 8, or 16 Analog Video Inputs; and 16, 12, 4 IP Camera Inputs Respectively
 - Embedded Linux ® Operating System
 - Record Video up to 600/500 ips (NTSC/PAL) at CIF, 2CIF, or 4CIF Resolution, Programmable on a Per-Input Basis
 - MPEG4-Based Compression with Constrained Variable Bit Rate for Optimum Picture Quality and Low Storage Consumption

- Endura ® System Integration Allows an Unlimited Number of DVR5100s to be Operated and Administered from an Endura Head-End
 - Continuous, Scheduled, Motion, Alarm and/or Event Recording
 - Up to 2.0 TB of Internal Storage Including EnduraStor™ Optimization. Hard drive space shall be 1T as a minimum unless specified otherwise.
 - DVR Configuration, Programming, and Operation from Front Panel Controls, USB Keyboard and Mouse, KBD5000, or Remote Client
 - Operating System on Compact Flash and Engineered Hard Drive Cooling System for Enhanced Reliability
- B. Provide and install rack mounting equipment, keyboard, mouse, and flat panel monitor (Pelco 300 series 15”) at DVR for programming purposes.

2.2 Indoor/Outdoor Fixed Dome Camera Assembly

The indoor/outdoor integrated CCTV camera and enclosure shall consist of a tamper/impact resistant, enclosure with integrated fixed camera and 3-9.5mm vari-focal lens. The indoor/outdoor integrated CCTV camera and dome style enclosure shall be Pelco IS111DWV9 Camclosure or approved equal. Contractor shall provide mounting options and hardware as required by site conditions.

2.3 Outdoor Fixed Camera Enclosure

- A. The environmental camera enclosure shall consist of an indoor/outdoor camera housing designed specifically for use with medium and smaller format cameras and fixed focal length or motorized zoom lenses in moderate to severe climate conditions and shall include thermostatically controlled heater and continuously operating blower along with any accessories which may be required for a complete environmental camera enclosure.

- B. The environmental camera enclosure shall be the Pelco EH3512-2 equipped with an EM3512 wall mount or approved equal.

2.4 Color Camera and Lens

- A. The color CCTV camera shall consist of a 1/3" format CCD imaging chip. The DSP color camera shall be a high resolution color camera with built-in connection for UTP or standard video output. Camera body shall be Pelco CCC1390H-6 or approved equal.
- C. Color camera shall be equipped with a 2.8-12mm vari-focal lens. Lens shall be Pelco 13VD2.8-12 or approved equal.

2.5 Color Pan, Tilt, Zoom Dome Camera

- A. PTZ environmental dome system shall be Pelco Spectra series SD435-PG-E1, with UTP options or approved equal.
- B. PTZ indoor dome system shall be Pelco Spectra series SD4-W0, with UTP options or approved equal.
- C. Where shown of the drawings the camera dome shall be equipped with a remote programming station Pelco PS-RDPE-2. Unit shall include IPS-CABLE as required.

2.6 UTP Video Baluns and Hubs

- A. Unless fiber optic connections are specified, all cameras with cable runs of less than 4900', shall be equipped with UTP conversion baluns and wired with standard Cat 5 cable as recommended by the balun manufacturer. Coaxial cable shall be used for patch cords only and as required to connect CCTV monitors, switching equipment, etc.
- B. Passive baluns shall be Pelco 3001P or approved equal.
- C. Active baluns shall be Pelco TW3001AR or approved equal.

2.7 High Resolution Color Monitor

- A. Monitor shall be Pelco 300 series 19" or approved equal.

2.8 Camera Power Supply

- A. The indoor camera power supplies shall allow for multiple cameras to be wired to a central power source. The power supplies shall consist of a metal can with a heavy-duty one hundred ten volt AC (110vAC) input to twenty-four volt AC (24vAC) step down transformer with a PC board individual wiring terminal outputs. The power supplies shall be available with four (4), eight (8), or sixteen (16) outputs. Provide and size power supplies as required and as shown on the drawings. Camera power supplies shall be Pelco MCS series or approved equal.
- B. All cameras shall have separate, fused power circuits.
- C. Outdoor power supplies shall be Pelco WCS series or approved equal.

2.9 Wiring

- A. Video wiring to all cameras shall be twisted pair, cat-5 UTP cable.
- B. Proper operating voltage shall be extended to each camera. Each camera shall have individual power conductors with sizing to be based on required voltage drop calculations. Each camera shall be independently fused.
- C. Contractor shall extend additional control, input, and output wiring to each camera as required.
- D. All video, power, and data circuits for all exterior cameras shall be equipped with surge arresting devices. Device shall be New Age Surge Protection model NAP12(24)V-PTZ or approved equal.

2.10 UPS W/LINE CONDITIONING

- A. Contractor shall provide a 1050 watt UPS system with integral line conditioning at each DVR location. UPS shall be Tripp-Lite SMART2200RML2U or approved equal.

2.11 EQUIPMENT RACK

- A. The equipment rack shall be a free standing, open frame, floor anchored, standard communications type. The equipment rack shall be constructed of 16 gauge CRS throughout. Cooper B-Line SB556072XUFB or approved equal.
- B. Contractor shall provide a rack mounted shelf for keyboard/mouse use.

Part 3 - Execution

3.01 Provisions

- A. Provide all miscellaneous hardware and items such as connectors, interconnect cables,

- fasteners, brackets, mounting adaptors, etc. to form a complete and functional system within the intent of this specification.
- B. Provide all equipment, wiring, conduit and outlet boxes required for the installation of a complete and operating system in accordance with applicable local, state and national codes, the manufacturers' recommendations, these plans and specifications. Wiring shall conform to the practices in the National Electrical Code and the Manufacturers recommendation.
 - C. All CCTV system wiring shall be installed in conduit. Conduit shall be minimum 3/4".
 - D. All system programming, camera focus, and aiming shall be fully coordinated with and approved by the system owner.
 - E. Full and seamless integration of the CCTV systems with themselves and other systems such as intrusion detection, access control, and intercom systems shall be included under this contract and accomplished by use of outputs and data interconnections of each control system.
 - F. All digital video recorders shall be equipped with local keyboard, mouse, and flat panel, LCD computer monitor (14" minimum).

3.1 INSTALLATION:

- A. The University's staff technicians and designers representative shall perform an inspection of the installation after written notice from the contractor that the installation is complete and ready for final aiming and focus.
- B. Contractor shall be responsible for provision and installation of all system components, conduit and wiring.
- C. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- D. Wiring color code shall be maintained throughout the installation.
- E. All installation will be in strict accordance with the Contract Documents, Manufacturers installation and wiring recommendations, the standards of the University of Tennessee, and all applicable local, state, and national codes and standards.
- F. All aspects of the installation including device coverage patterns, adjustments, balancing, and programming will be closely coordinated with the University alarm room staff, and their maintenance technicians.

3.2 INSPECTION AND TESTING

- A. The manufacturers' authorized representative shall provide as minimum, final system connections, perform a complete functional test of the system, and submit

- a written report to the Designer attesting to satisfactory operation of the system.
- B. Upon completion of the installation, four (4) copies of complete operational instructions and programming configuration as installed shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational and maintenance manuals have been received.
- C. Final acceptance will be granted after completion of successful acceptance testing, presentation and submittal of instructions, and transmittal of Owner's & Service manuals.
- D. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The engineer will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intents of these specifications.
- E. All testing will be witnessed by the designer and will be assisted by the University's alarm maintenance technicians.
- F. Contractor shall supply 2 technicians with appropriate means of communications for all phases of testing.

3.3 Training

- A. Before the system is turned over to the owner, the manufacturer shall provide 2 days of system training. One day for operators and one day for system maintenance personnel. All training shall be performed at the project site using the customer's equipment for up to 10 of the owner's representatives meeting a minimum expected level of computer competence.
- B. This training shall be conducted during normal business hours at a date and time of mutual convenience.
- C. Training shall be conducted by a trainer who is factory certified in installation, programming, maintenance, and operation of all supplied components.

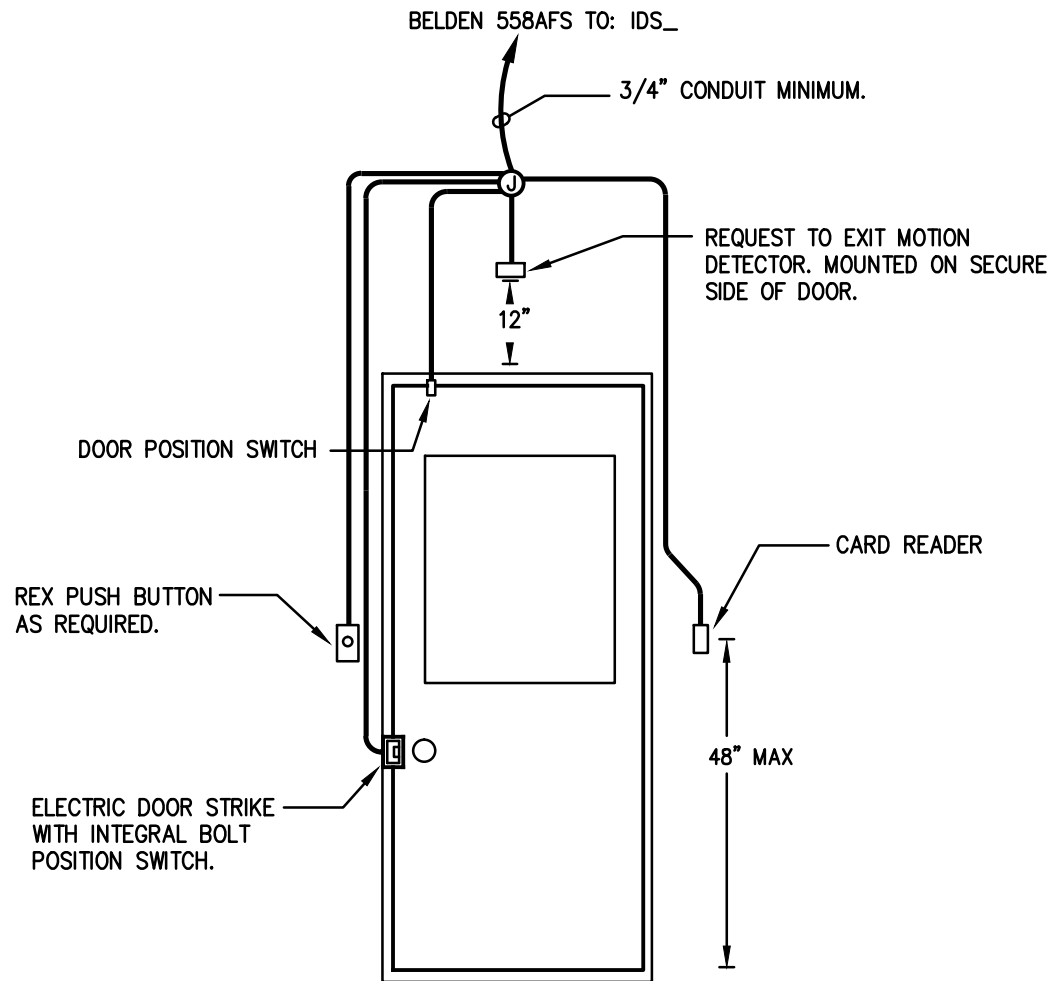
3.4 SYSTEM GUARANTEE:

- A. The selected vendor shall maintain a service branch within 50 miles of the job site. The selected vendor shall maintain a 24 hour per day service department manned at all times, seven (7) days per week, including holidays.
- B. All equipment and wiring shall be guaranteed against defects in materials and

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workmanship for a one year period from the start up and beneficial use of the system. Warranty service for the equipment shall be provided by the system supplier's factory trained representatives.

End of Section



NOTES:

1. ALL ELECTRICALLY HELD EGRESS DOORS SHALL RELEASE FROM REX APPROACH DEVICE (MOTION DETECTOR), PANIC BAR SWITCH, WALL MOUNTED REX PUSH BUTTON, AND FIRE ALARM INPUT.
2. ALL DOORS AND FRAMES SHALL BE FACTORY PREPPED FOR ALL SECURITY LOCKS, STRIKES AND HARDWARE
3. ALL WORK SHALL BE IN COMPLIANCE WITH IBC 2006, NFPA 101 2006.
4. ALL CONDUIT AND WIRING SHALL BE CONCEALED IN WALL OR ABOVE CEILING LEVEL.
5. CONTRACTOR SHALL SUPPLY ALL REQUIRED ACCESSORY EQUIPMENT SUCH AS POWER TRANSFER HINGES, POWER SUPPLIES, RELAYS, ETC.

TYPICAL DOOR SECURITY HARDWARE DETAIL A

SCALE: NONE