

BID # 16-27

PRIMARY SWITCH REPLACEMENT for FACILITIES MANAGEMENT BUILDING

SECTION "C" TECHNICAL SPECIFICATIONS

OWNER

Board of Trustees
Middlesex County College
2600 Woodbridge Avenue
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PREPARED BY

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SECTION C - TECHNICAL SPECIFICATIONS

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1. **SCOPE OF WORK**

The purpose of these specifications is to replace the existing primary selector switch in the Facilities Management Building. This work will be performed at the main Middlesex County College (MCC) campus in Edison, New Jersey.

The contractor shall provide all of the necessary labor, materials, tools and equipment required to complete the work described on the drawings and in these specifications.

The work under this contract shall be the responsibility of a sole contractor. Regardless of any reference in these construction documents to "contractor", "work by others", etc., it shall be understood that the contractor awarded a contract for this work shall provide all materials and trades necessary to complete all work.

The contractor shall apply for and secure all required building permits from Edison Township. The fee will be waived by Edison when a letter provided by MCC is submitted with the permit application. As part of the permit process, Edison also requires a Contractor's License. This fee is the responsibility of the contractor. The contractor is also responsible for obtaining and paying for a fire permit or any other such permit that may be required by the Township of Edison.

The contractor is also responsible for coordinating and obtaining all inspections, approvals and the final Certificate of Occupancy or Approval. Final payment will not be made until all work is completed and the final Certificate and all close-out documents described in these specifications are received.

The contractor shall be required to attend a pre-construction meeting on campus at a time to be scheduled after the contract is awarded and other job progress meetings as required by MCC and the Engineer.

The following is a list of drawings that are attached and are a part of these specifications and contract:

E1.0 Partial Plans and Details - Electrical

2. **MATERIALS**

The materials used under this contract shall be as specified on the drawings and in the specifications, be of a quality acceptable to the Engineer and meet applicable codes.

3. **INSTALLATION/EXECUTION**

The construction and installation under this contract shall be as specified on the drawings and in the specifications, be acceptable to the Engineer, and meet applicable codes.

The Contractor shall schedule and perform the work during one of the College's semi-annual Campus-wide electrical shutdowns. This applicable shutdown is scheduled for Friday, March 25, 2016. **If the required work cannot be completed that day, the Facilities Maintenance Building shall be isolated electrically from the rest of the Campus so electric supply can be restored to the Campus. All work must be completed by end of day Saturday, March 26, 2016.** No additional cost will be accepted for work needing to be performed during off hours.

Storage of Materials: The Owner shall designate an area of one of the parking lots for Contractor's materials storage and dumpster. The Contractor shall be responsible for providing a trailer for the storage of materials in this designated area.

4. **COMPLIANCE**

The Contractor shall comply with all of the College's safety and work rules when performing work at the college. All contractor employees, subcontractors, etc., shall sign-in daily at the Facilities Management Building upon arrival on campus to be issued a contractors identification badge. It is expected that all contractor employees will conduct themselves in a professional manner.

SITE CLEANUP

Work areas must be maintained in a neat, orderly, and safe manner at all times while the work is executed. Trash and debris must be removed daily.

6. **TIME CONSTRAINTS**

If the Board of Trustees of Middlesex County College has approved an award at least 10 days prior to November 30, 2015, the contractor shall complete the work on site for the buildings between March 25, 2016 and March 26, 2016. All work must be completed, operational and ready for use by this date. If the Board has not approved the award by this time, then MCC will advise the contractor of an alternate start date.

7. **WORK HOURS**

The contractor will be allowed to work on site 24 hours per day, to complete the contract work. The work hours in this Section take precedent over, and will supersede any conflicting references to hours of work elsewhere in these plans and specifications.

All work hours required to complete the work in the schedules shown shall be included in the contractor's bid price. The contractor shall provide MCC with a proposed project work schedule prior to the start of work and notification of any additional off-hours work schedules at least 48 hours prior to the desired work date.

8. **WARRANTY**

SEE SPECIFICATION SECTIONS FOR WARRANTY REQUIREMENTS.

9. **ADDITIONAL INFORMATION**

Additional information may be obtained from the following individuals:

Facility Specifications: Randolph Larate
Director, Facilities Engineering
732-906-7780
732-906-4199 Fax

Kelter & Gilligo Consulting
Engineers
609-799-8336
609-275-9306 Fax

Proposal: David Fricke
Director of Purchasing
732-906-2519
732-906-4236 Fax

10. SECTION 15000 - SPECIAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section is coordinate with and complementary to the General Conditions, Owner furnished information, and subsequent sections.
- B. Where items of the General Conditions are repeated in this Section of the Specifications, it is intended to qualify or to call particular attention to them; it is not intended that any other parts of the General Conditions shall be assumed to be omitted if not repeated herein.
- C. This Section applies equally and specifically to all Contractors and Subcontractors supplying labor and/or equipment and/or materials as required under other Sections of the Specifications.

1.2 DEFINITIONS

- A. "The Contractor" or "Each Contractor" means specifically, the Contractor, Vendor, or Subcontractor working under his respective Section of this Specification.
- B. "Provide" means to supply, erect, install, and connect up in complete readiness for regular operation, the particular work referred to.
- C. "Furnish" means to supply and deliver to the job.
- D. "Conduit" includes, in addition to conduit, all fittings, boxes, hangers, and other accessories related to such conduit.
- E. "Concealed" means hidden from sight as in chases, furred spaces, shafts, hung ceilings, or embedded in construction.
- F. "Exposed" means "not concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "exposed" unless otherwise specifically noted.
- G. "Approved equal" means any equipment or material, which, in the opinion of the Engineer, is equal in quality, durability, appearance, strength, design, performance, physical dimensions, and arrangement to the equipment, or material specified, and will function adequately in accordance with the general design.
- H. "Governmental" means all municipal, state, and federal governmental agencies.
- I. Where any device or part of equipment is herein referred to in the singular number

(such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.

1.3 CODES AND STANDARDS

- A. N.J. Uniform Construction Code (NJUCC).
- B. 2008 National Electrical Code (adopted by NJUCC).
- C. NFPA Standards for the Installation of Life Safety Systems (adopted by NJUCC)

1.4 INTENT

- A. It is the intention of the Specifications and Drawings to call for finished work, tested, and ready for operation. All materials, equipment, and apparatus shall be new and of first-class quality.
- B. Any apparatus, appliance, material, or work not shown on Drawings, but mentioned in the Specifications, or vice versa, or any incidental accessories, or minor details not shown but necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense to the Owner.

1.5 DRAWINGS

- A. The Drawings are generally diagrammatic and are intended to convey the scope of work and indicate general arrangement of conduits, wiring, and equipment.
- B. The locations of all items shown on the Drawings or called for in the Specifications that are not definitely fixed by dimensions are approximate only. The exact locations necessary to secure the best conditions and results must be determined at the project and shall have the approval of the Engineer before being installed. Do not scale Drawings.
- C. Follow Drawings in laying out work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom and space conditions appear inadequate, Engineer shall be notified before proceeding with installation.
- D. If directed by the Engineer, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- E. Piping or conduit connected to equipment may require different size connection than indicated on the Drawings. The Contractor shall provide transition pieces as required at the equipment.

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1.6 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Any questions or disagreements arising as to the true intent of this Specification or the Drawings or the kind and quality of work required thereby shall be decided by the Engineer, whose interpretations thereof shall be final, conclusive, and binding on all parties.
- B. In case of disagreement between Drawings and Specifications, or within either document itself, the better quality, greater quantity or more costly work shall be included in the Contract Price and the matter referred to the Engineer's attention for decision and/or adjustment.
- C. Maintain an awareness to avoid space conflict with other equipment or its service and/or access requirements.
- D. Purchase the equipment and material required in accordance with field measurements taken at the proper time during the construction progress.

1.7 VISITING THE SITE

- A. Before submitting the final proposal, examine the site of the proposed work to determine the existing conditions that may affect the work, as this Section will be held responsible for any assumptions in regard.

1.8 EQUIPMENT AND MATERIALS

- A. The proposal and bid must cover all items on the Drawings and in the Specifications exactly as drawn and specified.
- B. The proposal and bid must cover all items on the Drawings and in the Specifications.
- C. The words "or approved equal" shall be understood to apply only to those items of equipment and material listed.
- D. Within 20 working days after the acceptance of the proposal, and prior to the submission of any shop drawings for review, a complete list of manufacturers shall be submitted to the Engineer of all equipment and materials proposed for the work. No reviews will be rendered on shop drawings submitted before the complete list of manufacturers is reviewed.
- E. If material or equipment is installed before the Contractor obtained "Approved" or "Approved as Noted" comment from Engineer, and/or in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications, the removal, and replacement shall be made at no extra cost to the Owner.

- F. The materials, workmanship, design, and arrangement of all work installed under the Contract shall be subject to the approval of the Engineer.
- G. All equipment and materials required for installation under these Specifications shall be new and without blemish or defect. All electrical equipment shall bear labels attesting to Underwriters' Laboratories approval. Where no specific indication as to the type or quality of the material or equipment is indicated, a first class standard article shall be furnished.
- H. Where it is proposed to use an item of equipment other than that specified or detailed on the Drawings which requires any redesign of the structure, foundations, wiring, or of any other part of the electrical layout, all such redesign, and all new drawings and detailing required therefore shall, with the review of the Engineer and subsequent comments by the Engineer "Approved" or "Approved as Noted" on the shop drawings, be prepared at no additional cost to the Owner.
- I. Where such deviation from contract documents requires a different quantity and arrangement of wiring, conduit, and equipment from that specified or indicated on the Drawings, furnish and install any such structural supports, electrical wiring, and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.
- J. All equipment of one type shall be the product of the same manufacturer.
- K. Note that the comments "Approved" or "Approved as Noted" marked on the shop drawings or other information submitted in accordance with the requirements herein before specified does not assure that the Engineer or Owner's representative attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the mechanical performance of equipment. Comments on the shop drawings do not invalidate the Plans and Specifications if the shop drawings are in conflict with the Plans and Specifications.

1.9 SHOP DRAWINGS

- A. Prior to delivery to job site, but sufficiently in advance of requirements necessary to allow Engineer ample time for review, submit six (6) copies of shop drawings of all equipment, materials, sleeves, conduit and wiring diagrams, and further obtain written comments "Approved" or "Approved as Noted" for same from the Engineer, before installing any of these items.
- B. Shop drawings shall consist of manufacturer's certified scale drawings, cuts, or catalogs, including descriptive literature and complete certified characteristics of equipment, showing dimensions, capacity and code requirements as indicated on the Drawings or Specifications.
- C. Samples of materials or equipment, when requested by the Engineer, shall be submitted for review.

- D. Samples, drawings, specifications, catalogs, etc., submitted for review, shall be properly labeled indicating project name, specific service for which material or equipment is to be used, Section and Article number of Specifications.
- E. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.
- F. The comments "Approved" or "Approved as Noted" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, said review does not in any way relieve responsibility, or necessity, of furnishing material or performing work as required by the Contract Drawings and Specifications.
- G. "APPROVED AS NOTED" means, unless otherwise noted on the drawings, approved for construction, fabrication and/or manufacture subject the provision that the work shall be carried out in compliance with all annotations and/or corrections indicated on the shop drawings and in accordance with the requirements of the Contract Documents. If also marked "RESUBMIT", "APPROVED AS NOTED" is invalid and a corrected submittal of the drawing is required.
- H. Failure to submit shop drawings in ample time for checking shall not entitle an extension of Contract time, and no claim for extension by reason of such default will be allowed.
- I. Prior to submission of shop drawings, thoroughly check each shop drawing, reject those not conforming to the Specifications, and indicate (by signature) that the shop drawings submitted meet Contract requirements.
- J. All shop drawings showing routing of piping and conduit, shall be not less than $\frac{3}{8}$ " = 1'-0" scale.
- K. Incorporate a numbering system to help keep track of shop drawing submittals as follows:
- L. E.....Electrical shop drawings
- L. Concurrent numbers shall follow the prefix letter. Example: E-1, E-2, etc. In addition, shop drawings requiring resubmission should bear the number of the original submission and bear a suffix as follows: E-1A (second submission), E-1B (third submission), etc.
- M. Label resubmitted shop drawings with a stamp indicating the submittal number, for example: SECOND SUBMISSION; THIRD SUBMISSION, etc. and send separate transmittals for each item being submitted so that one transmittal does not cover more than one specific item or group of items from one manufacturer.

- N. Before request for acceptance and final payment for the work, write a letter to the Engineer stating that all shop drawings are brought to a condition "No Exception" or "Exception as Noted". Any outstanding shop drawings must be cleared with the Engineer.

1.10 RECORD DRAWINGS

- A. During construction, keep an accurate record of all deviations between the work as shown on the Drawings and that, which is actually installed.
- B. Secure from the Engineer, a complete set of Drawings and note thereon all changes. Make a complete record of all changes and revisions in the original design, which exist in the complete work. The cost for the record drawings shall be paid for by the contractor.
- C. Furnishing and preparing these Record Drawings shall be at no additional cost to the Owner. When all revisions showing the work as finally installed are made, the corrected drawings shall be submitted for review by the Engineer.
- D. After review of the "Record Drawings" by the Engineer, provide the Owner with one set of black-line prints and one set of cad files, at no additional cost to the Owner.

1.11 LAWS, ORDINANCES, PERMITS AND FEES

- A. Give all necessary notices, obtain all permits and pay all governmental taxes, fees, and other costs in connection with the work; file all necessary plans, prepare all documents, and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required Certificates of Inspection for the work and deliver to the Engineer before request for acceptance and final payment for the work.
- B. Include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings, (in addition to Contract Drawings and Documents) in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.
- C. All materials furnished and all work installed shall comply with the rules and recommendations of the National Fire Protection Association with the recommendations of the fire insurance rating organization having jurisdiction, and with the requirements of all governmental departments having jurisdiction.

1.12 INDEMNIFICATION

- A. Pay all royalties and defend all suits or claims for infringement of any patent rights and save the Owner harmless from loss on account thereof.

- B. If process or article specified is an infringement of a patent, promptly notify the Engineer in writing, and any necessary changes shall be as provided in the Contract for changes in the work. If the Contractor performs any work specified knowing it to be an infringement of patent, he shall bear all costs arising there from.
- C. Take out all necessary insurance, free of extra charge, and agree to indemnify and save harmless the party contracting for services against loss or expense, by reason of the liability imposed by law upon such party for damages because of bodily injuries, including death at any time resulting there from, accidentally sustained by any person or persons or on account of damage to property arising out of or in consequence of the performance of this Contract, whether such injuries to persons or damage to property are due or claimed to be due to any negligence in the performance of the Contract, the party contracting for services, employees or agents, or any other person.

1.13 ORGANIZATION OF WORK

- A. The work throughout shall be executed in the best and most thorough manner under the direction of and to the satisfaction of the Engineer and Owner's Representative, who will jointly interpret the meaning of the Drawings and Specifications, and shall have the power to reject any work and materials, which in their judgment, are not in full accordance therewith.
- B. Furnish and install all work as fast as possible to meet all construction schedules.
- C. Keep a competent superintendent in charge of the work at all times. Such superintendent shall be replaced if unsatisfactory to the Owner.
- D. Upon award of contract, consult with the Engineer and negotiate with subcontractors, vendors, and manufacturers, and within 15 days submit shop drawings for major equipment.
- E. Maintain a complete file of shop drawings at all times available to the Owner's representative.
- F. Every facility shall be provided to permit inspection of the work by the Owner's representative during the course of construction.
- G. Where the work is to be installed in close proximity to work of other trades, or where there is evidence that the work is to interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment.

1.14 PROTECTION OF WORK AND PROPERTY

- A. Maintain and protect all equipment, materials and tools from loss or damage from all causes until final acceptance by the Owner.

- B. Assume responsibility for the protection of any finished work or other trades from damage or defacement by the operations and remedy any such injury or damages.

1.15 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such regular time or at overtime when designated by the Owner.
- B. The Owner shall be notified of the estimated duration of the shutdown period at least 10 working days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance, including overtime, when approved by the Owner, if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.17 SCAFFOLDING, RIGGING, HOISTING

- A. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of all equipment and materials furnished under this Section of the Specifications, and remove same from premises when no longer required.
- B. In the event that supplementary bracing of the basic building structure is required to assure a secure rigging procedure and a secure route for the equipment being handled, assume full responsibility for such supplementary bracing.

1.18 BASES AND SUPPORTS

- A. Provide all bases and supports not part of the building structure of required size, type, and strength, as approved by the Engineer, for all equipment and materials furnished by him. All equipment, bases, and supports shall be adequately anchored to prevent shifting of position under operating conditions.
- B. Concrete bases are specified. The Contractor shall furnish dimensioned drawings showing reinforcing, steel dowels, sleeves and anchor bolts for approval by the Engineer.

1.19 SLEEVES, PIPE AND CONDUIT INSERTS AND ANCHOR BOLTS

- A. Provide and assume responsibility for the location and maintenance in proper position of all sleeves, inserts, and anchor bolts required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done without additional cost to the Owner.

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- B. All pipes and conduits passing through masonry walls or partitions shall be provided with sleeves having an internal diameter larger than the outside diameter of the pipe or insulation enclosing the pipe or conduit. Sleeves shall be Schedule 40 black steel pipe.
- C. Sleeves through foundation walls shall be James B. Clow & Sons No. F-1430 or F-1435 cast iron wall sleeve with intermediate integral flange. Sleeves shall be set with ends flush with each face of wall. The space between sleeve and pipe shall be packed with oakum to within 2" of each face of the wall. The remaining space shall be packed and made watertight with a waterproof compound.
- D. Sleeves through concrete floors or interior masonry walls shall be Schedule 40 black steel pipe, set flush with finished wall surfaces, but extending 12" above finished floors. The open sleeve space shall be packed with non-combustible materials.
- E. Sleeves through non-masonry partitions shall be 22 gauge galvanized sheet steel, set flush with finished surfaces of partitions.
- F. In general, all conduit shall be supported from structural steel building members only or approved malleable steel inserts imbedded in concrete pours.
- G. Conduit 2 1/2" and smaller shall be supported from existing structure by approved "Phillips" 3/4 bolts and beam clips. Conduit 3" and larger shall be supported by means of 2" x 2" x 1/4" angle iron knee braces in addition to approved hangers and fasteners. They shall be at 90° from the hangers and secured with 2 bolts per location. Provide a knee brace for every hanger location.
- H. No conduit or equipment shall be supported from corrugated decking construction. For this area, provide supplementary steel to support conduit or equipment. Supplemental steel members shall be welded to building structural steel.
- I. All hangers, rods and supports shall be installed prior to construction fireproofing.
- J. The required fire resistance rating of floor or floor/ceiling assemblies and walls shall be maintained where a penetration is made for electrical conduits, ducts and systems. Fire stopping shall be provided at openings around conduits.
- K. For openings around conduits and/or sleeves, use 3M product Caulk CP 25 and Putty 303 is approved equal.

1.20 MANUFACTURERS' IDENTIFICATION

- A. Manufacturer's nameplate, name or trademark, shall be permanently affixed to all equipment and material furnished under this Specification. Where such equipment is in a finished occupied space, the nameplate shall be in a concealed but accessible location. The nameplate of a Subcontractor or Distributor will not be acceptable.

1.21 TOOLS

- A. All special tools for proper operation and maintenance of the equipment shall be delivered to the Owner's representative and a receipt requested for same at no additional cost to the Owner.

1.22 QUIET OPERATION

- A. All equipment and material shall operate under all conditions of load without any sound or vibration, which in the opinion of the Engineer is objectionable. Where sound or vibration conditions arise which are considered objectionable by the Engineer, eliminate same in a manner reviewed by the Engineer.

1.23 RUBBISH REMOVAL

- A. See to it that the project is at all times maintained free of all rubbish, rubble, waste material, packaging materials, etc. accumulating as a result of his work. Assume responsibility for the cleaning up of packaging removed from materials and equipment furnished by other trades for the installation. Note that final acceptance of the work is contingent upon the project being free of all excess and waste materials resulting from the work.
- B. Clean all parts of the building exterior spaces and adjacent roads, sidewalks, and pavement, free from material and debris resulting from the execution of the work. Debris resulting from interior construction shall be neatly stacked on each floor near elevators, material hoists and rubbish chutes, as directed by the Engineer or his representative. Debris resulting from exterior construction shall be similarly stacked. All debris so stacked will be removed under other Sections. Excess material will not be permitted to accumulate either on the interior, exterior or on sidewalk.

1.24 DELIVERY OF MATERIAL

- A. Deliver the material and store same in spaces indicated by the Engineer and assume full responsibility for damage to structure caused by any overloading of the material.

1.25 CUTTING AND PATCHING

- A. Provide all necessary cutting and patching.
- B. Where existing piping or ductwork insulation are damaged by the requirements of the work, replace all damaged insulation to match existing.

1.26 PAINTING

- A. Provide all finish painting.
- B. Paint all unpainted, non-insulated, non-galvanized, ferrous metal surfaces of pipes, conduits, equipment, hangers, supports, and accessories.
- C. Match existing wall finishes when removed and replaced.
- D. Paint surface mounted equipment to match finish of existing space where they are mounted.

1.27 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work installed will be free from any and all defects and that all apparatus will develop capacities and characteristics specified, and that if during a period of one year from date of completion and acceptance of work any such defects in workmanship, material or performance appear, he shall immediately replace, repair, or otherwise correct the defect or deficiency without cost to the Owner within a reasonable time. Notify the Engineer in writing of the time required to do work.
- B. Replace or repair to the satisfaction of the Owner any and all damage done to the building for the work performed in fulfilling guarantee.
- C. This Article is general in nature and will not waive stipulations of other claims, which specify guarantee periods in excess of 1 year.
- D. The date of acceptance shall be the date of final payment by the Owner or notice of acceptance by the Owner.

1.28 OPERATION PRIOR TO COMPLETION

- A. The Owner may require operation of parts or all of the installation for the beneficial occupancy prior to final completion.
- B. The operation shall not be construed to mean acceptance of the work by the Engineer for the Owner. The Owner will furnish supervisory personnel to direct operation of the entire system and the Contractor shall continue to assume this responsibility until final acceptance.

1.29 SEMI-FINAL AND FINAL SITE VISITS FOR OBSERVATION

- A. As the project approaches completion, the Engineer and Owner's Representative, at their discretion shall determine a period of time in which they shall perform a Semi-Final Site Visit to observe the installation. At the conclusion of this Semi-Final Site Visit, a Semi-Final Punchlist shall be issued to the appropriate

contractor for the deficiencies in the work of his trade. Complete all work and perform all corrective measures as required by the Semi-Final Punchlist. After this corrective and completion work has been accomplished, in writing, advise the Engineer that every item on the Semi-Final Punchlist has been completed. After the Engineer makes a Final Site Visit to observe the installation and makes a Punchlist, a similar letter of Compliance shall be forwarded through channels.

END OF SECTION 15000

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11. SECTION 16000 - GENERAL PROVISIONS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. This Section is coordinate with and complementary to the General Conditions and Supplementary General Conditions of the work, wherever applicable.
- B. Section 15000 - Special Requirements shall apply.
- C. Drawings are diagrammatic and are a graphic representation of contract requirements to the best available standards at the scale required. Sizes and locations of equipment are shown to scale where possible, but may be distorted for clarity on the Drawings. Final locations of outlets and equipment shall be as shown in enlarged details or as approved by the Engineer or his representative.
- D. Power and system riser diagrams and schematic diagrams generally indicate equipment connections to be used for various systems. System conduit and wiring shall be as required for actual systems installed on this project. Provide all work shown on diagrams whether or not it is duplicated on the plans.

1.2 SCOPE OF WORK

- A. The Specifications and the accompanying Drawings are intended to secure the provisions of all material, labor, equipment, and services necessary to install complete, test, and make ready for operation the Electrical Systems in accordance with the Specifications and Drawings. All systems shall be complete with necessary appurtenances and minor auxiliaries, including pull boxes, offsets to clear interferences, and supports which are not shown but are needed to make each system complete in every respect. All work described in the Specifications and not shown on the Drawings, or vice versa, shall be furnished in complete working order. If mention has been omitted of any item of work or material necessary for completion of the system, then such items must be and are hereby included. The work includes but is not limited to the following:
 - 1. Raceways and installation components.
 - 2. Wire and Cable.
 - 3. Service and distribution equipment.
 - 4. Grounding.
 - 5. Testing.

6. Modification to existing electrical equipment and enclosure.
7. Demolition.
8. Furnishing and setting of all sleeves through the floors and walls where required, including waterproofing and fireproof sealing and cap flashing.
9. Excavation and backfill (Excavation in rock shall be included).
10. Hardware, such as inserts, bolts, etc., associated with concrete pads.
11. Cutting, drilling and boring associated with electrical work.
12. Prime painting, where required for electrical equipment and installation.
13. Final connection of all equipment unless otherwise noted.

1.3 QUALITY ASSURANCE AND STANDARDS

- A. The complete installation shall be in accordance with the applicable requirements and standards of National Electrical Manufacturers Association (NEMA), National Fire Protection Association (NFPA), Local Inspection Agency, along with state and local municipal codes and all applicable codes and authorities having jurisdiction. Any items or requirements noted in the Specifications or on Drawings, which conflict with these shall be referred to the Engineer for decision. The Contractor at no extra cost to the Owner shall perform all work necessary to comply with these requirements.
- B. All electrical equipment, materials, and appliances shall have the listing of Underwriter's Laboratories, Inc., and shall bear labels attesting to UL listing.

1.4 SUBMITTALS

- A. Refer to Section 15000 - Special Requirements.
- B. The Contractor shall submit shop drawings with such promptness as to cause no delay in his own work or that of another contractor.
- C. Submit shop drawings complete in every detail for items as described in the contract documents, or as may be required by the Engineer.
- D. Submit shop drawings as indicated in subsequent Sections of this Specification.

1.5 EXAMINATION OF EXISTING CONDITIONS ON PREMISES

- A. Before submitting his bid, this Contractor shall visit the site of the work and shall

thoroughly familiarize himself with the observable existing conditions affecting the work. By the act of submitting a bid, the Contractor shall be deemed to have made such an examination, to accept such conditions, and to have made allowance therefore in preparing his bid. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions. Verify all grades, elevations, dimensions, and clearances at the site.

- B. Existing conditions, equipment, material, and sizes are shown for reference only. Verify existing conditions and bring any discrepancies to Engineer's attention in writing prior to submission of bid.

1.6 COORDINATION OF WORK

- A. Scaled and figured dimensions with respect to the items are approximate only; sizes of equipment have been taken from typical equipment items of the class indicated. Before proceeding with work, the Contractor shall carefully check all dimensions and sizes and shall assume full responsibility for the fitting-in of equipment and materials to the building and to meet architectural and structural conditions.
- B. Exposed piping shall be installed to provide the maximum amount of headroom but in no case shall piping be installed less than seven feet six inches clear (7'-6") above the finished floor.

1.7 INSPECTION AND TESTS

- A. At the time of the final inspection and tests, all connections at the panels and all splices, etc., must have been completed. Each entire wiring system must test free from short circuits and grounds. When wiring systems are "megger" tested, the insulation resistance between conductors and between conductors and grounds, based on maximum load, shall not be less than that required by the National Electrical Code and local authorities having jurisdiction. A written record (five copies) of all test data shall be supplied to the Engineer.
- B. Provide all necessary testing equipment, instruments, and skilled personnel for the tests. If in the opinion of the Engineer, the results of such tests show that the work has not complied with the requirements of the Specifications or Drawings, the Contractor shall make all additions or changes necessary to put the system in proper working condition and shall pay for all expenses and for all subsequent tests which are necessary to determine whether the work is satisfactory. Any additional work or subsequent tests shall be carried out at the convenience of the Owner prior to final payment.

1.8 PERMITS, CERTIFICATES AND FEES

NOTE: THIS DOCUMENT IS FOR INFORMATIONAL PURPOSES ONLY. THIS IS NOT AN OFFICIAL BID DOCUMENT.

- A. Obtain and deliver a final Certificate of Approval from the applicable inspection authority having jurisdiction. Make delivery to the Owner upon completion of the work and before final payment. Pay all charges made by the inspection authority and include their cost in the bid.

1.9 PROTECTION, MAINTENANCE AND PRODUCT HANDLING OF ELECTRICAL EQUIPMENT

- A. Electrical equipment shall be delivered and stored at the site, properly packed and crated until finally installed. Store materials in spaces as designated. Investigate each space through which equipment must be moved. If necessary, equipment shall be shipped from manufacturer in crated sections of size suitable for moving through restricted spaces.
- B. Provide effective protection against damage for all material and equipment during shipment and storage at the Project Site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- C. Uninstalled equipment and materials shall be adequately protected against loss or theft; damage caused by water, paint, fire, plaster, moisture, acids, fumes, dust or other environmental conditions; or physical damage; during delivery, storage, installation and shutdown conditions. This Contractor shall replace any damaged or stolen material without extra cost to the Owner.
- D. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommend conditions for installation.
- E. This Contractor shall be responsible for the maintenance of all installed equipment and systems until final acceptance by the Engineer and the Owner. The operation of the equipment by the Owner does not constitute an acceptance of the work. Work will be accepted only after the Contractor has adjusted his equipment, demonstrated that it fulfills the requirements of the Drawings and Specifications, and has furnished all required certificates.

F. This Contractor shall guarantee in writing to the Owner that all work installed by him shall be free of defects in workmanship and materials and that all apparatus will develop the capacities and characteristics as indicated, and that, if during a period of one year from date of final approval of work by the Engineer, any defects in workmanship, materials or performance appear, he will remedy them without any cost to the Owner. Guarantee requirements shall consist of the aforementioned and other requirements, as established under applicable contract documents.

- G. After cabinets and boxes are installed, cover openings to prevent entrance of

water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.

- H. Protect all rough and finished floors and other finished surfaces from damage, which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor covering. Protect finished surfaces from welding and cutting splatters with baffles and splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.10 DELIVERY AND RECEIVING

- A. Have materials delivered to site. Unload and store materials in designated location, and protect from damage. Deliver materials to their point of installation.
- B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.
- C. Where items cannot be immediately placed in their final position, this Contractor shall store and protect until the time of their final installation. He shall be responsible for the care and protection until acceptance by the Owner.

1.11 ACCESSIBILITY AND MEASUREMENTS

- A. All work shall be installed so as to be readily accessible for operation, maintenance and repair. Minor deviations from the plans may be made to accomplish this, subject to the approval of the Engineer.
- B. Before ordering any material or doing any work, the Contractor shall verify all measurements at the Building, and shall be responsible for the correctness of same as related to the work under this Contract.

1.12 IDENTIFICATION NAMEPLATES

- A. Identify and mark all electrical equipment to meet OSHA standards and as specified herein.
- B. Furnish a nameplate for each separately installed feeder switch and circuit breaker, each individual panel, disconnect switch, controller, and equipment enclosure.
- C. Unless otherwise noted, match the existing nameplate style. As a minimum, nameplates shall be black laminate with white letters of uniform size.
- D. Inscription shall consist of name and number of equipment as shown on the Drawings and as approved by the Engineer.

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1.13 NAMES AND TRADE NAMES

- A. Where trade and manufacturers' names are specified or indicated on the Drawings, they are intended to indicate the standard of material or articles required. This shall not remove the responsibility of the Contractor from verifying the equipment's compliance with all rules and regulations governing the use of such equipment. No purchase of any equipment shall be done without written authorization if such equipment will not abide with all rules and regulations covering its intended use.

1.14 MATERIAL AND WORKMANSHIP

- A. All material shall be new and of the best quality and shall have the Underwriters Laboratories label attached. The Label shall be of the type for the intended application. The work throughout shall be executed in the best and most thorough manner under the direction of, and to the satisfaction of the Engineer, who will interpret the meaning of the Drawings and Specifications. The Engineer shall have the power to reject any work and materials which, in his opinion, is not in full accordance therewith.
- B. If, after installation, operation of the equipment proves to be unsatisfactory to the Owner by reason of defects, errors or omissions, the Owner reserves the right to operate equipment until it can be removed from service for correction by Contractor. Contractor shall pay for damages to work of other trades caused by this defective equipment and its replacement.

1.15 RECORD DRAWINGS AND GUARANTEE

- A. Refer to Section 15000.

1.16 OPERATING INSTRUCTIONS

- A. Two months prior to the completion of all work and the final inspection of the installation by the Owner, (5) copies of a complete Instruction Manual, bound in booklet form and suitably indexed, shall be submitted to the Engineer for approval. All written material contained in the Manual shall be typewritten or printed.
- B. The Manual shall contain the following items:
 - 1. Table of Contents
 - 2. Introduction - Explanation of manual and its use.
 - 3. Description of system or equipment.

- a. Complete schematic drawings of all systems.
- b. Functional and sequential description of all systems.
4. Systems operation:
 - a. Operation procedures.
 - b. All posted instruction charts.
5. Maintenance:
 - a. Systems trouble-shooting charts.
 - b. Procedures for checking out functions.
 - c. Recommended list of spare parts.
6. Listing of Manufacturers.
7. Manufacturer's Data (where multiple model, type and size listings are included, clearly and conspicuously indicate those that are pertinent to this installation):
 - a. Description - literature, drawings, illustrations, certified performance charts, technical data, etc.
 - b. Operation.
 - c. Maintenance - including complete trouble-shooting charts.
 - d. Parts list.
 - e. Names, addresses and telephone numbers of recommended repair and service companies.
 - f. Guarantee data.

END OF SECTION 16000

12. SECTION 16110 - RACEWAYS AND INSTALLATION COMPONENTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Section 16000 - General Provisions for Electrical Work shall apply.

1.2 DESCRIPTION OF WORK

- A. The requirements of this section apply to raceway work specified elsewhere in these Specifications.
- B. The work includes the provision of completely coordinated grounded raceway systems complete with boxes, fittings, flexible connections to vibrating equipment and accessories, as specified and as required for a complete system. Conduit or tubing sizes referred to in the specifications and on the Drawings are nominal internal diameters. Raceway is required for all wiring unless specifically indicated or specified otherwise.

1.3 QUALITY ASSURANCE

- A. Manufacturers - Firms regularly engaged in manufacture of raceways of types and capacities required and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Provide raceways and installation components which have been listed and labeled by Underwriters Laboratories and comply with applicable portions of National Electrical Manufacturers Association standards.
- C. Comply with National Electrical Code (NFPA No. 70) for construction and installation of raceways.

1.4 SUBMITTALS

- A. Refer to Section 16000 - General Provisions for Electrical Work and submit shop drawings. Shop drawings shall include duct identification warning tape, conduits and fittings.

1.5 GUARANTEE

- A. Refer to Section 16000 - General Provisions for Electrical Work.

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PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Raceways shall be manufactured by Triangle or approved equal by Allied or Republic.
- B. Rigid steel conduit:
 - 1. Shall be full weight steel pipe, hot dip galvanized inside and outside, threaded, minimum 3/4".
 - 2. Shall be painted with (2) protective coats of asphaltic compound where located underground or below slabs on grade or fill.
- C. Intermediate metal conduit:
 - 1. Shall be intermediate steel pipe, hot dip galvanized, threaded, minimum 3/4".
 - 2. Shall be painted with (2) protective coats of asphaltic compound where located underground or below slab.
- D. Liquid-tight flexible steel conduit (Seal-Tite) shall be zinc coated, flexible galvanized steel tubing over which is extruded a liquid-tight sheathing of polyvinyl chloride (PVC). Conduit shall be provided with a continuous copper bonding conductor wound spirally between the convolutions.
- E. Polyvinyl chloride (PVC) conduit (use in or below concrete at grade only):
 - 1. Shall be self-extinguishing, UL listed.
 - 2. Where noted as concrete encased, it shall be thin wall, Type EB.
 - 3. Shall be manufactured by Carlon, or approved equal by Queens City or National.

2.2 CONDUIT FITTINGS

- A. General
 - 1. Fittings shall be manufactured by Thomas and Betts or approved equal by O-Z/Gedney or Appleton.
 - 2. Couplings and connections in concrete shall be water tight. Thread compounds shall be UL approved conductive type to insure low resistance ground continuity through conduit.

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3. Metallic conduit fittings shall be corrosion resistant.
4. Bushings shall be of the metallic insulated type.
5. For weatherproof and dust tight installations provide liquid-tight fittings with sealing rings and insulated throat.

B. Rigid steel and IMC conduit fittings:

1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be steel or malleable iron only.
2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
3. Bushings shall be of the metallic insulating type, and shall consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type. In concealed work, each fitting shall be installed in a flush steel box with blank cover plate having the same finish as that of other electrical plates in the room.

C. Liquid-tight flexible metal conduit fittings:

1. Material shall be steel or malleable iron only.
2. Shall be of a type incorporating a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.

D. Direct burial plastic conduit fittings shall be as recommended by the conduit manufacturer.

2.3 CONDUIT SUPPORTS

- A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.
- B. Individual conduit hangers shall be designed for the purpose, and shall have pre-assembled closure bolt and nut, and provisions for receiving hanger rod.
- C. Multiple conduit (trapeze) hangers shall be not less than 1-1/2" by 1-1/2", 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8" diameter steel.

- D. Solid masonry and concrete anchors shall be a type approved for the purpose.

2.4 SLEEVES

- A. Provide and assume responsibility for locating and maintaining in proper position all sleeves required for the work.
- B. Sleeves through floors, exterior masonry walls, roof, and underground shall be schedule 40 galvanized steel pipe. For areas not requiring schedule 40 pipe, sleeves shall be 18 gauge galvanized sheet steel.

2.5 BOXES

- A. Junction, splice, and pull boxes:
 - 1. Junction, splice, and pull boxes shall be made of code gauge galvanized sheet steel and with removable covers fastened with brass or stainless steel machine screws, except as noted, and will include insulated supports for cables. Box dimensions shall conform to N.E.C. requirements as a minimum.
 - 2. Provide junction, splice, and/or pull boxes as noted or as required to facilitate pulling of conductors or in raceway runs that have more than (3) 90° bends or equivalent. All junction, splice, and pull boxes shall be accessible.
 - 3. Junction, splice, and pull boxes located outdoors and in damp locations shall be galvanized cast iron with threaded hubs and gaskets.
 - 4. Boxes shall have a prime coat of zinc chromate paint and a finish coat of gray enamel. Surfaces to be field painted shall be finished in flat gray.

PART 3 - EXECUTION

3.1 RACEWAYS

- A. General
 - 1. Install conduit and tubing products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with the recognized industry practices to ensure that products serve intended function.
 - 2. All raceways shall be run parallel with or at right angles to walls. Run

raceways concealed, except as noted. Exposed raceways shall be run in a neat symmetrical, inconspicuous manner.

3. Conduit ends shall be cut square and reamed smooth. Male threads or field threaded conduit shall be painted with graphite based pipe compound and drawn up tight with conduit couplings.
4. Raceways supports shall be provided by means of ceiling trapeze, straphangers, or wall brackets, structural steel angles or channels. Secure raceways to supports with pipe straps or U-bolts. Spacing of supports shall be as per NEC and per manufacturer's recommendations but in no case shall exceed 8'-0" on centers.
5. Mount supports to structure with toggle bolts on hollow masonry, expansion shields or inserts on concrete and bricks, machine screws on metal, wood screws on wood. Nails, rawl plugs or wood plugs are not permitted.
6. Allow a 3" minimum separation between raceways and steam and hot water pipes or appliances, except for crossings where raceways shall be at least 1" from pipe cover. Provide approved thermal insulation for electric lines where this separation cannot be maintained.
7. Install raceways so that they will not obstruct headroom, doorways, or walkways.
8. Mechanically join all metal raceways, enclosures and junction boxes to form a continuous electrical conductor. Connect all electrical boxes, fittings and cabinets so as to provide effective electrical continuity and firm mechanical assembly. Maintain grounding continuity of interrupted metallic raceways with ground conductor.
9. Install complete conduit runs before pulling in wire or cable. Install raceways so that required conductors may be drawn in without injury or excessive strain to raceway or cable. Where raceway size is not indicated, follow applicable code.
10. Do not cross pipe shafts or ventilation duct openings with raceway. Route raceway to avoid present or future openings in floor, wall or ceiling construction..
11. Close conduit openings, including those terminating in cabinets, with metal or plastic caps to prevent the entrance of water or foreign materials. Keep end of raceways plugged or capped during construction.
12. Arrange empty raceways for easy installation of cables in future. Cap raceways in accessible locations. For empty raceways over 10' long, provide a draw line, tagged at each end with identification and location of

other end. Draw line shall be reinforced nylon tape with foot markers, manufactured fish tape, or other approved means.

13. Concrete for encased conduits shall be colored red with an approved oxide additive included in the concrete mix.
14. Damaged or deformed raceway is not permitted and shall be removed.
15. Branch circuit conduits shall be supported by the building structure. They shall not be supported by the suspended ceiling or its supporting members, metal decking, lighting fixtures, mechanical piping, or air conditioning ducts.
16. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.

B. Rigid steel conduit:

1. Rigid steel conduit shall be used for underground installation; and for exposed runs on the exterior of the buildings.
2. Paint male threads of field threaded conduit with graphite base pipe compound.

C. Intermediate metal conduit:

1. May be used in place of rigid steel in dry locations only.

D. Liquid-tight flexible steel conduit:

1. Liquid-tight flexible steel conduit shall be used for final connections to motor terminal boxes, and other vibrating equipment. The flexible steel conduit shall include a separate insulated ground conductor. The minimum length of the flexible conduit shall be 18" with 50% slack. Connect the ground conductor to the enclosure or raceway at each end.

E. Polyvinyl chloride (PVC) conduit:

1. May be used in lieu of rigid galvanized steel for below concrete slab applications and in duct banks.
2. Cut ends square, ream smooth, wipe clean, apply approved solvent cement and quarter turn as drawing up tight.
3. Convert to manufactured rigid steel elbows and conduit using steel adaptors when entering the building from underground locations and when stubbing-up in slabs. Use rigid steel elbows for all below grade bends that are not concrete encased or provide concrete thrust blocks.

4. Provide a continuous green ground for entire circuit length for which PVC conduit has been used.

3.2 SLEEVES

A. General

1. Provide sleeves for conduit passing through foundations and other locations as required. Size sleeve to allow 1/2" annular space around conduit. Determine exact locations in field to avoid interference with structural members and equipment of all trades.
2. Sleeves shall be provided in accordance with the following guidelines:
 - a. Set required sleeves and inserts and maintain them in position during progress of construction to avoid cutting of completed work.
 - b. Where wall is waterproofed, allow annular space for waterproofing material between wall and sleeve on waterproofed side.
 - c. Finish sleeves through floors flush with underside of floor, and 1/2" above top of finished floor. Finish sleeves through walls and partitions flush on both sides. Finish sleeves through roof above the roof line but low enough to be covered by waterproofing. Provide waterproof installation at each sleeve piercing the roof.
 - d. For raceways in sleeves, fill annular space with seals of oakum packing and lead or O-Z/Gedney Type "WSC" compound on both sides.
 - e. For cables in raceways through sleeves, provide seals similar to O-Z/Gedney Type "WSC" compound or Type "C Series" terminators.

3.3 JUNCTION, SPLICE, AND PULL BOXES

- A. Provide pull, splice, and junction boxes where required to facilitate installation of wiring, whether or not shown on Drawings. Size boxes according to code, and provide interior partitions, insulated supports, hot dip galvanized angle iron braces, screw-on one-piece or split covers, ground connectors, and other accessories as required.
- B. In general, junction splice, and pull boxes shall be arranged so that wire pulls do not exceed 250' on conduit runs with one bend or less; 200' on conduit runs with 2 or 3 bends.

- C. Junction, splice, and pull boxes shall be located clear of other trade's equipment and shall be supported independently to the building structure with no weight bearing on conduits.
- D. All outdoor installations shall be weatherproof.

3.4 SUPPORTS - GENERAL

- A. Support all material from the building structure in an approved manner.
- B. Provide mounting structures for electrical equipment where required. Use continuous slot channel or fabricate structure from galvanized structural steel angles and channels. Bolt or weld fabricated assemblies rigidly together, coat with suitable rust inhibiting primer and two finish coats of color as directed by Engineer.
- C. Provide ¼" spacers behind electrical equipment cabinets to permit circulation of air.
- D. Provide racks of continuous slot channel for parallel runs of conduit, and suspend on adjustable hangers. Use adjustable clevis hangers for individual runs of suspended conduit. Align suspended runs in horizontal plane for neat appearance. Perforated strap iron will not be permitted. Use approved beam clamps for connection to structural steel. Where structural steel has fireproof coating, cut coating as required to mount clamp and restore fireproofing to its original condition.
- E. Do not support from steel roof decks, joist bridging, duct work, piping, or floor slabs less than 4" thick.
- F. Determine proper locations of anchors, inserts and supports, and maintain them in their proper locations during the period of construction.
- G. Use supporting hardware suitable for the purpose intended. Use expansion shields with machine screws to fasten to solid masonry. Use toggle bolts to fasten to hollow masonry. Use lag bolts to fasten to wood surfaces. Use approved methods for other conditions as required. No wood, plastic or fiber plugs will be permitted. Use approved beam clamps.
- H. Do not exceed manufacturer' load rating for mounting devices.

3.5 INSPECTION

- A. Contractor shall examine locations where raceways and installation components are to be installed, determine space conditions and notify interested parties in writing of conditions detrimental to proper and timely completion of the work.

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3.6 FIELD QUALITY CONTROL:

- A. Contractor shall perform continuity tests by testing the resistance of all feeder conduits from the service to the point of their final distribution using 1 conductor return. The maximum resistance shall be 25 ohms.

END OF SECTION 16110

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13. SECTION 16120 – WIRE AND CABLE OVER 600 VOLTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Section 15000 - Special Requirements for Mechanical and Electrical Work shall apply.
- B. Section 16000 - General Provisions for Electrical Work shall apply.

1.2 DESCRIPTION OF WORK

- A. The work includes the providing of cable complete with all accessories, in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted.

1.3 QUALITY ASSURANCE

- A. "Manufacturers" - Firms regularly engaged in the manufacture of cable of specified types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
- B. The cable shall meet or exceed the latest editions of ICEA S-68-516, ASTM B-8, AEIC CS6 and UL-1075 (MV-90).
- C. Comply with National Electrical Code (NFPA No. 70), National Electric Safety Code 1996, with local Electrical Codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
- D. Cable Splicer Qualifications: Sample splices are required from each cable splicer who will be doing the actual cable splicing. Cable splicer shall make sample splices in the presence of the Owner's Representative. Include the following additional information on the sample labels:
 - 1. Name of cable splicer.
 - 2. Name of Owner's Representative witnessing splice.
- E. Listing Agency: Cable types for which Underwriters' Laboratories, Inc. provides listing service shall be listed and bear the listing mark.
- F. Testing Company: Secure the services of one of the following companies for performing a high voltage test after installation test on cable having a rated voltage of 5000 volts or higher:

1. Holtaway Testing Company, 61 Brook Ave., North Plainfield, NJ 07060, Phone No. 201-757-0450.
 2. Burlington Testing Company, Inc., 3494 Progress Drive, Bensalem, PA 19020, Phone No. 215-638-4545.
- G. Test Reports: Submit for acceptance of field high-potential tests on all cable splices, and terminations rated 5 KV or greater.
- H. Record Drawings: Submit record drawings showing the locations of all concealed cables.
- I. Reference Standards: Comply with or exceed applicable provisions and recommendations of the following except where otherwise shown or specified.
1. National Electrical Code Article 310C.
 2. ASTM B-8 or B-231, Specification for Concentric Lay Stranded Copper Conductors.
 3. ASTM B-3, Uncoated annealed copper conductors.
 4. ICEA PUB. No. S-68-516.
 5. AEIC CS6-79.

1.4 SUBMITTALS

- A. Refer to Section 16000 - General Provisions for Electrical Work and Submit shop drawings. Shop drawings shall include detail drawings and data sheets for all cable, terminations, splices, materials, etc. to demonstrate proper installation as required by codes and standards.
- B. Submit the following for approval:
1. Complete manufacturer's construction details and specifications for the cable including physical and electrical characteristics of insulation, shields and jackets.
 2. Overall dimension and ampacity of cable.
 3. Premolded splicing and termination data, including the following:
 - a. List of materials.
 - b. Method of connecting conductors.
 - c. Details of cable preparation.

- d. Method of applying materials (including quantities).
 - e. Precautionary measures.
 - f. Written statement from cable manufacturer that splices and terminations submitted are acceptable.
 - g. Written statement from splicing/termination manufacturer that splices and terminations submitted are suitable for the proposed application.
- 4. Resume of each cable splicer's experience.
 - 5. Written statement from cable manufacturer indicating recommended pulling compounds.
 - 6. After approval but before installation, submit the following for final approval:
 - a. Cable manufacturer's certified test data.
 - b. Two 2' samples of each cable, taken from reel at job site prior to installation. Reseal cable on reel. Include the following additional information on the sample labels:
 - 1) The maximum voltage at which the conductor is designed to be used.
 - 2) Date of manufacturer.
 - 7. Submit samples of splices and terminators if requested. Samples of complete kits shall be returned and, if accepted, may be used in the Work. Samples shall include:
 - a. Complete kit in original box or container, with the date of manufacture indicated thereon.
 - b. Manufacturer's instructions.
 - c. Technical data as required for shop drawing submission.

1.5 GUARANTEE

- A. Refer to Section 16000 - General Provisions for Electrical Work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Cables shall be single conductors.
- B. Keep ends of cables sealed at all times, except when making splices or terminations. Use heat shrinkable plastic elastimold end caps with sealant as manufactured by Raychem Corp., Thomas & Betts Co., or equal methods approved by cable manufacturer.
- C. Mark and tag cables for delivery to the site the same as required for sample labels. Store cables on rolls in accordance with manufacturer's requirements.
- D. Cable over one year old when delivered to the site will not be acceptable.
- E. Ground conductor shall be copper with Type THW, XHHW or THWN, insulation rated 600 volts.

2.2 HIGH VOLTAGE CABLE

- A. Conductors furnished under this specification shall be rated 15 KV. Cable insulation shall be Ethylene - Propylene - Rubber ("EPR") based on suitable for normal installation, indoors or outdoors, in conduit, in air, and intermittent or continuous submersion in water. Cable shall be Kerite 15 KV shielded SPS.
- B. Basic Construction:
 - 1. 1/C Class B copper strand bare compact round conductor, extruded semiconductor strand screen, wall of a flexible thermosetting dielectric based on an ethylene-propylene type elastomer (EPR) insulation, extruded semiconducting insulation screen, bare copper shielding tape, and a polyvinylchloride jacket overall.
 - 2. The cable shall be rated 105°C for normal operation, 130°C for emergency overload operation; and 250°C for short circuit conditions.
 - 15000 volt class cables shall be used for 13.2 KV systems.
- C. Conductor:
 - 1. Uncoated soft copper compact round wire. Stranding shall be Class B, stranded per ASTM B-8.
 - 2. It shall meet the electrical resistance requirements of ICEA S-68-516, Section 2.5.2.
- D. Conductor Screen:
 - 1. Extruded layer of semiconducting thermosetting EPR compound with

volume resistivity not in excess of 10 ohm-meters at 105°C shall be applied over the conductor. The compound shall have a minimum elongation after an air oven test at 121°C for 168 hours of 100% and a brittleness temperature not warmer than -50°C. The thickness of insulation shall be per AEIC CS6.

E. Insulation:

1. The insulation shall be Okoguard, a compound based on an ethylene-propylene type elastomer which meets or exceeds the electrical and physical characteristics of ICEA S-68-516 and AEIC S56. The ethylene content of the base elastomer shall not exceed 72% by weight. The thickness shall be 115 mils. The insulation shall be triple tandum extruded with the conductor and insulation screens, and applied in accordance with the above referenced industry standards.

F. Insulation Screen:

1. The insulation screen shall be an extruded semiconducting EPR compound with a volume resistivity not in excess of 10 ohm-meters at 105°C when tested per AEIC No. 6-75.
2. Peel strength of the extruded screen from insulation shall be between 4 - 25 lbs/0-5 inch width when tested per AEIC No. CS-6-79.
3. The insulation screen shall have a minimum elongation after air oven test at 121°C for 168 hours of 100% and a brittleness temperature not warmer than -50°C. The screen shall be applied in complete accordance with AEIC S56.

G. Metallic Shield:

1. The semiconducting screen shall be covered with a 5 mil bare copper tape shield applied helically with a 12 ½% minimum overlap.

H. Jacket

The overall jacket shall be black polyvinyl chloride and shall meet the requirements of ICEA S-68-516, Part 4. The thickness shall not be less than 80% of the specified minimum average.

I. Identification:

1. A permanent marker indicating manufacturing company, year of manufacture, and sequential footage number repeated each foot shall be inserted under the copper shielding tape.
2. The following legend shall be printed every 24 inches on the jacket:

a. Manufacturing and Plant Location

- b. Type
- c. Insulation Thickness
- d. Conductor Size
- e. Type of Conductor (Copper)
- f. Rated Voltage
- g. Year of Manufacture

J. Factory Tests:

1. Each length of cable to be used on this project shall be tested at its point of manufacture.
2. Conductor dc resistance shall meet the requirements of ICEA S-68-516 Section 2.5.
3. High voltage ac test shall be performed in accordance with part 6.27 of ICEA S-68-516. The test voltages shall be as follows:

Voltage Application	Insulation Wall (Mils)	AC Test Voltage
15000	220	27

4. The insulation resistance test shall be performed in accordance with ICEA S-68-516, Part 6.28 and shall have an insulation resistance constant of at least 50,000 megohms/1000 feet at 15.6°C.
5. Corona Test: The completed cable shall be tested for corona discharge and comply with ICEA and AEIC requirements.

2.3 TERMINATIONS

A. General:

1. Provide modular stress cone cable terminators. Cable terminators shall be Elastimold type “35MT “or “35MTG” with cable shield adaptor or approved equal by 3-M or RTE.

2.4 SPLICES AND TAPES

- A. Provide premolded cable splicing devices. 3-way splicing devices shall be Elastimold type K656. Cable shielding shall be carried across the cable tap or splicing device by connecting the leads to ground.

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- B. All material shall be the standard product of one manufacturer.
- C. Ampere rating of splices shall meet or exceed the ampere rating of the cable.
- D. Voltage rating of splice shall meet or exceed the voltage rating of the cable.
- E. Field made epoxy-resin or built up field applied splices and taps not acceptable.
- F. Splices are to be used only where indicated on Drawings. No other splicing is to be done without written authorization of the Engineer.
- G. All below grade splices, shall be watertight and submersible.

2.5 PULLING COMPOUNDS: As recommended by cable manufacturer

2.6 ARC PROOFING TAPES

- A. Arc Proofing Tape: 3M Scotch 7700; Plymouth Rubber Co. Plyarc; Quelcor Inc. Quelpyre; Tomic 43A or equal.
- B. Glass Cloth Tape: 3M Scotch No. 27; Plymouth Rubber Co. Plyglass; Tomic 77T or equal.
- C. Glass-Fiber Cord: 3M Scotch A-4; Quelcor Inc. Quelpyre 1/8" tying cord or equal.

2.7 TAGS

- A. Phenolic Type: Standard phenolic nameplates with 3/8" minimum size lettering engraved thereon.
- B. Embossed stainless steel: Standard stamped or embossed stainless steel tags:

PART 3 - EXECUTION

3.1 GENERAL

- A. Install wire and cable in accordance with the NEC and as hereinafter specified. Use the National Electrical Contractors Association's "Standard of Installation", and the manufacturer's written instructions unless superceded by these specifications. In all cases the installation shall be in accordance with recognized industry practices.

3.2 INSTALLING CABLES

- A. Install cables after conduit system is completed.

- B. In general, there will be no splices in a feeder run except where shown on the drawings.
- C. No grease, oil, or lubricant other than approved pulling compound may be used to facilitate the installation of cables.
- D. Use pulling eye attached to each conductor.
- E. Pull all cables with a dynamometer or strain gauge incorporated into the pulling equipment. Pulling equipment shall be designed for the cables used. Do not pull cables unless the Owner's Representative is present to observe readings on the dynamometer or strain gauge during the time of actual pulling. Total strain on cables shall not exceed manufacturer's recommended pulling tension.
- F. Use extreme care in handling of reels and cable prior to its installation. Set up reels and pull points to insure minimum pulling tension on the cable. For each termination or splice, allow extra 36" cable length to be cut off after pull is completed. Keep ends at site for Engineer's review.
- G. Submit sketches of proposed pulling directions as part of cable shop drawing submission. Obtain approval before proceeding. Do not exceed manufacturer's allowable pulling tensions.
- H. Use large radius snatch blocks, pulleys, dollies, and trucks as required to insure that cables do not drag on grade, or other construction. Pull cables in and out at each manhole. Limit bending radius to 24 times cable diameter.
- I. Make cable splices and terminations in accordance with cable manufacturer's recommendations. Ground all shields and metallic sheaths.
- J. Train cables in enclosures to obtain smooth, long radius bends. Allow sufficient slack cable for making splices and for absorbing vibrations.
- K. Rack cables around perimeter walls of manholes without sharp bends, and support on porcelain pillow blocks on galvanized hardware.
- L. Do not install cables directly beneath manhole cover.
- M. Individually fireproof all medium voltage cables in manholes. Use manufactured arc proof tape and install in half-lap servings around each individual cable in accordance with manufacturer's recommendations.
- N. Mark cables with stainless steel or plastic tags with cable number and phase. Attach tags with stainless steel or nickel wire. Provide tag on each cable in each manhole, pull box and termination point.

3.3 TERMINATIONS AND SPLICES

- A. Terminate medium voltage cables in accordance with manufacturer's approved installation instructions. Ground shield at all terminations.

3.4 PHASE RELATIONSHIP: Connect feeders to maintain phase relationship through system. Phase legs of feeders shall match bus or cable arrangements in equipment to which the feeders are connected. Color coding shall be as follows:

A – Phase: Brown B – Phase: Orange C – Phase: Yellow

3.5 FIELD TEST

- A. A high potential DC test as follows shall be performed on all medium voltage feeders.
- B. Test shall be performed by one of the testing companies specified. Test results shall be submitted to the Engineer for review. If in the opinion of the Engineer the results for a particular feeder are questionable, a second test shall be performed at no additional cost to the Owner. If the second test yields similar results as the first, the feeder (all three) cables are to be replaced at no additional charge to the Owner. The ground cable may be reused, but must be removed from the conduit and reinstalled with the new cables. The new cables shall also be tested.
- C. All precautions and limits as specified in the applicable NEMA Standard for the specific cable shall be adhered to. Current sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage current of the test equipment. Test procedure shall be as follows and the results for each cable test shall be recorded as specified herein.
 1. Perform tests in strict accordance with IEEE Standard 400-2001.
 2. Record wet and dry bulb temperatures. Do not perform test unless weather is clear and relative humidity is below 70 percent.
 3. Each section of cable must be tested individually. "Daisy chain" tests are not permitted.
 4. Each conductor shall be individually tested with all conductors grounded at both ends. All shields shall be grounded.
 5. Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable methods.
 6. Care shall be taken to insure that the maximum test voltage does not exceed the limits for terminators specified in IEEE Standard 48-1996.
 7. The D.C. high potential shall be applied in at least five equal increments

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until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. D.C. leakage current shall be recorded at each step after a constant stabilization time consistent with system charging current decay.

8. The test conductor shall be raised to a maximum test voltage and held for a total of fifteen minutes. Readings of leakage current shall be recorded every 15 seconds for the first minute, every minute for the next 4 minutes, and at 10 minute and 15 minute intervals.
9. The conductor test potential shall be reduced to zero and residual voltage measured after 60 seconds.
10. Grounds shall be applied for a time period adequate to drain all insulation stored potential. Proper notification must be made to all concerned parties if grounds are left in place.
11. The D.C. test voltage shall be as specified under "Insulation Test Voltage" in Table #1 of IEEE Standard 400-2001.

END OF SECTION 16120

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14. SECTION 16121 - WIRE AND CABLE 600 VOLTS OR LESS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS:

- A. Section 16000 - General Provisions for Electrical Work shall apply.

1.2 DESCRIPTION OF WORK:

- A. The requirements of this Section apply to wire and cable work specified elsewhere in these Specifications.
- B. The work includes providing wire and cable complete with all accessories in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted. For special wiring for individual systems, refer to respective Section of these Specifications.

1.3 QUALITY ASSURANCE:

- A. "Manufacturers" - Firms regularly engaged in manufacture of wire and cable of types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Provide wire and cable which has been listed and labeled by Underwriters' Laboratories, and complies with applicable portions of National Electrical Manufacturers Association Standards.
- C. Comply with National Electrical Code (NFPA No. 70) and local Electrical Code for construction and installation of wire and cable. Comply with most restrictive code.
- D. Provide wire and cable produced by a manufacturer listed as an Approved Manufacturer in this section.
- E. Provide equipment whose performance under specified conditions is certified by the Manufacturer.
- F. The size of all wire and cable and the minimum size of conduit in which they shall be pulled shall in all cases conform to NEC as a minimum requirement.

1.4 SUBMITTALS

- A. Refer to Section 16000 - General Provisions for Electrical Work, and submit shop drawings. Shop drawings shall include detail drawings and data sheets for all wire and cable, compression wire connectors, and large copper wire connectors.

1.5 GUARANTEE:

- A. Refer to Section 16000 - General Provisions for Electrical Work.

PART 2 - PRODUCTS

2.1 600 VOLT WIRE AND CABLE:

A. Conductors:

1. This project has been designed for copper conductors. Aluminum conductors are not acceptable and shall not be used. Cable shall be manufactured by Triangle or approved equal by Carol or Guardian Products.
2. No. 10 and smaller conductors shall be ASTM Standard, solid copper; and, No. 8 and larger conductors shall be ASTM standard, stranded copper.
3. Minimum conductor size shall be No. 12 for lighting and power and No. 14 for control and alarm. Increase wire sizes as noted hereinafter for long runs to overcome voltage drop.
4. Control and signal wiring shall conform to the recommendations of the systems manufacturer.

B. Insulation:

1. Rubber and thermoplastic insulation shall comply with ASTM and ICEA standards.

C. Types and application:

1. "THWN or "XHHW" shall be used for interior branch circuit and feeder wiring.
2. Rating of THWN and XHHW shall be 90°C in dry locations and 75°C in wet locations.
3. Bare conductors shall be permitted for grounding only where so indicated in GROUNDING Section of Specifications. Green colored insulated wire shall be used for all other grounding applications.

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D. Wire Sizes

1. For General Use:

- a. Size as per drawings. 2 conductors, plus ground No. 12 wire shall be the minimum required.

2. For Control and Alarm; unless otherwise noted:

- a. No. 14 wire minimum.

E. Color Coding

1. Match existing college campus color code. If none exists, phase wires shall be color-coded as follows:

- a. 120/208 volt system: Black for A phase
Red for B phase
Blue for C phase
- b. Neutral conductors shall be white with gray stripe.
- c. Equipment ground wire shall have a green outer covering throughout.

2. For cable sizes 1/0 and larger and where color-coded insulation is not available, certify in writing and permission will be granted for overlap color taping of conductors (minimum length 6") in accessible and visible locations.

3. Conductors for control circuits and signal systems shall also be consistently color coded or numbered to avoid confusion and to permit easy identification of conductors.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install wire and cable in accordance with the NEC, and as follows. In the absence of specific instruction listed below, use The National Electrical Contractors Associations "Standard of Installation", and the manufacturers written instructions. All work shall be in accordance with recognized industry practices.

- B. Exercise care in storage and installation of wire and cable to avoid damage to conductors and their covering. Use an approved pulling compound as lubricant for pulling wires into raceway.

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3.2 600 VOLT WIRE AND CABLE:

A. General

1. Wire and cable shall not be drawn into conduit and raceway until all conduit work is complete - joints made up tightly and the entire run secured in place.
2. The inside of conduits and raceways shall be dry and clean before wires are pulled.
3. Care shall be exercised in pulling to avoid damage to the wire or cable. Lubricants shall be used for pulling wire or cable if the character of the pull would otherwise damage the conductors, insulation, or jacket. Pull no thermoplastic wires at temperatures lower than 0°C.
4. Cables shall be supported at the upper end of all risers and at intermediate points as required by the NEC. Supports shall be O-Z/Gedney Type "R" or approved equal insulation wedges or Kellems grips. Use pull boxes of appropriate size and strength to support load.
5. Wire and cable shall be installed in accordance with manufacturer's instructions.
6. Provide O-Z/Gedney Type "CSB" series or approved equal seal fittings between the wire and conduit for all cable and wire entering the building from underground, including service cables.
7. Not more than 3 current carrying conductors shall be in 1 conduit unless otherwise indicated. Provide one neutral conductor for each 3 phase 4-wire homerun to a panelboard unless otherwise noted.
8. In the event the Contractor for the work under this Division or Section chooses to furnish and install a system or item of equipment of different arrangement from that shown or specified, and receives approval to do so, he shall furnish and install any additional wiring and conduit required by the system at no additional cost to the Owner.
9. In wireways and large pull boxes, lace and tie off conductors in groups of 3 phases and neutral (if used) to limit conductor unbalanced loading.
10. Tag feeders and risers in all pull boxes and in all gutter spaces through which they pass. Tags shall be engraved white core nameplates identifying feeders as shown on the Drawings or the circuit protective device from which they originate.
11. Leave sufficient slack at terminal ends for convenient connections to fixtures and for convenient servicing. Stow slack neatly in outlet box.

B. Terminations, Splices, and Connections:

1. Make wire splices electrically and mechanically secure. Install small wire connectors so that no bare conductor is exposed. Tighten bolts on large conductor connectors so that conductor is deformed, but do not break strands of wire. Use compression tool with proper die for compression connectors in accordance with manufacturer's recommendations, so that conductors are deformed but not broken. Apply insulation over splice so that insulation thickness is at least 1 ½ times that on conductor. Lap applied insulation at least 1" over conductor insulation so that no bare conductor is exposed.
2. In general, all feeders No. 8 and larger shall be continuous from point of origin to equipment being served. Splices shall only be used where necessary and with prior written approval of the Engineer.
3. Terminate conductors on terminal strips in equipment where terminal strips are used. Provide appropriate connectors, or hook conductors around terminal screws as required.
4. Provide encapsulated splice kits (3-M type 85 series or approved equal) for all splices in areas subject to moisture, including wet locations inside buildings and underground handholes, manholes, and buried junction boxes. Install splice kit in accordance with manufacturer's recommendations, and make splice waterproof. Apply sealing putty to surround each cable. Install mold body so that resin covers each cable sheath by a minimum of 1".
5. Splices and taps shall be made in accessible boxes, panelboards fittings, gutters, terminal panels, etc. only. Materials shall be compatible with the conductors, insulations, and protective jackets on the cables and wires.
6. All copper conductors No. 8 & larger shall be terminated, spliced, and tapped with color-keyed compression connectors, as manufactured by Thomas & Betts Co., Series 54000, Ideal Industries Series 87000, or approved equal. The manufacturers recommended tooling shall be used. Mechanical type connectors shall not be used.
7. Coat all copper lug connections with Thomas & Betts Co. Koper-Shield conductive compound, Series GP-8, or approved equal.
8. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined. Use insulating boots supplied for compression connectors or fill joint with "Scotchfill" insulating putty and serve (3) ½ -lap layers of "Scotch" #33 electrical tape.

C. Cable Tying:

1. All circuit and control wiring in cabinets, panels, pullboxes, and junction boxes shall be tied and held with nylon Ty-Rap cable ties as manufactured by Thomas & Betts Co., Ideal Industries Series Ty-51M, 53M, or approved equal.

D. Tags:

1. Cables shall be tagged in all pull boxes, wireways, wiring gutters of panels, and at all places where wires may not be readily identified by nameplate markings on the equipment to which they connect. Where 2 or more circuits run to or through a control device, outlet box, or junction box, each circuit shall be tagged as a guide in making connections.
2. Tags for feeders shall indicate feeder number, size, phase, voltage, origin, and termination. Feeder tags shall identify all phases individually.
3. Tags for control and alarm wiring shall indicate type of control or alarm, size of wire and origin and termination.
4. Tags shall be Thomas & Betts Co., Ideal Industries, wire-marker dispenser type, self laminated wire markers.

E. Lubrication:

1. Wire lubricating compound shall be suitable for the wire insulation and conduit with which it is used, and shall not harden or become adhesive. Lubricating compound shall be Ideal Industries Yellow 77 Type or approved equal. Lubricating compound shall not be used on wire for isolated type electrical power systems.

3.3 INSPECTION:

- A. Contractor shall examine the areas and conditions under which wire and cable are to be installed, and notify interested parties in writing of conditions detrimental to proper and timely completion of the work.

3.4 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:

1. Inspect for physical damage and proper connections. Replace damaged material and secure all connections.
2. Cable connections shall be tightened using a calibrated torque wrench.
3. Verify branch circuit voltage is suitable for connected equipment prior to energizing circuit.

4. Megger conductors phase-to-phase and phase-to-ground for continuity and insulation tests before connection.
- B. Perform tests prior to connecting equipment and in presence of authorized representatives.
 - C. Exercise suitable and adequate safety measures prior to, during, and after the high potential tests, including placing warning signals and preventing people and equipment from being exposed to the test voltages.
 - D. Submit certified written report of test results to Engineer.

END OF SECTION 16121

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15. SECTION 16420 - DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Section 16000 - General Provisions for Electrical Work shall apply.

1.2 DESCRIPTION OF WORK

- A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner distribution equipment in accordance with Drawings and Specifications.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Select from firms listed under description of each piece of equipment hereinafter specified.
- B. Primary switchgear, substations, and distribution equipment shall be designed, assembled and tested in accordance with applicable standards of NEMA, IEEE, and ANSI, and shall be listed and labeled by Underwriters Laboratories.
- C. Comply with the NEC (NFPA 70) for construction and installation of distribution equipment as applicable.
- D. Provide distribution equipment whose performance under specified conditions is certified by the manufacturer.

1.4 SUBMITTALS

- A. Refer to Section 16000 – General Provisions for Electric Work. Shop drawings shall include:
 - 1. Dimensional layout shop drawing.
 - 2. Single line diagram and outline drawing.
 - 3. Manufacturer's catalog cuts.

1.5 GUARANTEE

- A. Refer to Section 15000 - Special Requirements for Mechanical and Electrical Work.

PART 2 – PRODUCTS

2.1 SWITCHBOARD

- A. Furnish and install where indicated a dead front type, completely metal enclosed, self-supporting structural switchboard section independent of wall supports. Voltage rating shall be as indicated on the Drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard 90-3/8" high. The sides and rear shall be covered with removable screw-on plates. All edges of front covers or hinged front panels shall be formed. Switchboards shall have a minimum integrated equipment rating equal to the available fault capacity as shown on the Drawings. Switchboard shall be as manufactured by Square D or approved equal. Final custom assembly and modifications to existing transformer section shall be by Gavan Graham or approved equal.
- B. Equipment shall comply with the latest applicable standards of NEMA, ANSI & U.L.
- C. All wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.
- D. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
- E. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating. Color shall be ANSI 61 gray or manufacturer's standard ANSI color.
- F. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.
- G. All bus bars shall be copper and fully rated. All bus work shall be rated to withstand maximum short-circuit stresses when connected to a supply system having fault capacity of 65,000 amps symmetrical at rated voltage unless otherwise noted on the Drawings. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. A ground bus and lug shall be furnished, firmly secured to each vertical section structure, and shall extend the entire length of the switchboard. All hardware used on conductors shall be high-tensile strength and zinc plated. All terminals shall be of the anti-turn solderless type suitable for Cu or Al cable of sizes as indicated.

- H. All principal bus joints shall be bolted with Belleville washers. Bolted joints shall be silver plated. The bus assembly shall be constructed so as to maintain the minimum UL electrical clearances without the use of insulating material.
- I. The switchboard section shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. A certified test report shall be available to the Engineer for approval.
- J. Furnish cable pull sections or top cable pull boxes where shown on the Drawings, or where otherwise required, complete with cable tie down supports.

2.2 PRIMARY LOAD INTERRUPTER SWITCHES

- A. Primary fused switches consist of dead-front, completely metal enclosed, free standing structures containing interrupter switches and fuses of the number, rating and type noted on the Drawings or specified herein. All switches shall meet or exceed all applicable NEMA, ANSI, and IEEE Standards. Switches shall be as manufactured by Square D, type HVL/cc, or approved equal.
- B. The load interrupter switches shall be quick-make, quick-break, 3-pole, gang operated, with stored energy operation. Each switch shall have the following minimum ratings:

System Voltage	13.2 KV 3 phase 3 wire
Maximum Design Voltage	15 KV
Basic Impulse Level (BIL)	95 KV
Withstand Voltage	36 KV
Amperes Continuous	600 Amps
Amperes Interrupting	600 Amps
Momentary (Switch	
Closed, 10 Cycle)	40,000 Amps Asym.
Fault Close	40,000 Amps Asym.
Main Bus Rating	600 Amps

- C. A manually charged mechanism shall be supplied which utilizes a heavy duty coil spring to provide opening and closing action of the switch. The speed of opening and closing of the switch shall be independent of the operator, and it shall be

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impossible to tease the switch into any intermediate position.

- D. The interrupter shall have separate main and make/break contacts to provide maximum endurance for fault close and load interrupting duty. The switch or switch and fuse assembly shall have glass polyester insulating barriers between phases and between the outer phases and the enclosure.
- E. The following features shall be supplied on every 3 pole, 2 position (open, closed) switch:
1. A high impact viewing window that permits full view of the position of all three switch blades through the closed door.
 2. A fuse access door interlocked with the switch so that:
 - a. The switch must be opened before access to the fuses is possible.
 - b. The door must be closed before the switch can be closed.
 3. Provision for padlocking the switch in the open or closed position.
 4. Permanent "Open-Closed" switch position indicators.
- F. Fuses shall be as sized on Drawings and shall be current limiting type. Furnish (3) spare fuses for each fused switch and provide a storage rack on the inside of the main door for these spare fuses.
- G. Stress cone type cable terminals suitable for copper or aluminum cable of the number and sizes indicated on the Drawings shall be supplied. Sufficient vertical space shall be supplied for contractor stress cone terminations.
- H. All bus shall be tin plated copper and mounted on NEMA rated glass polyester insulators. All bussing shall be braced for the maximum available fault current.
- I. Enclosure construction shall be of the universal frame type using die formed, welded, and bolted members. All enclosing covers and doors shall be fabricated from not less than 11 gauge steel, except 14 gauge is acceptable for doors. To facilitate installation and maintenance of cables and bus, the top and rear covers shall be removable.
- J. Each switch cubicle shall have a single, full length, flanged front door over the switch and fuse assembly and shall be equipped with rotary latch type padlockable handle. Provision shall be made for operating the switch without opening the full length door.
- K. All enclosing and supporting steel shall be thoroughly cleaned and phosphatized to assure proper surface for prime and finish coats. Color shall be ANSI 61 gray or manufacturer's standard ANSI color.

- L. Small wiring, fuse blocks and terminal blocks within the switch shall be furnished as required. All groups of control wires shall be labeled with wire markers and all wires leaving the switch shall be provided with terminal blocks having suitable numbering strips.
- M. A nameplate shall be mounted on the front door of the switch cubicle. In addition, a "Danger High Voltage" sign shall be mounted on all doors providing access to high voltage.
- N. Supply key/mechanical interlocks as shown on the Drawings to prevent switch operation unless the associated device is open.
- O. 15 KV MOV distribution class surge lighting arresters shall be provided connected at the incoming terminations and securely grounded to the metal structure.
- P. Tests: The manufacturer shall supply test results to confirm that the switch has been tested to substantiate designs according to applicable ANSI and NEMA Standards. The tests shall verify not only the performance of the switch and integrated switch/fuse assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, each switch shall be factory tested in accordance with ANSI Standards.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where this equipment is to be installed, determine space conditions and notify interested parties in writing of conditions detrimental to proper and timely completion of the work.

3.2 INSTALLATION

- A. Install equipment where shown, in accordance with manufacturer's written instructions, and with recognized industry practices to ensure that equipment complies with requirements and serves intended purposes.
- B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.
- C. Installation shall comply with the requirements of NEMA standard and NEC and applicable portions of NECA's "Standard of Installation".
- D. Tighten all connections and mechanical fasteners prior to energization in accordance with manufacturer's instructions.

- E. Provide 24" wide insulation mat in front of switchgear and distribution equipment. Provide insulation mats in front of and in rear of free standing equipment.
- F. Provide protective covering during construction.
- G. Upon completion of work vacuum clean all interiors, touch-up damaged or scratched surfaces to match original finish. Clean all exterior surfaces and apply automatic wax to all switchgear and distribution equipment at time of acceptance by Owner.
- H. Coordinate installation of distribution equipment with cable and raceway installation work.
- I. Provide fuses of the ratings indicated in installed panels. Provide one complete set of spare fuses for each rating.
- J. Adjust operating mechanism for free mechanical movement.
- K. All switchgear shall be set on 4" concrete housekeeping pads. Pads shall have chamfered exposed edges and shall be flush at the front of the gear.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of equipment, and after connection to power source, test equipment to demonstrate compliance with requirements. When possible, field-correct malfunctioning units, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.
- B. Prior to energizing of distribution equipment:
 - 1. Megger check phase-to-phase and phase-to-ground insulating resistance levels of conductors.
 - 2. Check distribution equipment for continuity, and for short circuits.
 - 3. Set all circuit breaker trip ratings for maximum coordination with upstream and downstream devices, including ground fault trips where supplied.
 - 4. Subsequent to wire and cable hook-ups, energize distribution equipment and demonstrate functioning in accordance with requirements.
 - 5. Open and close load break switching devices under load.
 - 6. Provide manufacturers recommended DC high potential test for transformer and verify acceptability of results prior to energizing.

END OF SECTION 16420

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16. SECTION 16470 - GROUNDING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Section 16000 - General Provisions for Electrical Work shall apply.

1.2 DESCRIPTION OF WORK

- A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, all grounding in accordance with Drawings and Specifications and as required for a complete system.

1.3 QUALITY ASSURANCE

- A. "Manufacturers" - Firms regularly engaged in manufacture of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Provide equipment whose performance under specified conditions is certified by the manufacturer and comply with applicable publications of NFPA and UL.
- C. Grounding shall comply with National Electrical Code (NFPA 70) for construction and installation.

1.4 SUBMITTALS

- A. Refer to Section 16000 – General Provisions for Electrical Work and submit shop drawings. Shop drawings shall include splice kits, ground rods, ground clamps, and ground wire.

1.5 GUARANTEE

- A. Refer to Section 16000 – General Provisions for Electrical Work.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Ground rods shall be copper clad steel not less than 3/4" diameter and 10' long; use

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a minimum of (2) per grounding location.

- B. Ground clamps shall be bronze, solderless type with bronze screws suitable for receiving required or noted conductors.
- C. Grounding wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the Drawings, or specified.
- D. Grounding equipment shall be manufactured by Chance, Burndy, Cadweld, Thomas & Betts, Blackburn or O-Z/Gedney.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where grounding is to be installed and notify interested parties in writing of conditions detrimental to proper and timely completion of work.

3.2 INSTALLATION

- A. The complete electrical installation shall be permanently and effectively grounded before the water meter and grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified. Measured resistance to ground shall be 5 ohms, maximum.
- B. Parts of the electrical installation to be grounded shall include, but not be limited to, the following: underground distribution, conduit system, cabinets, housings of alarm and control panels and associated devices, and other non-current carrying metal parts of electrical equipment.
- C. All ground connections shall be executed with the same thorough workmanship as the connections for normal current carrying parts. The work must be neatly installed, as careless grounding either in appearance or workmanship will be rejected.
- D. All copper bars for grounding shall be medium hard drawn. After installation, the copper bar shall be painted with one coat of an approved lacquer.
- E. Ground conductors shall be of sizes and material in accordance with the requirements of the National Electrical Code. Cable for grounding connections shall be bare in accordance with the latest revisions of ASTM Designations B3 and B8. All open bare grounding cable shall be secured in place with cast 1 hole malleable clamps and clamp backs and 1/4" bolts.

- F. Ground wires shall be continuous without splices. There shall be no soldered joints in any ground connection. Connectors, clamps, etc. shall be solderless type.
- G. Ground outdoor electrical equipment to driven ground rods.
- H. Ground interrupted metallic raceways with ground conductors connected to metallic raceway at each end.
- I. Ground rods shall be vertically driven with tops below grade. Where required to obtain the specified ground resistance, install multiple rods.
- J. Where ground connections will be permanently concealed, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connections.
- K. Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of grounding system, test system for continuity and resistance to demonstrate compliance with requirements and submit certification to Engineer that material and installation has been properly installed,
- B. Inspect all connections prior to concealing same.

END OF SECTION 16470