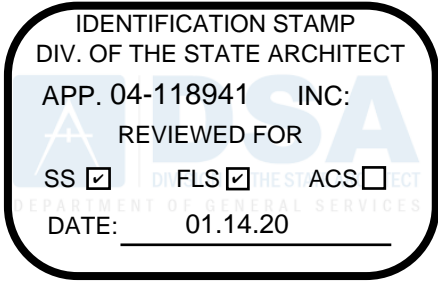


IMPERIAL VALLEY COLLEGE
BUILDING 700 TRANSFORMER UPGRADE

IMPERIAL COLLEGE DISTRICT



December 17, 2019

Michael Wall Engineering

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PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions and Division 1 are part of this section and the contract for this work and apply to this section as fully as if repeated herein. This section, 260500, applies to all Division 26 categories.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 EXPLANATION OF DRAWINGS

- A. These construction documents are intended to be diagrammatic and reflect the scope, quality, and character of the work to be performed; all miscellaneous materials and work required for a complete and operational system, though not specifically mentioned, shall be furnished and installed by the Contractor.
- B. The Contractor shall confirm sizes, dimensions, weights and locations of all devices, light fixtures, and equipment prior to installation.
- C. The specifications and the drawings are an integral document and shall be considered complementary to each other. In the case of a conflict between the specifications and the drawings, the more constricting condition shall be enforced.
- D. The Contractor shall be responsible for reporting any discrepancies, errors, or omissions noted prior to bid.
- E. It is the intent of the drawings to indicate schematic routing and placement of devices, fixtures, equipment and conduit. Offsets, elbows, or extensions shall be furnished and installed by the Contractor as necessary to avoid structure, piping, and clearances and to provide a complete and workmanlike installation.

1.3 QUALITY ASSURANCE

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications and supplements, of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)

8. National Electrical Contractor's Association (NECA)
9. National Electrical Manufacturer's Association (NEMA)
10. National Electrical Testing Association (NETA)
11. National Fire Protection Association (NFPA)
12. Underwriters' Laboratories, Inc. (UL)
13. International Building Code (IBC)
14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the Contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the Contractor.

1.4 SUBMITTALS

- A. Shop drawings for materials, equipment, devices, fixtures, and systems shall be submitted by the Contractor for review within 30 days after award of the contract. In addition to the requirements for submittals stated herein, the Contractor shall be responsible for compliance with the requirements of Division 1.
- B. The Contractor shall bear the responsibility for any materials installed which were not submitted for review or not installed in compliance with the review comments and the contract documents.
- C. Verbal modification of submittal documents or changes to the requirements of the contract documents shall not be acceptable. All submittal material must be documented in a written format.
- D. All submittal packages must be submitted at one time and in accordance with the specification section appropriate for the material. All packages must be identical and clearly labeled indicating the specification section, project name, submittal date, Contractor's name, Engineer's name, preparer's name and submission version (first submission, resubmittal #1, etc.).
- E. Product catalog cutsheets and descriptive literature shall be cross-referenced to the specification section by paragraph.
- F. All submittal packages shall be permanently bound in brochure or booklet format. A minimum quantity of six (6) submittal booklets shall be provided by the Contractor; additional printed copies may be required if so noted. Electronic copies of completed submittal packages, furnished on a USB memory stick, in pdf format, may be furnished in lieu of printed copies.
- G. Materials which bear a certification or approval of a testing agency, performance criteria, society, agency, of other organization shall be submitted with all labels identified.

- H. The submittal shall be complete and with catalog data and information properly marked to show, among other things, materials, capacity and performance data to meet the specified requirements.
 - I. Incomplete submittals will be rejected at the discretion of the reviewing Engineer.
 - J. Review of the submittal is only for general conformance with the contract documents. The Contractor is responsible for confirmation and coordination of dimensions, quantities, sizes, fabrication, installation methods, and for coordination of work of other trades with electrical work.
 - K. Detailed working drawings shall be prepared and submitted showing items which are to be fabricated including transformer mounting racks, unistrut mounting frames, equipment room layouts, pull boxes, splice boxes, gutters, etc.
 - L. Minimum scale for submitted drawings shall be 1/8". Details shall be drawn to 1/4" scale. All drawings shall be 8.5"x11" or larger.
 - M. Submittal brochures shall be complete and descriptive of the type, make, manufacturer, application, quantity, performance, capacity, ratings, options, dimensions, clearances, weights, nameplate data, special installation requirements, mounting method, NEMA type, NEMA class, environmental restrictions, layout requirements or other information as may be necessary for review of the material.
 - N. Submittal brochures for switchgear shall include, as a minimum, the following: singleline diagrams; fault current ratings of buses and devices; device identification, ratings, layout and characteristics; dimensions; circuit identification; identification label type and method of affixing; mounting; conduit entry point and quantities; NEMA enclosure type; and additional data as required for a complete review.
 - O. Submittal brochures for lighting systems shall include, as a minimum, the following: manufacturer; detailed drawing or photograph; dimensions; lamp data; ballast data; certified photometric data from a third-party testing agency; U.L. label listing; fixture number or identification from the drawings; finish color and material; mounting equipment; socket type and rating; environmental ratings (damp location, watertight, explosion-proof, etc.); voltage; input wattage; and additional information as necessary for a complete review.
 - P. The Contractor shall be responsible for all aspects of substitutions of material including any additional cost or delay incurred as a result of the substitution. The Contractor shall coordinate all substitutions with other trades, verify code compliance, verify clearances, photometric performance, appearance, suitability, constructability, and availability of the material prior to submitting the substitution for review. The Contractor shall bear the responsibility of any increased costs to other trades which are directly related to the substitution.
- 1.5 MATERIAL HANDLING
- A. The Contractor shall deliver all equipment and material to the site in the manufacturer's original packaging without seals broken.
 - B. The Contractor shall handle, store, protect, and unpack all equipment and materials in accordance with the manufacturer's recommendations.
 - C. The Contractor shall inspect the equipment and materials in a timely manner to ensure the completeness and appropriateness of the shipment.

- D. The Contractor shall immediately replace damaged or defective equipment or materials with identical new equipment or material at no cost, inconvenience, or delay to the College.

1.6 EXISTING CONDITIONS

- A. The Contractor shall verify all existing conditions prior to bid and include all costs associated with the existing conditions in bid.
- B. The Contractor shall match the finish and appearance of all existing conditions where constructing new work adjacent to existing surfaces or equipment.
- C. Coordinate with the College's Representative for all ongoing projects or the work of other trades which may affect the Contractor's work. Verify College schedule requirements for special or standard events which may impact the Contractor's work.
- D. Coordinate work to be performed in occupied areas and comply with the College's requirements such that the College's work or ongoing activities are not disrupted by the Contractor. Verify the need for work to be performed during premium hours, evenings, weekends, or holidays prior to bid and include all costs in bid. Bring to the College's attention the need and locations for all disruptive work prior to commencement of work.

1.7 COLLEGE UTILITY REQUIREMENTS

- A. The contractor shall contact the college for all utility system requirements prior to commencement of work. Utility work shall include electric power, telephone, data, fiber optic cable, cable television or other utilities as may require connections as a part of this contract. Coordinate and comply with all serving utility company requirements, designs, and schedules.
- B. The utility information depicted on the contract documents is for bidding purposes only and shall not be used for construction purposes. All construction shall be performed according to engineered documents provided by the serving utility company. The Contractor shall obtain and coordinate with utility company requirements as a part of this contract and furnish and install all work as a part of this contract.
- C. Verify all connection points, routing, and requirements with the serving utility company prior to commencement of work and coordinate final requirements with other trades.
- D. The Contractor shall be responsible for all costs associated with failure to contact or coordinate with utility company requirements.

1.8 TEMPORARY CONSTRUCTION UTILITY REQUIREMENTS

- A. Power, telephone or other temporary construction utility services required by the Contractor shall be the responsibility of the Contractor.
- B. Arrangements for temporary construction utility services shall be made by the Contractor in coordination with the College Representative.

1.9 CONTINUITY OF SERVICE

Imperial Valley College
Building 700 Transformer Upgrade

- A. The Contractor shall coordinate all shutdowns, outages, and service interruptions with the College's Representative. Electrical shutdowns shall be kept to the minimum number necessary to complete the work.
- B. The Contractor shall coordinate all work done on overtime or premium time with College's Representative prior to commencement of work.
- C. All work performed in or through occupied spaces, or other work disruptive to existing occupants shall be considered as performed during premium time or as overtime for the purposes of the bid; include all costs in bid.
- D. The Contractor shall notify College Representative of all shutdowns or disruptive work a minimum of 72 hours prior to commencement of work. The Contractor shall obtain written approval from the College Representative prior to commencement of work.
- E. The Contractor shall provide all necessary temporary power, including temporary power generation, to accommodate shutdowns and minimize disruption of the College activities.
- F. The College reserves the right to provide emergency repairs or temporary power to maintain service continuity at the Contractor's cost in the event Contractor fails to provide adequate service continuity.

1.10 RECORD DOCUMENTS

- A. The Contractor shall prepare as-built documents depicting all revisions to branch circuits, conduit routing, equipment, panel schedules, lighting control schedules, or materials. Drawings shall be in AutoCAD .dwg format and Adobe .pdf formats. Contractor shall provide (1) full-size hard copy print and (1) USB memory stick of all as-built drawings and files. Hand-drawn or "red-line" drawings shall not be accepted. Drawings shall be legible, reproducible, and properly identified such they may be used as a reference for maintenance or construction.
- B. The Contractor shall provide a minimum of three copies of the operation and maintenance manuals to the College Representative at the completion of the project. Each copy shall be bound in a three-ring binder and labeled indicating: the project name; system name; Contractor's name, telephone number, and contact person; and College name. The Contractor shall provide the following minimum information within each manual:
 - 1. List of the Subcontractors performing work on the system including contact names, telephone numbers, and email addresses.
 - 2. Routine and emergency service contact names, telephone numbers, and email addresses for each system.
 - 3. Description of system operation.
 - 4. Single line diagrams and control wiring diagrams.
 - 5. Detailed product literature with technical information.
 - 6. Local factory representative contact name, telephone number, and email address.
 - 7. Sequence of starting, shutdown and operation.
 - 8. Installation instructions and safety requirements.
 - 9. Maintenance schedule, testing instructions and performance parameters.
 - 10. Parts list including recommended spare parts.

1.11 GUARANTEE

- A. All electrical work, materials and equipment provided under this contract shall be guaranteed for a period of one year from the date of acceptance of the work by the College. Any failures,

problems, or deficiencies experienced during this period due to defective materials or faulty workmanship shall be immediately corrected by the Contractor without cost to the College. The Contractor shall be responsible for all damages to the College due to deficiencies in the electrical system. Equipment guarantees in excess of one year shall not be superseded by this guarantee.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, of prime quality, listed as suitable for the application, and bear factory-applied U.L. labels.
- B. Materials shall be currently in production and shall be supported by spare parts, repair service, maintenance, and factory technical support.
- C. Materials of one assembly (switchboards, substations, motor control centers, etc.) shall be of one manufacturer unless specifically stated otherwise in the contract documents.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. All work shall conform to National Electrical Contractors Association standards of installation and the requirements of the manufacturer, Division 1, Division 26, and the College Representative.
- B. The Contractor shall field-verify all dimensions and coordinate dimensions with equipment sizes and locations.
- C. The Contractor shall coordinate and install all penetrations, openings, slots, chases, or sleeves as necessary for the routing and installation of raceways, conductors, or equipment. The Contractor shall provide approved fire sealant to maintain fire ratings at all penetrations.
- D. The Contractor shall coordinate the placement and sequence of installation of all mounting bolts, conduits, sleeves, etc. which are to be set in poured-in-place concrete slabs, concrete walls, and post-tension slabs per the structural drawings.
- E. The Contractor shall verify and coordinate all equipment points of connection, voltages, wiring requirements, disconnecting means, fuse sizes, overcurrent protection, etc. with the equipment supplier. The Contractor shall immediately notify the Engineer of any discrepancies with the construction documents.
- F. All equipment shall be installed plumb, parallel, or orthogonal to structure and in a neat orderly fashion. All material shall be accessible for maintenance, inspection, servicing or replacement.
- G. The Contractor shall coordinate and arrange for the proper sequence of construction including scheduling of long-lead items, shutdowns, work of other trades, and College -scheduled events.
- H. The Contractor shall provide adequate and qualified supervision for the work performed; no work shall be performed without the supervision of a representative of the Contractor.

- I. The Contractor shall coordinate and cooperate with all other trades for a successful completion of the project.

3.2 SEISMIC BRACING

- A. The Contractor shall seismically brace all equipment in accordance with requirements of the California Code of Regulations, Title 24, Seismic Design Category D and provide certification of seismic compliance upon request, including structural calculations as required.

3.3 CUTTING AND PATCHING

- A. The Contractor shall provide cutting and patching as required to install the electrical system in this contract.
- B. Coordinate the schedule of all cutting such that the work may be performed in an expeditious manner with minimum inconvenience to the College.
- C. Remove or cut structures or materials as necessary for demolition prior to the installation of new electrical work.
- D. The Contractor shall protect all surfaces, structure, furnishings, and finishes not directly affected by cutting or patching.
- E. Provide dust and moisture barriers as required during cutting and prior to patching openings.
- F. Patching shall be performed with materials which exactly match the adjacent surfaces in color, texture, character, and appearance.
- G. All patches must maintain the fire ratings of the original surface and shall be sealed with a U.L. listed and Fire Marshal approved sealant.

3.4 COMMISSIONING

- A. The Contractor shall initiate start up of all electrical equipment including operation of all devices, switches, generators, transfer switches, overcurrent protection, disconnect switches, etc. to verify normal operation of all moving parts and electrical performance.
- B. The Contractor shall test, adjust, aim, align, label, clean and complete all systems prior to acceptance by the College Representative.
- C. The Contractor shall demonstrate that all systems operate within the manufacturer's recommended performance characteristics, the electrical construction documents, system requirements, and College requirements.
- D. The Contractor shall test each system per the manufacturer's requirements and shall perform the following system tests:
 1. Inspect cables for physical damage and proper connection.
 2. Torque test cable connection and tighten in accordance with termination manufacturers recommendations.
 3. Infrared scan all connections under loaded conditions and provided color printed images.
 4. Insulation resistance test of each cable.
 5. Inspect ground system connections.

6. Voltage drop tests on the main grounding electrode of system.
7. Determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral points.
8. Check rated voltage and phase balance at all equipment, motors and selected devices at full load conditions. Measure no load voltage conditions at each location.
9. Furnish all material, equipment, instruments and labor as required to complete testing.
10. Provide all test results properly bound in a three-ring binder.

3.5 TRAINING

- A. Furnish at least one copy operating instructions from the manufacturer for all electrical equipment to the College's Representative. Instructions shall be clean, legible, and properly bound in a three-ring binder.
- B. The Contractor shall provide training for the College's staff as directed by the College's Representative for a minimum of one man-day (eight hours).
- C. Provide classroom training by a qualified instructor for the operation, installation, and maintenance of designated equipment or systems including, but not limited to, generation systems, transfer switches, uninterruptible power supplies, energy management systems, lighting control systems, power distributions systems, and other systems which may require instruction.

3.6 CLEANING

- A. Contractor shall clean all equipment, panelboard interiors, conduit interiors, fixtures, devices, etc. of all extraneous paint, drywall mud, overspray, dust, dirt, debris, trash, grease or markings. All cleaning shall be performed by the Contractor in accordance with the appropriate manufacturer's recommendations.

END OF SECTION 26 05 00

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications and supplements, of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriters' Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the Contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Conductor materials
 - 2. Connector and fitting materials
 - 3. Installation materials and methods

4. Termination materials and methods
- B. Complete data sheet for cable construction, shielding, insulation material, insulation rating, thickness of insulation, jacket cable stranding, voltage rating, and total amount of order in feet.
- C. Certified test reports for:
 1. Sample test on insulation: physical properties, solvent extraction, heat distortion, and accelerated water absorption.
 2. Insulation resistance, power factor corona level, AC dielectric.
 3. Certified Factory Test Report including the results of the test plus cable identification, factory order number, cable length and all cable specifications. No cable shall be installed in any duct or conduit until a related test report has been accepted by the College Representative.
 4. Field Test Report.
 5. Submit a certification for the approval of the College Representative containing the names and the qualifications of persons recommended to perform the splicing and termination of medium voltage cables approved for installation. Refer to Section 01400 including Exhibit A for certification requirements and information regarding cable installation termination and testing.
 6. A complete test shall be done on each length of cable at the factory in accordance with ICEA S-93-639, and UL-1072. In addition, a corona test shall be done per AEIC CS8.
 7. Complete cable pull-tension study. Study shall model the route of each conductor in 3-dimensions and shall indicate pull-tensions, conduit sidewall pressures, pulling rates, minimum bend radius, and suggested pulling directions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cable manufacturers shall be Okonite, Southwire, Pirelli or equal.
- B. Cable terminations and splices shall be manufactured by 3M, Elastimold, or equal.
- C. Fire-proofing and arc-proofing tape shall be manufactured by Bishop (Model 43A), 3M (Model 7700), or equal.
- D. The manufacturer shall have a minimum of twenty (20) years of experience in manufacturing medium voltage EPR power cables and shall submit a certified copy of its AEIC CS8 qualification.
- E. Provide the services of a qualified testing laboratory to perform the specified field tests. Notify the College Representative 7 days in advance of performance of work requiring testing. Refer to Section 26 05 00 regarding additional requirements.

2.2 MATERIALS

- A. 15kV, ungrounded, shielded, single copper conductor, UL listed Type MV105, with ethylene-propylene rubber (EPR) insulation, jacketed. Manufactured within one (1) year of installation.
- B. Suitable for installation in conduit, subject to alternately wet and dry conditions.

- C. To operate satisfactorily, both electrically and mechanically, at conductor temperatures not exceeding 105 degrees C continuous for normal loading; 140 degrees C for emergency loading, emergency of 36 hours; 250 degrees C for short circuit loading assuming a short circuit duration of two seconds. Emergency overload operation may occur for periods up to 100 hours per year and with as many as five (5) such 100-hour periods within the lifetime of the cable.
- D. Cable to meet the specifications and the minimum requirements of the latest revisions of ICEA S-93-639 and AEIC CS8.
- E. Soft, annealed copper, compact Class B stranded per ASTM B-496 for sizes up to and including 1,000 Kcmil.
- F. Thermoset EPR based material with a volume resistivity not in excess of 100 ohm-meters at 105°C; chemically compatible with the conductor and the cable insulation; firmly and continuously bonded to the overlaying insulation; easily removable from the conductors. Compatibility of material shall be demonstrated by laboratory test results.
- G. High quality, ethylene-propylene base, thermosetting compound of high dielectric strength with heat, moisture, ozone, and corona resistant properties, homogenous, solid, and applied with good workmanship. Insulation thickness shall be 220 mils minimum average, and meet the latest editions of AEIC CS-8 and ICEA S-93-639. EPR insulation compound shall be compounded by the cable manufacturer and be free from polyethylene.
- H. Insulated conductor to have a suitable layer of semi-conducting, extruded, thermosetting, EPR-based shielding applied directly over the insulation. The semi-conducting shield shall have a peel strength between 4 and 24 pounds.
- I. Uncoated copper tape shield, helically applied over insulation 0.0005 inch thick with minimum 12.5% overlap.
- J. 80 mil, minimum average thickness polyvinyl chloride jacket extruded over the shielding tape; smooth, of uniform composition and free of holes, cracks and imperfections; longitudinal shrinkage relative to the insulation less than five percent.
- K. Strand shielding insulation and semi-conducting insulation shield shall be applied in a continuous triple-tandem extrusion process to insure accuracy of applied material.
- L. Provide durable lifetime identification printed, embossed, or engraved on outer surface of the jacket including manufacturer's name, year of manufacture, place of manufacture, conductor type and size, insulation thickness in mils, and the rated voltage, all on 3 foot center maximum spacing.
- M. Seal ends of cable with mastic material and heat shrink end cap to prevent entrance of moisture.

2.3 CABLE TERMINATIONS

- A. IEEE 48; Class 1, shrinkable rubber or polymeric cable termination in kit form with ground clamp, non-tracking skirts, moisture-blocked ground braid and auxiliary materials; rated for voltage class of cable being terminated.

2.4 CABLE SPLICES

- A. 15kV splices shall consist of a 600 ampere separable insulated connection T-Bolt system rated

for continuous operation at 15kV for single-conductor shielded power cables. The system components shall be designed according to the specifications listed in ANSI/IEEE Standard 386-1985 for 15kV 600A dead-break interfaces. The system shall be made up of specific kits designed for splicing, tapping (adding-on) dead-ending, and 600A equipment connecting. Each kit shall contain all the components necessary for its intended application. The connector cable sizing adapter and shield adapter shall be contained in a separate adapter kit. The system shall be capable of making dead-end, 2-way, 3-way or multiple tap splices, and of making connections to 15kV 600A apparatus bushings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Use swab to clean conduits and ducts before pulling cables.

3.2 INSTALLATION

- A. Install cable and accessories in accordance with manufacturer's instructions.
- B. Avoid abrasion and other damage to cables during installation.
- C. Use listed cable pulling lubricants and pulling equipment.
- D. Do not exceed any value generated by the pull-tension study. Provide a recording dynamometer with break-away fitting at each pulling station. Record the cable pulling tensions during installation and provide the recording to the Engineer.
- E. Ground cable shield at each termination and splice. Conductor shield continuity must be maintained at all splices.
- F. Install cables in manholes such that cables loop around the complete the interior of the manholes and have sufficient slack for addition of minimum one set of T-bolt splices. Attach all cables to vertical cable racks installed in all manholes. Coordinate exact attachment requirements with College prior to rough-in.
- G. Arrange cable in manholes to avoid interference with duct entrances and future splicing.
- H. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing one inch into duct.
- I. Spiral wrap fireproofing tape with glass tape 3M number 27 or equal.
- J. Keep splices to a minimum. Pull cable in directions indicated by the pull-tension study from central manhole wherever possible.
- K. All cables shall be tagged with laminated Micarta type nameplates engraved with 5/32-inch high white letters on black background, showing the size of the cable, what the cable feeds and the date it was first energized. The tags shall be attached to the cables with heavy duty nylon ties and shall be located in every pullbox, junction box, etc., and at every splice and termination. The cables shall also be phase marked "A", "B", and "C".
- L. The cables shall be terminated, and spliced as shown on drawings with self-vulcanizing tapes in accordance with the printed instructions of the manufacturer of the cable supplied. All self-

vulcanizing tapes used to provide the cable insulation shall have an EPR base. All cable splices shall be 15kV, 133% rated. Cable splices shall be constructed per IEEE #404 1986 standard.

- M. Single conductor cables in gutters or wireways, or racks in vaults, shall have the three conductors or each circuit bound together with plastic cable ties at points not over three feet apart.
- N. Stress cones shall be made on all cable splices and terminations, and shall be made in accordance with the printed recommendations of the cable manufacturer.
- O. The conductor shields shall be grounded at each termination of the cable run, and on both sides of all splices, using a stranded, #6 bare copper wire to the nearest grounding electrode system. Conductor shield continuity must be maintained at all splices. The ground wire shall be protected from mechanical injury by enclosing it in a metal protective covering or by placing it where it will not be subject to damage.
- P. Provide one #4/0 bare copper ground conductor in each conduit with phase conductors.

PART 4 - TESTING

4.1 FIELD TESTS

- A. Testing of cables shall be performed by an independent testing agency at the Contractor's expense. The testing agency shall have a minimum of 5 years experience. Each person engaged in the testing procedures shall also meet the experience requirements. Provide to College Representative, documentation, including references, of the testing agency's, and agency's personnel experience for approval.
- B. Perform DC high potential test of each conductor in accordance with NEMA WC 74.
- C. Connect untested conductors in circuit to ground during test.
- D. Apply test voltage in at least eight equal increments to maximum test voltage.
- E. Record leakage current at each increment, allowing for charging current decay.
- F. Hold maximum test voltage for fifteen minutes. Record current at 30 seconds and every 60 seconds thereafter. Plot results on X-Y axis.
- G. Each insulated conductor provided under this section of the specification shall be tested in accordance with Section E of AEIC CS8.

4.2 PROTECTION

- A. Protect installed cables from entrance of moisture. Provide heat shrink caps per Cable Manufacturer's recommendations for cables to be energized at a later date.

END OF SECTION 26 05 13

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

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No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer and College Representative by the contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the UL label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
1. Conductor materials and stranding.
 2. Connector and termination materials.
 3. Installation materials and methods.
 4. Termination materials and methods.

PART 2 - PRODUCTS

- 2.1 Conductors shall be copper; conductors size #12AWG and smaller shall be solid, conductors size #10AWG and larger shall be stranded. Conductors shall be minimum size #12AWG for power and lighting circuits; control circuits shall use a minimum conductor size of #14AWG.
- 2.2 Insulation shall be type THW or THHN/THWN for all branch circuits up to and including size #2AWG. Insulation for conductors over size #2AWG shall be XHHW.
- 2.3 Jackets shall be nylon or PVC material.
- 2.4 All cables shall be UL listed for the application.
- 2.5 All conductors shall be installed in conduit in the field, unless specifically noted otherwise in these documents. Type AC and type NM cable is not acceptable; type MC cable may be used where specifically noted for purposes of flexibility, maintenance, or ease of installation but shall not be used without explicit permission and direction of the Engineer.
- 2.6 Multi-conductor flexible cords shall be types SO, SJO, STO, or SJTO.
- 2.7 Electrical connectors shall be UL listed and suitable for the conductor material being connected and rated appropriately. Connectors shall be solderless helical metal spring pressure type for conductors #10AWG and smaller. Push-in connectors (WAGO) shall not be used. Connectors shall be compression type for conductors #8AWG and larger.

PART 3 - EXECUTION

- 3.1 All wiring methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.
- 3.2 Conductors shall be installed in clean raceways using nylon cord, polypropylene cord, hemp rope, or other material which will not damage the conductors or conduit. Do not use metal fish tape to pull conductors. Use a listed cable pulling lubricant when necessary for pulling.
- 3.3 Conductors shall be pulled into conduit simultaneously so as to not damage conductors during pulling.
- 3.4 Conductors installed at outlets and switches shall have a minimum of 6" pigtail left in the box for future connections. All conductors not connected to devices shall be terminated with splice caps and tape.
- 3.5 Conductors shall be terminated such that no copper material is exposed. Conductors shall be trained and labeled at terminations in a neat and workmanlike manner.

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- 3.6 Mechanical lugs for conductor terminations at equipment (switchboard bussing, circuit breakers, disconnect switches, etc.) shall be sized and rated to accept the conductors specified. Oversized conductors shall utilize reducing pins to facilitate terminations.
- 3.7 All terminations shall be mechanically sound, featuring helical twisting of the terminating conductors prior to the application of an electrical connector. The electrical connector shall not be used for the mechanical connection of the conductors.
- 3.8 All terminations shall comply with the manufacturer's installation and torquing requirements.
- 3.9 Splices on conductors #10AWG and smaller shall be made with splice caps twisted onto the conductors. Tape all splices.
- 3.10 Splices on conductors #8AWG and larger shall be made with pressure connectors and terminal lugs. Where exposed to water, damp air, or moisture splices shall be watertight.
- 3.11 Splices shall be not be made in feeders; splices to branch circuits shall not be made within panelboards or similar enclosures.
- 3.12 When combining homeruns, the Contractor shall derate all conductors per NEC requirements including reducing the conductor ampacity and using high temperature insulation where necessary. Conduit sizes shall be adjusted by the Contractor, per NEC requirements, for any conductor revisions.
- 3.13 The Contractor shall provide a code-sized insulated grounding conductor, in addition to the feeder conductors indicated on the drawings, for all feeder circuits.
- 3.14 Conductors shall be color-coded as follows:

208Y/120V	Phase	480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- 3.15 Where tape or labels are used for color-coding, apply material at each end of the conductor, at all splices, within all boxes, and at all terminations.

END OF SECTION 26 05 19

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 SCOPE

- A. Permanently and effectively ground conduit systems, supports, cabinets, switchboards, equipment cases, motor frames, lighting standards, landscape lighting, etc., and system neutral conductors per National Electrical Code.
- B. Grounding details, symbols and singlelines shown on plans are schematic only. If additional equipment, such as ground rods, clamps, conductors, etc., is required per National Electrical Code furnish and install without additional cost to Owner.

1.3 QUALITY ASSURANCE AND STANDARDS

- A. The latest revision of standards listed below form an integral part of this specification.
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriters' Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)
- B. Furnish products listed by Underwriters Laboratories, Inc. as suitable for purposes specified and shown.

1.4 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review.
- B. Manufacturer's data on grounding and bonding products and associated accessories.

1.5 ACCEPTABLE MANUFACTURERS

- A. Burndy Corporation
- B. Cadweld Division
- C. Crouse-Hinds
- D. Thomas and Betts Corporation
- E. Okonite Company
- F. Tecto Weld

PART 2 - PRODUCTS

2.1 GROUNDING MATERIAL

- A. Rod Electrode: Material to be copper clad steel rod, 3/4 inch diameter with minimum 10 feet length.
- B. Mechanical Connectors: Material shall be copper and of sound continuity when installed.
- C. Exothermic Connectors: Material shall be of low emission, electric-start type and of sound continuity when installed.
- D. Bare Ground Conductors
 - 1. Conductor shall be 7-strand annealed copper.
 - 2. Individual members of stranded conductor shall meet the requirements of ASTM B-3.
 - 3. Stranded conductors shall be assembled in accordance with the requirements of ASTM B-8.
- E. Insulated Conductor (Equipment grounding conductor)
 - 1. Size in accordance with NEC Article 250-95 unless otherwise shown as oversize.
- F. Grounding Well Components
 - 1. Well Pipe: Material shall be 8 inch diameter by 24 inch long concrete pipe with belled end.
 - 2. Well Cover: Material shall be cast iron with the text "GROUND" embossed on cover.
- G. Ground Bus Bar
 - 1. ASTM B187, 98% conductivity copper bus bar, size 4 inches wide by 1/4inch thick by 24 inches long.
- H. Terminal Lugs
 - 1. For 4/0 AWG and smaller conductors: Copper compression lugs.
 - 2. For 250kcmil and larger: Aluminum mechanical lugs.

- I. Bonding Plates, Connectors, Terminals and Clamps
 - 1. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
- J. Jumpers
 - 1. Copper braided or leaf-type flexible jumper, size as necessary.
- K. Bus Bar Insulators
 - 1. Fiberglass reinforced polyester insulator with 2 inch diameter threaded holes at both ends for bus bar installation.
- L. Electrical Grounding Connection Accessories
 - 1. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service indicated.
- M. Field Welding
 - 1. Field Welding: Comply with AWS Code for procedures, appearance, and quality of welds; and for methods used in correction welding work. Provide welded connections where grounding conductors connect to underground grounding and plate electrodes.
- N. Grounding Resistors
 - 1. Provide a low-resistance grounding resistor in compliance with the latest IEEE-32 standard.
 - 2. Temperature rise shall not exceed 760 degrees C above an ambient temperature of 30 degrees C for a ten-second duration.
 - 3. Neutral grounding relays shall be set to protect the resistor and clear the fault within ten-seconds.
 - 4. For resistors above 600V, an applied high potential test shall be performed equal to 2.25 times the rated voltage, plus 2000 volts.
 - 5. Grounding resistors shall be UL or CSA listed and labeled.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's Standard of Installation, and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Ground each separately-derived system neutral to nearest cold water piping, service entrance equipment grounding electrodes, and electrically continuous building steel.

- D. Connect together system neutral, service equipment enclosures, electrically continuous building steel, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- E. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

3.2 GROUND INSTALLATION

- A. Equipment Grounding Conductor
 - 1. Provide separate, insulated conductor within each feeder and branch circuit raceway including lighting circuits.
 - 2. Terminate each end on suitable lug, bus, bushing, or device.
- B. Motors or equipment rated at 480V shall have bonded ground jumpers from feeder conduit to motor frame.
- C. Grounding bushing shall be used wherever conduits are grounded.
- D. Ground the electrical service system neutral at service entrance equipment to the grounding electrode system.
- E. Install rod electrodes at locations indicated.
- F. Provide grounding well pipe with cover at rod locations where indicated. Install well pipe top flush with finished grade.
- G. Install products in accordance with manufacturers' instructions.
- H. Use mechanical connections in above ground and accessible locations and use exothermic connectors in underground and inaccessible locations.
- I. Provide bonding to meet Regulatory Requirements. Include bonding of metallic gas and sprinkler piping systems.
- J. Install ground clamps specifically designed for grounding purposes. Where grounded conductor is in conduit, use ground clamp which grounds both conductor and conduit. Strap metal is not acceptable for grounding and bonding.

3.3 GROUND RESISTANCE TESTING

- A. Grounding electrode resistance testing shall be accomplished with a ground resistance direct reading single test meter utilizing the fall-of-potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet apart.
- B. Maximum grounding system resistance to be 5 ohms for secondary systems. Install additional ground rods as needed to achieve a resistance of 5 ohms.

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- C. Test results shall be provided in writing and shall show temperature, humidity and condition of the soil at the time of the tests.

END OF SECTION 26 05 26

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriter's Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer and College Representative by the contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Support materials
 - 2. Attachment and anchor materials
 - 3. Installation materials and methods

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Thomas & Betts Corporation.
 - c. Unistrut; Tyco International, Ltd.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following and shall be compatible with all building surfaces and materials:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
- 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
- 6. Toggle Bolts: All-steel springhead type.
- 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and GRC as required by the NEC. Minimum rod size shall be 3/8 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

END OF SECTION 26 05 29

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriter's Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer and College Representative by the contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Raceway materials
 - 2. Fitting materials
 - 3. Installation materials and methods

PART 2 - PRODUCTS

2.1 RIGID GALVANIZED STEEL (RGS) CONDUIT

- A. Continuous hot-dipped galvanized manufactured per UL and ANSI requirement.
- B. Rigid aluminum conduit is not acceptable.
- C. Conduit bodies for use with steel conduit, rigid or flexible, shall be manufactured per UL requirements and shall be cast metal with gasketed closures.
- D. Fittings for RGS conduit shall be malleable iron or forged steel with cadmium or zinc coating.
- E. Union couplings for joining rigid conduit at intermediate runs shall be of the same material as the conduit. Couplings shall be threaded concrete-tight to permit completing conduit runs when neither conduit can be turned and to permit breaking the conduit run at the union.
- F. Set screw connectors or threadless type are not acceptable.
- G. Minimum raceway size shall not be less than ¾".

2.2 LIQUID TIGHT FLEXIBLE CONDUIT

- A. Conduit shall be manufactured in accordance with UL and ANSI requirements. Conduit shall be approved for grounding and compatible with approved fittings. Flexible steel conduit shall be hot dipped galvanized with extruded PVC covering manufactured per UL requirements.
- B. Fittings shall be liquid tight type with body and gland nut of steel or malleable iron with provisions for grounding flexible conduit to fittings.
- C. Minimum raceway size shall be ¾".

2.3 POLYVINYL CHLORIDE (PVC) CONDUIT

- A. PVC shall be constructed of a virgin homopolymer PVC compound and be manufactured according to NEMA and UL specifications. PVC conduit shall be Schedule 40 or 80.
- B. Minimum raceway size shall be ¾".

PART 3 - EXECUTION

3.1 RIGID GALVANIZED STEEL (RGS) CONDUIT

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- A. RGS shall be used where exposed to weather or where subject to physical damage in exposed areas below 8'0" above finished floor.
- B. RGS shall be used in NEC classified hazardous locations with seal connections per NEC requirements.

3.2 LIQUID TIGHT FLEXIBLE CONDUIT

- A. Liquid tight flexible conduit shall be used for final connection to machines, motors, transformers and equipment that requires vibration isolation.
- B. Liquid tight flexible conduit shall be used for final connection to equipment in wet or damp locations or where exposed to grease, water, dust, dirt, vapors, or chemicals.
- C. The conduit grounding system shall be continuous as recommended by the manufacturer and UL requirements.

3.3 POLYVINYL CHLORIDE (PVC) CONDUIT

- A. All sweeps, bends, and risers shall be concrete encased Schedule 80.
- B. All underground conduit, telephone conduit, service entrance conduit and feeders 100A and over shall have 3" of red mixed concrete cover and a metallic locating tape installed 6" above the top of the conduit.
- C. All PVC conduit feeders shall contain a copper green grounding conductor sized per NEC requirements and continuity shall be maintained throughout conduit runs and pullboxes.

3.4 CONDUIT INSTALLATION

- A. All conduit installation methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.
- B. All conduit runs containing segments exposed to different temperatures shall utilize listed fittings suitable for expansion, expansion-deflection, and deflection.
- C. All conduit installations shall comply with the manufacturer's installation requirements.
- D. All spare conduit shall be cleaned, mandrelled, and provided with a pullwire.

END OF SECTION 26 05 33

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriters' Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Box materials
 - 2. Accessory materials

PART 2 - PRODUCTS

- 2.1 Boxes shall be flat rolled steel sized as required by code and as suitable for the application. Boxes shall have mounting holes and knock-outs in sides and back. Grounding shall be accommodated by means of threaded holes.
- 2.2 Provide accessories, extension rings, gaskets, supports, trim rings, hangers, straps, and other material as necessary for a complete code complying installation.
- 2.3 Boxes installed outdoors shall be weathertight, dusttight, and corrosion resistant. Provide gaskets and conduit hubs.
- 2.4 Provide type FS boxes for surface mounted applications.
- 2.5 Provide additional support for boxes as necessary when mounting fixtures or devices from boxes.
- 2.6 Provide ganged boxes for multiple switches and devices; provide barriers for boxes served by separate voltages.
- 2.7 Acceptable manufacturers shall be Appleton, Crouse Hinds, Steel City, or Raco.

PART 3 - EXECUTION

- 3.1 All box installation methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.
- 3.2 Install all boxes plumb, square, and securely fastened to structure.
- 3.3 Boxes shall be placed such that they are readily accessible.
- 3.4 Cover or plug all unused openings in boxes where knockout blanks have been removed.
- 3.5 Install boxes such that they are flush with the finished surface of the wall or surface within which they are mounted.
- 3.6 Install all boxes at mounting heights per plans, NEC requirements, and ADA requirements.
- 3.7 Boxes shall not be mounted back to back in walls. Minimum offset shall be 12".
- 3.8 Boxes in sealed environments shall be sealed with an approved sealant suitable for the application.
- 3.9 Boxes penetrating fire rated walls or surfaces shall be sealed with a Fire Marshal approved fire sealant to maintain the fire rating of the wall or surface.

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- 3.10 Boxes located above inaccessible ceilings shall be made accessible by means of access doors or hatches in the ceiling.
- 3.11 Install all boxes per manufacturer's recommendations and requirements.
- 3.12 Provide for ground continuity at all boxes.

END OF SECTION 26 05 34

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
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 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriter's Laboratories, Inc. (UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Handhole material
 - 2. Installation materials and methods

- B. Product data: For the following:
 - 1. Shop drawings for precast or factory-fabricated handholes: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Reinforcement details.
 - c. Grounding details.
 - d. Joint details.
 - 2. Shop drawings for factory-fabricated handholes other than precast concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Cover design.
 - c. Grounding details.
 - 3. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
 - 4. Qualification Data: For professional engineer and testing agency.
 - 5. Source quality-control test reports.
 - 6. Field quality-control test reports.

- C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

- D. Comply with ANSI C2.

- E. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store precast concrete and other factory-fabricated underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

- B. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 COORDINATION

- A. Coordinate layout and installation of handholes with final arrangement of other utilities, site grading, and surface features as determined in the field.

- B. Coordinate elevations of ducts and duct-bank entrances into handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as

required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by College.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE HANDHOLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete Products.
 - 2. Oldcastle Precast Group.
 - 3. Utility Vault Co.
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3. Cover Legend: Molded lettering, as indicated for each service.
 - 4. Configuration: Units shall be designed for flush burial and have Integral closed bottom, unless otherwise indicated.
 - 5. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
 - 6. Handholes located in vehicle areas shall feature a minimum full traffic H-20 rating.

2.2 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONCRETE HANDHOLES

- A. Precast Concrete Handhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, and compacted to same density as adjacent undisturbed earth.
- B. Elevations:

1. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

3.2 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding."

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.4 CLEANING

- A. Clean internal surfaces of handholes. Remove foreign material.

END OF SECTION 26 05 44

PART 1 - GENERAL REQUIREMENTS

- 1.1 It is the intent of these acceptance tests to assure that all Contractor supplied equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with designed specifications.
- 1.2 The acceptance tests and inspections shall determine suitability for energization of switchgear and cables.
- 1.3 Items that shall be checked, inspected, and tested include, but are not limited to, the following:
- A. Relays
 - B. AUX compartment with control power transformer
 - C. AUX compartment with potential transformer
 - D. AUX compartment with batteries and rectifier
 - E. Sets of Current Transformers
 - F. Surge arrestors
 - G. Grounding system
 - H. Power/Lighting panelboards
 - I. 15kV rated cable
 - J. 600V rated cable
 - K. Substations and distribution switchgear
- 1.4 APPLICABLE CODES
- A. All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.
 - 1. California Electrical Code (CEC 2016).
 - 2. National Electrical Manufacturer's Association - NEMA.
 - 3. American Society for Testing and Materials - ASTM.
 - 4. Institute of Electrical and Electronic Engineers - IEEE.
 - 5. National Electrical Testing Association - NETA.
 - 6. American National Standards Institute - ANSI:
 - a. C2, National Electrical Safety Code
 - b. Z244-1, American National Standard for Personnel Protection
 - 7. State Codes and Ordinances.
 - 8. Insulated Cable Engineers Association - ICEA.
 - 9. Association of Edison Illuminating Companies - AEIC.
 - 10. Occupational Safety and Health Administration:

- a. Part 1910, Subpart S, 1910.308
 - b. Part 1926, Subpart V, 1926.950 through 1926.960
11. National Fire Protection Association - NFPA:
- a. ANSI/NFPA 70B, Electrical Equipment Maintenance
 - b. NFPA 70E, Electrical Safety Requirements for Employee Workplaces
 - c. ANSI/NFPA 70, National Electrical Code 2005 Edition
 - d. ANSI/NFPA 78, Lightning Protection Code
 - e. ANSI/NFPA 101, Life Safety Code
12. All inspections and tests shall utilize the following references:
- a. Project Design Specification.
 - b. Project Design Drawings.
 - c. Manufacturer's instruction manuals applicable to each particular apparatus.

1.5 QUALIFICATIONS OF TESTING AGENCY

- A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm and all the testing personnel shall have been engaged in such practices for a minimum of ten years.
- D. The testing firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910, and 1936. Full membership in the National Electrical Testing Association constitutes proof of such criteria.
- E. The lead, on site, technical person shall be currently certified by the National Electrical Testing Associate (NETA) in Electrical Power Distribution System Testing.
- F. Testing firm shall utilize only full-time technicians who are regularly employed by the firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians may assist, but may not perform testing and/or inspection services.
- G. The testing firm shall submit proof of the above qualifications.
- H. The testing firm shall be an independent organization as defined by OSHA Title 29, Part 1936 and the National Electrical Testing Association.
- I. All instruments used by the testing firm to evaluate electrical performance shall meet NETA's Specifications for Test Instruments. (See Section 1.7 of this specification).
- J. The terms used herewith such as Test Agency, Testing Laboratory, or Contractor Test Company, shall be construed to mean testing firm.

1.6 RESPONSIBILITIES

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- A. The Contractor shall notify the College Representative prior to commencement of any testing.
- B. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported.
- C. The testing firm shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.
- D. A stable source of 60 hertz power shall be provided for testing purposes by the Contractor. All tests shall be witnessed by College Representative and a minimum of 14 days notice shall be provided.

1.7 TEST EQUIPMENT

A. Test Instrument Calibration

- 1. The testing firm shall have a calibration program which assures that all applicable test instrumentation are maintained within rated accuracy.
- 2. The accuracy shall be directly traceable to the National Bureau of Standards.
- 3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog - 6 months maximum
 Digital - 12 months maximum
 - b. Laboratory Instruments – 2 months
 - c. Leased specialty equipment - 12 months (where accuracy is guaranteed by lessor)
- 4. Dated calibration labels shall be visible on all test equipment.
- 5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
- 6. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.
- 7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.8 TEST REPORTS

A. The test report shall include the following:

- 1. Summary of project.
- 2. Description of equipment/device tested.
- 3. Description of test, including date, time, and duration of test.
- 4. Test results.
- 5. Conclusions and recommendations.
- 6. Appendix, including appropriate test forms.
- 7. Identification of test equipment used.
- 8. Signature of responsible test organization authority.
- 9. Signature of the person witnessing the tests.
- 10. Furnish five copies of the complete report to the College Representative no later than thirty (30) days after completion of project unless otherwise directed.

1.9 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act of 1970 - OSHA.
 2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
 3. Applicable State safety operating procedures.
 4. NETA Safety/Accident Prevention Program.
 5. College safety practices.
 6. National Fire Protection Association - NFPA 70E.
 7. ANSI Z244.1 American National Standards for Personnel Protection.
- B. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
- C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

PART 2 - PROTECTIVE DEVICE COORDINATION STUDY

- 2.1 A protective coordination study shall be performed using SKM's Dapper or equal software to select or check the selection of power fuse ratings, protective relay characteristics and settings, ratios, and characteristics of associated voltage breaker trip characteristics and settings.
- 2.2 The coordination study shall include all voltage classes of equipment from the College main incoming line and down to and including panelboards. The entire electrical system shall be included in the coordination study including all emergency feeders. Verify characteristics and settings of existing devices in the field and from the manufacturer.
- 2.3 The time-current characteristics of the specified protective devices shall be plotted on the appropriate log-log paper. The plots shall include complete titles, representative one-line diagrams of both buildings and legends, associated relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current National Electrical Code shall be adhered to. Reasonable coordination intervals and separation of characteristic curves shall be maintained. Separate coordination plots for phase and ground protective devices shall be provided on a system basis. Separate curves shall be used to clearly indicate the coordination achieved for feeder breakers with downstream fuses and circuit breakers in switchgear and substations. There shall be a maximum of six protective devices per plot.
- 2.4 The selection and setting of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Discrepancies, problem areas, or inadequacies shall be promptly brought to the project College Representative's attention.
- 2.5 Five copies of coordination curves and tabulated data indicating selection and settings of protective devices shall be submitted to the College Representative for approval.

PART 3 - EQUIPMENT VERIFICATIONS, TESTS, AND CALIBRATIONS

3.1 GENERAL

- A. As part of the contract, the Contractor shall perform tests of installed work as herein specified

and specified in other Sections of these Specifications.

- B. The Contractor shall provide all materials, equipment, labor and technical supervision to perform such tests and inspections.
- C. All tests shall be performed in compliance with the recommendations and requirements of the National Electrical Testing Association, Inc. (NETA), and applicable codes and standards.
- D. Upon completion of the tests and inspections noted in these Specifications, a label shall be attached to all serviced devices. These labels shall indicate date serviced and the service company responsible.
- E. The test and inspections shall determine suitability for continued reliable operation.
- F. All tests shall be conducted in the presence of the College Representative. Provide a minimum of two weeks notice to the College Representative.
- G. Furnish the necessary equipment and personnel to perform all required tests of all wiring and connections for continuity, short circuit, and improper grounds. Included, but not limited to, the following systems: substations, SF6 switches, air interrupting switches, low voltage main and feeder circuit breakers, interlocking controls, panelboards, distribution transformers, branch circuits.

3.2 SWITCHGEAR AND DISTRIBUTION BOARDS

- A. Visual and mechanical inspection:
 - 1. Inspect for physical damage and code violations.
 - 2. Clean interior and exterior surfaces.
 - 3. Inspect for proper alignment, anchorage, and grounding.
 - 4. Check tightness of accessible bolted bus joints by torque wrench method. Tighten connections in accordance with industry standard torque levels.
 - 5. Make closure attempt on locked open devices. Make opening attempt on locked closed devices.
 - 6. Make exchange with devices operated in off-normal positions.
- B. Electrical tests:
 - 1. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
 - 2. Inspect all accessible bus joints and cable connections by infrared scanner to detect loose or high-resistance connections and other circuit anomalies.
 - 3. Inspect correctness of control wiring.

3.3 MEDIUM VOLTAGE SWITCHES AND OVERCURRENT PROTECTION

- A. Visual and mechanical inspection:
 - 1. Inspect for physical condition.
 - 2. Inspect alignment and grounding.
 - 3. Perform mechanical operator and contact alignment tests on the breaker and its operating mechanism in accordance with manufacturer's instructions.
 - 4. Perform insulation resistance test on control wiring.
 - 5. Clean mechanism, insulating surfaces and contacts.

B. Electrical Tests

1. Measure contact resistance.
2. Trip overcurrent protective device by operation of each protective device.
3. Perform an insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
4. Perform insulation resistance test in accordance with Doble procedure.
5. Perform timing test with Travel Analyzer to insure proper contact overtravel and pressure.

3.4 SURGE ARRESTERS

A. Visual and mechanical inspection:

1. Inspect for physical damage such as chipped or fractured porcelain.
2. Inspect ground and discharge counter connections for integrity.

B. Electrical tests:

1. Perform a 60Hz sparkover test.
2. Perform a radio influence voltage (RIV) test.
3. Perform an insulation power factor test.
4. Perform ground continuity test to ground grid system.

3.5 INSTRUMENT TRANSFORMER

A. Visual and mechanical inspection:

1. Inspect for physical damage and connection tightness.
2. Check transformer nameplate with singleline diagram.
3. Check proper operation of grounding or shorting devices.

B. Electrical tests:

1. Measure current transformer ratio by primary current injection.
2. Measure potential transformer ratio.
3. Measure insulation resistance primary-to-ground, secondary-to-ground and primary-to-secondary.
4. Verify secondary wiring connections by secondary current injection.
5. Verify transformer polarity markings.
6. Perform current transformer saturation test. Plot transformer voltage current curve.

3.6 CONTROL POWER TRANSFORMERS - ENCAPSULATED TYPE

A. Visual and mechanical inspection:

1. Inspect for physical damage, proper installation, anchorage, and grounding.
2. Clean interior and all bushing and insulator surfaces.
3. Verify proper auxiliary device operation such as fans and indicators.
4. Check tightness of accessible bolted electrical joints. Tighten connections in accordance with industry standards.

B. Electrical tests:

1. Perform insulation resistance tests winding-to-winding and winding-to-ground. Apply appropriate guard circuit over all bushings.
2. Perform dielectric absorption test winding-to-winding and winding-to ground for ten (10) minutes. Compute the polarization index.
3. Perform turns ratio test between windings for all top positions.
4. Perform insulation power factor tests on all high and low-voltage windings.
5. Check output voltages.

3.7 PROTECTIVE RELAYS

A. Visual and mechanical inspection:

1. Inspect relays for physical damage, presence of foreign material, moisture, condition of spiral spring, disc clearance and corrosion.
2. Clean cover glass interior and relay components.
3. Check for freedom of movement, proper travel and alignment, and tightness of mounting hardware and top screws.

B. Electrical test:

1. Perform insulation resistance tests on each circuit branch to frame.
2. Perform the following tests at the settings specified by College Representative:
 - a. Pickup parameters on each operating element.
 - b. Timing at three (3) points on time dial curve.
 - c. Pickup target and seal in units.
 - d. Special test as required to check operation of restraint, and other elements per manufacturer's instructions.
3. Perform phase angle and magnitude contribution tests on all differential type relays after energization to vectorially prove proper polarity and connection.
4. Check polarity and correctness of control wiring.

C. Relay calibration and tests:

1. Two relay wiring tests shall be made.
 - a. Primary circuit polarity test shall include a DC test from the current transformer to each terminal block and relay terminal.
 - b. Relay and circuit breaker operation test by application of power from the portable relay test set.

D. Relay testing shall be accomplished after completion of the switchgear installation, using standard portable test set equipment and the relay manufacturer's testing directions and parameters to determine conformance of the relay to the time-overcurrent information given in the manufacturer's performance curves and the tap settings provided by coordination study. Overcurrent relay testing shall include:

1. Zero set tests.
2. Pickup tests.
3. Time-current characteristic (operation at currents 3 and 4 times the directed tap settings), and instantaneous at the directed tap setting.
4. Target and seal-in operation.

E. Target differential relays shall be tested similarly, except for the following additional tests:

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1. Low voltage “through-currents” of approximately “full load” and “fault” magnitudes shall be circulated in HV busses. Bus differential relays shall not trip.
2. Low voltage currents shall be circulated within the differential zones of “low-fault” and “high-fault” magnitudes. Bus differential relays shall initiate tripping momentarily.

3.8 CABLES 15kV

A. Visual and mechanical inspections:

1. Inspect exposed section for tracking corona, and physical damage.
2. Clean all creepage from surfaces of termination.

B. Inspect shield grounding, cable support, and termination.

1. Perform infrared scan of all connections under loaded conditions.

C. Electrical tests:

1. Perform shield and conductor continuity test by ohmmeter method. Record ohmic value.
2. Perform insulation-resistance test of each cable with respect to ground and adjacent cables.
3. Perform DC hypotential test:
 - a. Test each conductor individually with all other conductors grounded. All shields to be grounded.
 - b. Corona at terminations will be suppressed with guard rings, field reduction spheres, or other suitable methods.
 - c. Apply DC hypotential in at least eight (8) equal increments until maximum test voltage is reached. Record DC leakage current at each step after a constant stabilization time, consistent with system charging current decay. Plot leakage current (X axis) versus voltage (Y axis) at each increment.
 - d. Raise the test conductor to a maximum test voltage and hold for a total of ten (10) minutes. Record readings of leakage current (Y axis) versus time (X axis) and plot on thirty (30) second intervals for the first two (2) minutes and every minute thereafter. Perform maximum voltage decrement test by reducing the applied voltage to zero and monitoring voltage decay versus time. Apply grounds upon completion to drain all absorpic potential to zero.
 - e. Test each conductor in accordance with Section E of AEIC C56.

3.9 LOW VOLTAGE CIRCUIT BREAKERS

A. Visual and mechanical inspection:

1. Inspect for physical condition.
2. Inspect alignment and grounding.
3. Perform mechanical operator and contact alignment tests on the breaker and its operating mechanism in accordance with manufacturer’s instructions.
4. Perform insulation resistance test on control wiring.
5. Clean mechanism, insulating surfaces and contacts.

B. Electrical tests:

1. Measure contact resistance.
2. Trip overcurrent protective device by operation of each protective device.

3. Perform an insulation resistance test phase-to-ground, phase-to-phase and across open contacts.
4. Perform insulation resistance test in accordance with Doble procedure.
5. Perform timing test with Travel Analyzer to insure proper contact overtravel and pressure.

3.10 CABLES, LOW VOLTAGE (600 VOLTS AND LESS)

A. Visual and mechanical inspections:

1. Inspect cables for physical damage and proper connection.
2. Torque test cable connection. Tighten connections in accordance with industry standards.
3. Perform infrared scan of all connections under loaded conditions.

B. Electrical tests:

1. Perform insulation resistance test of each cable with respect to ground and adjacent cables.

3.11 GROUNDING SYSTEMS

A. Visual and mechanical inspection:

1. Inspect ground system connections for completeness and adequacy.

B. Electrical tests:

1. Perform "fall of the potential" test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points.

3.12 INFRARED INSPECTION

A. All doors and cover shall be removed and upon completion of test be reinstalled by testing agency technicians.

B. A load bank shall be furnished to circulate low voltage currents of 400A magnitude through each bus, main breaker and feeder breaker. After two hours infrared scans shall be made of all bus joints. Problem area shall be photographed before and after corrections. After corrections, another current test of two hours duration shall be made. Again an infrared scan shall be made to confirm correct operation.

C. Upon completion, the switchgear shall be energized. After 4 hours, infrared scans shall be made to determine areas of excessive corona. Problem area shall be treated the same as under B., above.

D. Upon completion of infrared scans, all covers and doors shall be reinstalled.

END OF SECTION 26 05 75

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act
 - 2. American National Standards Institute
 - 3. American Society for Testing and Materials
 - 4. Institute of Cable Engineers Association
 - 5. Institute of Electrical and Electronic Engineers
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code
 - 8. National Electrical Contractor's Association
 - 9. National Electrical Manufacturer's Association
 - 10. National Electrical Testing Association
 - 11. National Fire Protection Association
 - 12. Underwriter's Laboratories, Inc.
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the Contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the UL label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
 - 1. Outline dimensions
 - 2. Connection and support points
 - 3. Lifting and rigging requirements
 - 4. Concrete pad dimensions, capacities, and requirements
 - 5. Weight
 - 6. Specified ratings
 - 7. Materials
 - 8. Product data indicating standard model design tests and options
 - 9. Manufacturer's installation instructions

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers shall be Eaton, General Electric, Siemens, or Square D.

2.2 LIQUID-FILLED PAD-MOUNTED TRANSFORMERS

- A. The transformer shall be compartment type, self-cooled, for mounting on a concrete pad and shall comply with the latest applicable standards.
- B. The average temperature rise of the windings, measured by the resistance method, shall be 65 degrees C when the transformer is operated at rated kVA output in a 40 degrees C ambient environment. The transformer shall be capable of being operated at rated load in a 30 degrees C average, 40 degrees C maximum ambient, as defined by ANSI C57.12.00 without loss of service life expectancy.
- C. Coolant and insulating fluid shall be a bio-degradable oil; Enviro-temp or equal.
- D. The high and low voltage compartments shall be located side by side, separated by a steel barrier. When facing the transformer terminal compartment, the low voltage compartment shall be on the right. Terminal compartments shall be full height, air-filled, with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened.
- E. The following accessories shall be provided as standard on all transformers:
 - 1. Nameplate in low voltage compartment, 1" upper filter press and filling plug, 1" drain plug.
 - 2. Drain plug provided on units up to and including 500kVA.
 - 3. Lightning arrester mounting provisions in live front units only.
 - 4. Tap changer, for de-energized operation only, which is externally operable and padlockable. The front of both compartments shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in both compartments.
- F. The transformer shall be rated as indicated on the plans. Primary voltage: 4160V delta. Secondary voltage: 480Y/277V 3PH 4W, 60Hz with (2) 2 ½% full capacity above normal taps and (2) 2 ½% full capacity below normal taps. Impedance shall be 5.75% or manufacturer's standard impedance, +7 ½%. Basic impulse level of the primary winding shall be 95kV as specified in ANSI C57.12.00 for comparable kV class.

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Secondary voltage: 208Y/120V 3PH 4W, 60Hz with (2) 2 ½% full capacity above normal taps and (2) 2 ½% full capacity below normal taps. Impedance shall be 5.75% or manufacturer's standard impedance, +7 ½%. Basic impulse level of the primary winding shall be 95kV as specified in ANSI C57.12.00 for comparable kV class.

- G. The transformer shall be of sealed-tank construction or sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the fastenings tamper-resistant. The transformer shall remain effectively sealed for a top oil temperature range of 5 degrees C to 105 degrees C. When required, cooling panels will be provided on the back and sides of the tank. Lifting eyes and packing pads will be provided.
- H. Coils shall be wound with copper conductors.
- I. Core and coil assembly shall be the five-legged wound core-type, using high grade, grain-oriented silicon steel laminations carefully annealed after fabrication to restore high magnetic permeability. Magnetic flux is to be kept well below the saturation point.
- J. Transformers connected wye-wye shall be built with five-legged core-type design to avoid the tank heating problems sometimes associated with wye-wye connections.
- K. Transformers 10kVA and larger shall comply with the latest NEMA TP-1 energy efficiency requirements as mandated by California Administrative Code Title 24 and 24.
- L. The high voltage terminations and equipment shall be dead front and conform to ANSI C57.12.26.
- M. Live front bushings shall be porcelain. Bushings shall be externally clamped and front removable.
- N. Dead front bushings shall be either universal wells or one-piece integrated for use with separable connectors. Bushings shall be externally clamped and front removable.
- O. The low voltage bushings shall be molded epoxy, and provided with blade-type space terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing, grounded to the tank by a removable ground strap.
- P. Provide a load break, gang operated, liquid immersed switch that is externally operable from the high voltage compartment through the use of a distribution hot-stick.
- Q. Switch to be 2-position "OFF-ON" type for use on a radial feed-system.
- R. Liquid-immersed switch shall be rated at 600A.
- S. Provide Bay-O-Net oil immersed current limiting fuses that are externally replaceable with a hot-stick without opening the transformer tank.
- T. Surge Protection: provide three 9kV distribution class lightning arresters for surge protection. Arresters shall be mounted in the high voltage compartment.
- U. Accessories
 - 1. Dial type thermometer
 - 2. Magnetic liquid-level gauge
- V. Tests shall be conducted in accordance with the provisions of ANSI C57.12.90 and shall include, as a minimum, the following tests:

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1. Turns ratio
2. Polarity
3. Phase rotation
4. No-load loss
5. Excitation current
6. Impedance voltage
7. Load loss
8. Applied potential
9. Induced potential
10. QA Impulse Test

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that concrete pads are ready to receive work.
- B. Verify field measurements.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Commencement of the installation process shall indicate that the Contractor has accepted the existing conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with Seismic Design Category D requirements.
- C. Install safety labels per NEMA 260.

3.3 FIELD QUALITY CONTROL

- A. Test dielectric liquid to ASTM D877, using 25,000 volts minimum breakdown voltage, after installation and before energization from system.
- B. Test transformer to ANSI/IEEE C57.12.90.
- C. Test transformer to ANSI/IEEE C57.12.I91.

3.4 ADJUSTING

- A. Adjust primary taps so that secondary voltage is within 2% of rated voltage.

END OF SECTION 26 12 00

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

1.2 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement including all amendments, modifications, and supplements of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. Local Code Enforcement Agency Requirements
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Contractor's Association (NECA)
 - 9. National Electrical Manufacturer's Association (NEMA)
 - 10. National Electrical Testing Association (NETA)
 - 11. National Fire Protection Association (NFPA)
 - 12. Underwriter's Laboratories, Inc.(UL)
 - 13. International Building Code (IBC)
 - 14. California Electrical Code (CEC 2016)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, and College Representative by the Contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the contractor.

1.3 SUBMITTALS

- A. Submit shop drawings per Section 26 05 00 for review including the following:
1. Switchboards
 2. Overcurrent protection
 3. Instrumentation
 4. Dimensions, weights, ratings, and layouts
 5. Device settings and trip ratings

PART 2 - PRODUCTS

- 2.1 Switchboards shall be factory assembled, dead-front, metal enclosed, self-supporting floor standing sections as noted in the construction documents.
- 2.2 Vertical sections shall contain overcurrent protective devices including circuit breakers and fuses and shall be nominally 90" in height.
- 2.3 Switchboard finish shall be baked enamel factory paint of manufacturer's standard color.
- 2.4 Provide front accessibility for wireways on each side of overcurrent protective devices for entire height of section. Provide welded steel framework with screw covers removable from the front; covers may be hinged.
- 2.5 All bussing shall be silver-coated copper (maximum 1000A/square inch current density) with ratings as indicated in the construction documents.
- 2.6 Switchboard, bussing, and devices shall be fully-rated for the available short circuit current as determined by the Contractor's short circuit study (see 2.16 below), inclusive of all motor contribution and utility contribution. The minimum AIC ratings of the equipment may exceed those indicated on the construction documents, due to the results of the Contractor's short circuit study. The Contractor shall include all study costs and resultant equipment costs during bidding. The Contractor may provide series-rated equipment, fully compliant with all NEC requirements and the short circuit study, but shall not provide series-rated equipment without explicit written permission from the Engineer.
- 2.7 Switchboards shall be equipped with lifting eyes.
- 2.8 Switchboards shall be suitable for the environment in which they are located and shall be NEMA 1, indoor, and rated for Seismic Design Category D, unless noted otherwise on the construction documents.
- 2.9 Main circuit breakers shall be provided and shall be insulated case solid-state (LSIG) trip type with ratings as noted. Main breakers shall be 100% rated devices.
- 2.10 Main circuit breaker shall be individually mounted, unless noted otherwise.
- 2.11 Main circuit breaker shall have maximum closing time of five (5) cycles, three (3) cycles upon opening.
- 2.12 Main circuit breaker shall have field-replaceable trip plugs.
- 2.13 Distribution circuit breakers shall be molded case type. All circuit breakers shall be bolt-on type. Provide lugs sized for termination of the conductors indicated on the Construction Documents.

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- 2.14 All circuit breakers sized 1200A and larger shall feature an arc energy reduction system in compliance with Article 240.87 of the latest adopted version of the CEC.
- 2.15 Cross bussing shall be fully rated (maximum 1000A/square inch current density) for the length of the switchboard.
- 2.16 Instrumentation shall be provided where noted. Utility company metering shall be provided in accordance with the serving utility company requirements.
- 2.17 The Contractor shall contract a California Registered Professional Electrical Engineer to furnish and submit a coordination/short circuit study and ARC Flash Study (using SKM "Power Tools" software or equal) for the entire system provided including long time, short time, instantaneous, and ground fault settings.
- 2.18 Provide mechanically-fastened "bakelite" labels indicating the identification of each device on the switchboard adjacent to the device and visible on the enclosure exterior.
- 2.19 Provide a ground bus in each switchboard section with connecting ground bonds between sections. Ground bus shall be rated at 30% of the incoming capacity.
- 2.20 Rodent-proof ventilation as required to maintain allowable temperature rise at rated capacity.
- 2.21 Acceptable manufacturers shall be General Electric, Siemens, Eaton, or Square D.

PART 3 - EXECUTION

- 3.1 Installation method of switchboards shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.
- 3.2 Install all switchboards in accordance with the manufacturer's recommendations and requirements.
- 3.3 Coordinate switchboard size with concrete housekeeping pads.
- 3.4 Check all connections, phase rotation, ground resistance and insulation resistance levels.
- 3.5 Ground fault protective devices shall be tested by an approved third party testing agency and a written report submitted with the operation manual for review.
- 3.6 Test all switchboards and overcurrent protection devices for voltage level, continuity, ground fault, and short circuits.
- 3.7 Install all switchboards plumb and square to structure and adjacent surfaces.
- 3.8 Connect and inspect all ground bonds prior to energizing switchboard.
- 3.9 Demonstrate the proper operation of all ground fault protective devices.
- 3.10 Clean all switchboard interiors and exteriors to be free of dirt, dust and debris prior to handing over to College. Touch up scratched paint and finishes as necessary.
- 3.11 Adjust and set all devices for proper operation. Set all protective devices as per the written report recommendations.

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3.12 Install Arc Flash labeling on switchboards and panelboards per NFPA 70E.

END OF SECTION 26 24 13