

ITEM 29

ELECTRICAL WORK

1.0 DESCRIPTION. All labor, materials, permits, fixtures, equipment, tools and services required for the installation, testing and adjusting of all electrical work required on this Project shall be furnished and placed in compliance with the following specifications and the Contract Drawings. Bidders tendering proposals shall have examined the site(s) and satisfied themselves as to the conditions under which the Contract is to be executed. No allowance will be made subsequently for errors or omissions on the part of the Bidder in this regard.

2.0 SUBMITTALS. The Contractor shall provide the following submittals as part of this contract:

A. Reference Standards. Latest revisions:

1. National Electric Code (NEC).
2. Underwriters Laboratories (UL).
3. NFPA (National Fire Protection Association) 70E.
4. General OSHA safety including but not limited to Title 29 Code of Federal Regulations (CFR) 1910.147 - Lockout/Tagout.
5. The current regulations and specifications of all Federal, State, County, City, and local codes, ordinances and regulations; the National Bureau of Standards Handbook H30 shall apply to all equipment and construction, as applicable, insofar as they do not lower the requirements set forth.
6. The entire installation when completed shall conform to all rules and regulations of the local Board of Fire Underwriters and State and local authorities having jurisdiction.
7. Local telephone utility standards in effect on the bidding date shall apply to all equipment and construction related thereto.
8. Reference to SCMSD refers to Stark County Metropolitan Sewer District (Sanitary Engineer).
9. Reference to the Contractor under this item/specification may refer to a subcontractor performing electrical work. In either case, contractual obligations to the SCMSD are equivalent.

B. Shop Drawings.

1. Shop drawings shall include but not be limited to, the proposed panels/cabinets, variable speed drives, meters, controllers, sensors, surge suppressors (TVSS), conduit, wire and cable, fuses, disconnect switches, wiring devices, telemetry equipment, meters, transmitters, transformers, lighting fixtures, power company service prints, transfer switches, generator receptacle cabinets, generator cable support grips, and motor receptacles and plugs, dongles, circuitry, wiring, wiring

diagrams, conduit, and all other ancillary components and indicate all principal dimensions utilizing the listed materials of all equipment, outputs, set points, transmission frequency, ranges and accuracy pertaining to all electrical panels provided under this project in accordance with all contract drawings and specifications.

2. Shop drawings shall include all manufacturers illustrated catalog data and parts schedule in sufficient detail to serve as a guide in assembly and disassembly of all components to include ordering of repair parts as specified under this item.
3. The attention of the Electrical Contractor performing the electrical work on the Project is directed to the provision in the General Conditions of the Contract requiring the submission, to the Engineer, of shop and setting drawings.
4. On all electrical work, such submission shall include shop drawings on all electrical equipment assembled off the site, and descriptive catalog cuts on all equipment, fixtures, or appliances included on the Project even though items proposed to be furnished conform to the exact description named in the General or Project Specifications or named in the Schedules on the Contract Drawings.
5. All literature submitted shall be identified as to the project specific application of the equipment described. If the literature describes multiple models and/or options, the information not pertaining to this specific project and/or project specific application shall be neatly and clearly lined out.
6. All shop drawings shall be reviewed and approved by the Electrical Contractor performing the Electrical Work before the drawings are submitted to the Engineer for review.
7. Electronic copies of catalog cuts showing size, model, color selections, etc. shall be submitted for review. Internet/web-site printouts are not acceptable for shop and approval Drawings.
8. Electrical Contractor and/or the supplier shall be responsible for all devices and components omitted and/or installed incorrectly. Submittals shall include, but not be limited to conduit, wire and cable, fuses, disconnect switches, wiring devices, telemetry equipment, transformers, lighting fixtures, power company service prints, transfer switch, generator receptacle cabinets, generator cable support grips, and motor receptacles and plugs.
9. The drawings shall include complete and exact location of all conduit runs underground or in concrete slabs, in buildings and structures; location of all equipment and mounting details of same; detailed wiring and connections diagrams; operating characteristics of circuit breakers and relays; specifications for wire and cable, % impedance, % regulation, and maximum sound level in decibels as measured per ANSI C89.2-1974, and no load loss of all transformers.
10. The Engineer's review of drawings and specifications shall extend only to determine the conformity of such equipment and materials with the general features of the Contract Drawings and Contract Specifications prepared by the Engineer.
11. It shall be the responsibility of the Electrical Contractor to determine the correctness of all dimensions and minor details of equipment and materials so that they will fit into the completed work and so that, when incorporated into

the completed work, all codes are satisfied and correct operation will result. Review of shop drawings shall not be considered as a guarantee of measurements or of building conditions.

12. Where drawings are reviewed, said review does not mean that drawings have been checked in detail; said review does not, in any way, relieve the EC from his responsibility for furnishing material and performing work as required by the contract drawings and specifications. Engineer takes no responsibility, financial or otherwise, for accuracy of reviewed shop drawings or for the performance of the products reviewed.
 - a. The Contractor shall provide electrical line/wiring diagrams for all panels, which shall be included with the panel when field installed, prior to the actual field installation of said panel, for final review and approval to assure the panel meets all shop drawing approvals. No components shall be added or removed to the panel as approved on the original shop drawing without engineering approval.
 - b. The Contractor shall be required to contact the building department and electrical power utility to obtain all permits and work orders necessary to install, de-energize and energize all electrical service power all equipment. In the event the regulating authority and/or power utility requires the owner (SCMSD) to make said requests, the Contractor shall be responsible to coordinate when SCMSD needs to request said work. The Contractor shall be responsible for any delays in obtaining permits or de-energizing, energizing any power due to their failure to notify and coordinate with SCMSD. No additional payment will be provided.
13. The Contractor shall provide an electronic copy of all materials listed herein for shop drawing approval. All submittals shall be via email.
14. Shop drawings shall show relationship of all components, connections, mounting arrangements and support items.
15. Shop drawings shall be complete in all details and shall include identified parts lists.
16. After examination of such drawings by the Engineer and the return thereof, the Contractor shall make such correction to the drawings as have been indicated and shall furnish the Engineer with electronic corrections.

C. Calculations. The Electrical Contractor shall provide sufficiently durable labeling per NEC 110.24, legibly marking the maximum available fault current and date of calculation. NFPA 70E requires labeling on all electrical distribution equipment/panels.

D. Certifications.

1. The Contractor shall secure and pay for electrical permits and inspection fees. After completion of work, the Contractor shall secure at his expense, a certificate of final inspection and approval from the inspection department(s) that have jurisdiction.

E. Schedule: The Manufacture shall provide a schedule of the proposed production and delivery of the panels and all componentry. Said schedule shall include:

1. Shop drawing submittal dates.
2. Electrical equipment and panel order date.
3. Electrical equipment and panel manufacture date.
4. Electrical equipment and panel shipment date.
5. Electrical equipment and panel estimated arrival date

3.0 MATERIALS. All materials shall comply with the following:

A. General. It shall be noted that electrical work, material and equipment indicated on the Contract Drawings and not mentioned in the Specifications shall not be construed as a discrepancy between Specifications and Contract Documents, and shall be furnished and installed as indicated.

1. It is the intention of the Project Specifications and of the Contract Drawings for the electrical work that each part will be complete as related to other parts, and that there will be no omission from any portion of the system or systems, including the connection to the Electric Utility serving the Project, even though each and every minor item may not be specifically mentioned in the Specifications nor shown on the Contract Drawings. The systems shall be complete with all necessary accessories for proper operation. Transformers, disconnecting devices, protective devices, and all other equipment shall be properly coordinated to secure the required results.
2. All incidental items necessary for complete operating systems, and/or required by any applicable code, shall be included in the bid. This includes but is not limited to reworking the existing telemetry systems.
3. Wiring information and diagrams for all miscellaneous electrical systems are typical only.

B. Conduit.

1. Unless directed otherwise on the plans or approved by the Engineer, all conduit:
 - a. Above grade shall be rigid galvanized steel (RGS, RGC) with threaded couplings.
 - b. Below grade proximal to structures and panels shall be rigid galvanized steel (RGS, RGC) with threaded couplings.
 - c. Below grade shall be Schedule 80 PVC.
2. Intermediate Metal Conduit (IMC) conduit will not be accepted as RGS or a substitute for RGS. Electrical Metallic Tubing (EMT) shall only be permitted where specifically called for on the Drawings. All threads on steel conduit shall be standard tapered threads; each conduit length shall be standard 10-ft. length with coupling. All threads shall be coated with a lubricant as recommended by the conduit manufacturer.
3. Where rigid conduits are to be encased in mortar or concrete they shall be PVC coated RGS with a standard 40-mil thickness of PVC factory applied. Particular

care shall be taken to secure tight joints, thoroughly grounded, and secure without any obstructions in the conduits.

4. Where conduits are stubbed up in the floor they shall be PVC, coated six (6) inches minimum above the floor to protect the conduits at slab level. All PVC coated RGS conduits shall be touch-up spray painted after bending threading and installation to the outlet box or fitting with spray PVC coating to the original factory thickness per conduit manufacturer's recommendations. PVC coated RGS conduit shall be installed by persons trained and certified by the conduit manufacturer's authorized training personnel. All fittings and hangars, tools and methods used in installation of this type of conduit shall be as recommended by the conduit manufacturer.
5. All conduits run concealed or concrete encased shall be one (1) inch minimum size, and the minimum size for any purpose shall be 3/4" conduit.
6. Where conduit runs are in poured concrete structures containing expansion joints, approved expansion/deflection joints shall be provided in the conduit. All such expansion joints shall be made watertight. Similar expansion joints shall be installed whenever conduit crosses structural expansion joints is attached to two separate structures or wherever the conduit run is more than 100-ft. in straight length. All expansion joints shall be complete with bonding jumpers.
7. For exposed work conduit one and one-half (1-1/2") inch and less shall be supported at 10'-0" centers or less. Clamps or brackets shall be secured to brick, masonry or concrete walls by means of expansion bolts. "Shot-in-place" anchors and fasteners will not be acceptable. Exposed conduit shall be installed one quarter (1/4") inch minimum distance from concrete or brick surfaces. All steel supports, hangers or framework, nuts, bolts, etc., shall be stainless steel and included under this contract. All unistruts and mounting hardware shall be stainless steel.
8. At all locations where conduit enters structures below ground, such entries shall be through sleeves and both sleeves and conduit shall be watertight unless noted otherwise on the plans. The penetrating pipe shall be sealed with adjustable interlocking rubber links as manufactured by "Link-Seal" or equal.
9. Provide conduit insulating bushings with ground lugs on all conduits terminating in or under, control cabinets, wireways, and ground to the components system ground. Insulating bushings shall be provided at all other locations as required by the N.E.C. Conductors installed in vertical raceways shall be adequately supported with approved conductor supports, at the intervals stipulated by the N.E.C., conductors shall be supported at points of termination independent of panel lugs.
10. All connections to motors, transformers, control-sensing devices, electrically operated valves, transmitters and adjustable equipment shall be made with liquid tight flexible metallic conduit and appropriate fittings.

C. Conduit Fittings.

1. All conduit fittings and pull boxes except as noted on the contract drawings shall be of the cast copper-free aluminum (0.4% max. copper content) threaded hub type (five full threads).
2. All fittings and boxes shall have cork neoprene gaskets and non-magnetic stainless-steel screws. All connections of concealed conduits to boxes or fittings shall be painted with bituminous paint or sprayed with PVC coating after assembly.
3. Fittings shall be vapor proof, weatherproof, or explosion proof where indicated on the drawings or required by code.
4. In areas designated as hazardous, all fittings, material, and equipment shall be of the type approved for such installation. Seal-off fittings shall be used as required by the national and local codes and the complete installation shall be in accordance with the requirements of such codes. After installation of wire/cable, CHICO compound shall be poured in all seal-off fittings.
5. All fittings and boxes shall be equal to Adalet Manufacturing Company, Crouse Hinds, Inc. or Appleton Electric.

D. Wireway.

1. Wireway shall be NEMA 4X stainless steel and shall comply with U.L. Standards for Wireway Gutters and Associated Fittings.
2. Wireway shall be hinged on one side and have a lockable clasp on the other side for opening and closing. Removable covers secured by threaded fasteners are not acceptable.
3. If any captive screws are utilized they shall be covered to prevent contact and damage to the conductors. The hinged cover shall be hinged the full length of the wireway and lockable with a stainless-steel hasp and padlock. Wireways shall be sized as indicated on the contract drawings, complete with all required fittings, hangers, and supports.

E. Wire and Copper.

1. Unless specified otherwise, all conductors shall be soft drawn annealed copper wire of 98% conductivity, with insulation rated for 600-volt service.
2. In general, all feeder conductors shall be copper 600-volt, type RHW-2 (THWN) insulation stranded wire for service conductors. Feeder conductors shall be continuous throughout their entire length, no splices on any feeder will be allowed. All conductors of a feeder or set of parallel feeders shall be in the same raceway. Provide one (1) No. 1/0 copper cable for utility connection to ground one corner of Open Delta System.
3. Contractor shall verify exact wiring requirements with the electrical service provider and the manufacturer of all electrical equipment supplied and shall provide wiring as required for proper operation under the base bid.
4. Branch circuit conductors shall be copper 600-volt type XHHW, THHN or THWN insulation. Minimum wire size for power and lighting branch circuits shall be #12. All wire shall be the stranded type.

5. After installation of wire/cable in conduits in hazardous areas, CHICO compound shall be poured in all Seal-Off fittings.
6. Where wire size is not shown, conductor size #12 minimum shall be used for circuits less than 100-feet. All 120-volt branch circuits in excess of 100-feet shall be #10 conductor minimum.
7. Leave at least 6-inches free wire at all outlets for connection to wiring devices or control component.
8. All wire and cables shall be installed in a careful, workmanlike manner to avoid damage to conductors or insulation. Conductors shall not be drawn to raceways until all work which may cause cable damage has been completed. Mechanical means may be used to pull #4 AWG conductors or larger. Ideal Industries "Yellow 77" pulling compound shall be utilized only as necessary.
9. Conductors in vertical runs shall be adequately supported with approved conductor supports. Keep ends of cables sealed until spliced or terminated, prior to splicing and/or terminating cut-off ends of cable subjected to pulling grip. Cables must be kept clean and dry prior to splicing.
10. All wire and cable shall be delivered in full coils or reels and shall be properly tagged and well protected against injury or damage. A tag or label shall be affixed to each coil or reel indicating manufacturer, grade of insulation, sizes, and length of wire in each coil or reel. Wire 600-volt or less shall be Pirelli Anaconda, Okonite or equal.
11. All mechanical wire and cable terminations shall be torque tightened with torque wrench or torque screwdriver to manufacturers recommended torque values.
12. Splices and joints in branch circuit conductors shall be made with enough spare wire to enable two or more to be remade with the wire in the event of a fault. The Owner or resident engineer reserves the right to inspect any and all joints made in 600-volt wiring before they are taped, or if they are taped without being inspected have the tape removed for inspection. Splices shall not be made in underground duct sections.
13. All joints and splices in wire #8 and smaller shall be twisted and made mechanically strong with electrical spring pressure type connectors similar to "Scotch-Lok" of the proper size, rated 600-volt. Solderless, pressure type connectors shall be used on splices and taps in wires larger than #8 AWG. These pressure type connectors shall be ClearTap or approved equal.
14. All connectors having irregular surfaces shall be properly padded with "Scotch-Fill" insulation putty to eliminate sharp corners and voids before applying insulating tape. Tape insulation shall be applied in sufficient layers to equal the thickness and 150% insulating value of the original insulation, utilizing half-capped layers of Scotch #88 and #22 or 33+ plastic tape.
15. All shielded cable pairs shall be grounded at one (1) end only so that ground loops are NOT formed which could pick-up noise and interference by induction.
16. Joints and splices in copper wire larger than No.6 AWG shall be made with ClearTap connectors or approved equal.

17. All compression type connectors shall be installed with annular crimp type tools in accordance with connector manufacturer's recommendations.
18. All bolting hardware for connections to bus, bars, lugs, etc., shall be high strength copper silicon alloy. Each bolt shall be complete with two flat washers, one shake proof lock washer, and one hex nut, except where otherwise noted.
19. Whenever aluminum is a part of a connection, the surface shall be cleaned with an abrasive cloth or a wire brush, an oxide inhibiting and sealing compound shall be applied to the surfaces. Belleville washers shall be used for mounting to aluminum surfaces or mounting aluminum lugs.
20. All joints, splices and connections shall have half lapped layers of insulating tape applied in sufficient layers to equal the original thickness and 150% insulating value of the original insulation. Compatible insulating covers may be used with bolt type connectors in lieu of insulating tape.
21. Color code wire and cable to differentiate both the different voltage systems, and the phase, neutral and ground conductors of the two systems. Provide a submittal to Engineer for review. If during load balancing, a load is shifted from one phase to another in a color-coded system, the Electrical Contractor shall paint or tape the ends of the wire at all accessible points, with the proper color code for the phase.
22. Special conductors and requirements for analog and digital signal conductors required for the telemetering system shall be defined and specified under the appropriate paragraphs for the telemetering/communication equipment.

F. Wiring Devices and Connections.

1. Local branch switches shall be of the toggle type, specification grade, complying with Fed. spec WS896, CSA and U.L. test UL20 – 20-amp, 277-volt A.C. suitable for full rating on fluorescent and incandescent loads.
2. Switches shall be Hubbell 1223 Series unless otherwise noted.
3. GFI receptacles shall be 3-wire grounding type with self-grounding feature specification grade, complying with Fed. spec and UL test, 20-amp 120-volt, Hubbell No. GF-5362 with waterproof box and No. WPFS26 cover plate.
4. Generator and hinged panel GFI receptacles shall be 120 VAC, 20-amp. Rated with 5 mA trip. Each unit shall be installed in a waterproof box with waterproof in-use cover plate, Hubbell WP26M or approved equal.
5. Contractor shall verify the accuracy of all wiring information riser diagrams by comparing them to the plan views and manufacturer's shop drawings, and include all wiring and devices shown and/or required.

G. Fuses.

1. Fuses shall not be installed until equipment is ready to be energized. All fuses shall be of the same manufacturer to assure selective coordination.
2. The Electrical Contractor shall furnish and install complete set of fuses for all fusible equipment on the job. Unless otherwise noted all fuses shall be U.L. listed, current limiting and have an interrupting rating of 200,000 RMS amperes symmetrical.

3. Fuses rated 600-amp or less shall be time-delay current-limiting U.L. class RK1, unless otherwise noted.
4. Spare fuses amounting to 20% (minimum three) of each type and rating shall be supplied by the Electrical Contractor for each station. Fuses shall be contained and catalogued when delivered to the County.

H. Disconnect Switches.

1. The Contractor shall clean/refurbish and reuse all existing disconnect switches as shown on all Bid plans.
2. Disconnect switches, unfused or fused, single throw, shall be installed where shown on the Drawings and/or where required by Code.
3. Each switch shall have a ground lug, be pad lockable in the Off position, and have a solid neutral bar where specified. Fusible switches shall have Class RK1/5 rejection type fuse clips. Switches shall be heavy duty for indoors or outdoors as required and manufactured by Square D, General Electric, ITE or Cutler-Hammer.
4. Manual transfer switch for transferring from the normal power source to the portable auxiliary power source shall be heavy-duty double throw switch rated 150-amp (or as specified on the drawings or Item 33), 240-volt, single phase.
5. The switch shall be non-fused, load break rated with a ground lug, solid neutral and be pad lockable in all positions. Enclosure shall be rated NEMA 4X stainless steel and be as manufactured by Square-D or Cutler-Hammer. Transfer switch shall include a portable generator receptacle as shown on the drawings.
6. Disconnect switches indicated as NEMA 4x shall be stainless steel.

I. Dry Type Transformers.

1. Furnish dry type transformers of the ratings shown on the drawings.
2. Transformer insulation shall be temperature classified and listed by Underwriters Laboratories. Temperature rise shall be 150° C. rise over a 40° C. ambient plus a 30° C. hot spot for a temperature classification of 220° C. Transformers shall be capable of operating at 100% of nameplate rating continuously in a 40° C ambient temperature.
3. Taps in the high voltage winding shall be as follows:
 - a. Up to 2 KVA: No taps
 - b. 3 through 25 KVA: (4) 2-1/2% taps, 2 above and 2 below normal voltage
 - c. 25 through 500 KVA: (6) 2-1/2% taps, 2 above and 4 below normal voltage.
4. Winding temperature rise shall be as follows:
 - a. 5 to 25 KVA: 115° C
 - b. 30 to 1000 KVA: 150° C
5. Sound rating shall be as follows:
 - a. Up to 9 KVA: 50 dB
 - b. 10 to 50 KVA: 50 dB
 - c. 75 to 150 KVA: 60 dB
 - d. 167 to 300 KVA: 60 dB
 - e. 500 KVA: 60 dB

6. Transformers 15 KVA and larger shall be in a stainless-steel ventilated enclosure. Single-phase transformers through 167 KVA and three-phase transformers through 112.5 KVA shall be designed for either wall or floor mounting.
7. Transformer enclosures shall be in compliance with U.L. Specification #506.
8. Transformers shall be provided with wall brackets for mounting in control enclosure where indicated.
9. Primary and secondary feeds shall be piped to approximately 3 feet with rigid conduit. Final connection to transformer shall be made with seal tite flexible conduit with ground wire bonding.

J. Grounding.

1. All electrical equipment shall be grounded per the NEC, Article 250, and all other applicable articles.
2. The grounding electrode shall consist of each of the following where applicable:
 - a. The electrode encased by at least two inches of concrete located near the bottom of a concrete foundation or footing that is in direct contact with the earth.
 - b. In addition, or if the above system for electrodes is not available, the following electrodes shall be used:
 1. Ground rods or ground grid:
 - i. Ground Rods – Copperweld Steel Company
 - ii. Connectors – Bundy, Thomas & Betts or O.Z. Thermite
 - iii. Welding – Cadweld or Thermoweld
 - iv. Copper alloy or copper-clad steel ground rods shall be not less than $\frac{3}{4}$ " in diameter by 10' long.
 - v. Bare medium soft-drawn copper ground grid conductors of the sizes shown shall be used.
3. Temporary Grounding: Install ground rods at the distribution panel and elsewhere, as required to provide adequate grounding for neutral conductor of the wiring system, metal enclosures and portable power tools. Drive additional rods until satisfactory low ground resistance is obtained. A separate ground conductor paralleling the receptacle circuits may be installed in lieu of ground rods at each point of utilization.
4. Temporary grounding shall comply with latest requirements of OSHA.
5. Permanent Grounding: Ground the following: Neutral conductor of wiring systems, all equipment enclosures, busway, receptacles, switch boxes, luminaries, cable ladder, trough or tray, conduit, motors, and other electrical devices, as required by the NEC. Provide ground jumpers around flexible conduits, as required by the NEC.
6. Ground conductors shall be bare or insulated type THW, identified by green insulation or by painting green at all accessible locations and shall be connected with approved connectors and terminators to boxes, devices, equipment, etc., and to ground bars in panels.

7. An equipment grounding conductor shall be included with all motor and circuit conductors. Size in accordance with the NEC Table 250-95, except not smaller than No. 12 AWG, for all power and lighting circuits.
8. Cord-connected appliance frames shall be grounded to the conduit system and wired grounding system, where applicable, through a green grounding conductor in the cord.
9. The system ground is the intentional grounding of the neutral to hold all exposed metal enclosures at ground potential and to limit the voltage that can be impressed upon the electrical system due to lightning or other high-voltage surges.
10. The ground system consists of:
 - a. The grounding electrode conductor shall be connected to the neutral in only two locations – on the supply side of the service disconnect means, per the NEC 250-23, and on separately derived systems, per the NEC 250-26.
 - b. Because the ground is lost through the transformer, it must be re-established by use of a grounding conductor, minimum size per the NEC Table 250-94(a), which connects the transformer secondary neutral point to the interior cold-water system and to the service entrance grounding conductor connection. The generator is not a separately derived system unless the neutral is being switched at the transfer switch.
 - c. A grounding conductor shall be installed in each non-metallic PVC conduit.
 - d. The neutral of the service entrance shall be bonded to the enclosure by a main bonding jumper, minimum size per the NEC Table 250-95. The neutral of the transformer of a separately derived system shall also be bonded by a main bonding jumper, minimum size per the NEC Table 250-95, to the transformer enclosure.
 - e. These jumpers may be omitted if the equipment is supplied with manufacturer's bond in accordance with NEMA and UL standards. The service entrance conduits shall be bonded to the switchgear structure.
11. Other than the above two exceptions, neutral connections and assemblies shall be insulated from metal enclosures.
12. The building neutral shall be identified throughout with white wire.
13. Test and prepare a listing of the measured resistance for each ground rod. If the resistance of a rod is greater than 25-ohms, increase contact area of ground rod either by adding to the length of the rod, or by driving additional rods with minimum separation of six feet between them until satisfactory resistance is obtained. Resistance of the ground system to earth shall not exceed 25-ohms. Final resistance tests of each rod and system shall be submitted to the Engineer and witnessed at his option.

K. Lightning Arresters.

1. The Transient Voltage Surge Suppressors (TVSS) shall be provided as shown on the one-line diagrams in the contract drawings.

2. The TVSSs shall be listed per UL 1449, 2nd Edition, for use on 3-phase, 480Y/277 VAC MDP and for use on 1-phase 240/120 VAC secondary, and have a peak surge current per phase rating of 160,000 amperes.
3. Each TVSS shall have the following ANSI/IEEE C62.41-1991 measured limiting (let-through) voltage ratings:

3-phase TVSS	B3/C1 Impulse Wave 6000-volt, 3,000-amp	C3 Impulse Wave 20,000-volt, 10,000-amp
	<u>90° Phase Angle</u>	<u>90° Phase Angle</u>
L-N	1060	1840
L-L	960	1650
L-G	1060	1840
N-G	960	1650
1-phase TVSS	B3/C1 Impulse Wave 6000-volt, 3,000-amp	C3 Impulse Wave 20,000-volt, 10,000-amp
	<u>90° Phase Angle</u>	<u>90° Phase Angle</u>
L-N	580	1210
L-L	530	1130
L-G	580	1210
N-G	530	1130

The TVSSs shall have a 20-year warranty and be Innovative Technology, Inc Part No. PTX160-3Y201-SS for 3-phase and Part No. PTX160-1S101-SS for 1-phase, or approved equal. Modular types will not be accepted.

4.0 EXECUTION. All installations shall be in accordance with all governing authority/permits, codes and contract specifications and drawings.

A. Coordination with Other Trades.

1. Contractor shall be responsible to coordinate with all regulating authorities and utility services as indicated above.
2. Consult the plans covering the work for the various other trades, the field layouts of the Contractors for the trades and their shop drawings, govern accordingly in laying out work and as indicated above.
 - a. SCSE Specification Item 29. Only the work as indicated under Item section 29.07 Measurement and Payment shall be performed and paid for under this Item for electrical work.
 - b. SCSE Specification Item 36. All labor, materials and equipment required to provide all other electrical work necessary to remove the existing control panels and install the new panels, controls, support rack, conduit and all

accessories as described under Item 36 shall be performed and paid for in accordance with this specification and paid for under Item 36

B. Protection of Equipment and Material.

1. The Electrical Contractor shall protect all electrical work, fixtures, equipment and materials from damage at all times during construction and until final acceptance of the completed project by the Owner.
2. Conduits shall be plugged or capped until ready for pulling wires and making connections. Fixtures and equipment shall be properly covered and protected against dirt, debris, water chemicals or mechanical injury.
3. The Electrical Contractor shall retouch, or when directed by the Engineer, refinish or replace damaged equipment prior to final acceptance of the project by the Owner, without any additional cost to the Owner.
4. All equipment and material shall be new and shall bear the manufacturer's name and trade name. The equipment and material shall be the standard product of a manufacturer regularly engaged in the production of the required type of equipment and shall be the manufacturer's latest approved design.
5. The Electrical Contractor shall receive and properly store the equipment and material pertaining to the electrical work. The equipment shall be tightly covered and protected against dirt, water, chemical or mechanical injury, and theft. The manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of all equipment and materials.
6. The Electrical Contractor shall provide and install all items necessary for the complete installation of the equipment as recommended or as required by the manufacturer of the equipment or required by local code without additional cost to the Owner, regardless of whether the items are shown on the plans or covered in the specifications.
7. It shall be the responsibility of the Electrical Contractor to clean the electrical equipment, make the necessary adjustments and place the equipment into operation before turning equipment over to the Owner. Any items that are damaged during construction shall be replaced.

C. Equipment Identification.

1. The Contractor shall provide the following equipment identification.
2. Provide name plates on all equipment of the type listed in the following schedule.
 - a. Telemetering Equipment.
 - b. Fusible and Non-fusible Disconnect Switches, Main and Branch.
 - c. Control Panels.
 - d. Control Devices.
 - e. Junction and Pull Boxes.
 - f. Transfer Switches.
 - g. Lighting Transformers and Circuit Breaker Panels.
 - h. Fuse holders (fuse sizes).
 - i. Conduits (what wire and cable feeds).

- j. Conduits labeling at points entering and exiting below grade.
- 3. Lettering shall include name of equipment, voltage rating and service designation. Label all boxes and enclosures as to the highest voltage present.
- 4. Name plates shall be laminated phenolic with a white surface and black core. Use 1/16" thick material for plates up to 2" by 4". For larger sizes use 1/8" thick material.
- 5. Lettering shall be Condensed Gothic. The space between lines shall be equal to the width of the letters. Use 1/4" minimum height letters which occupy four to the inch. Increase letter size to 3/4" on largest plates.

D. Cutting and Patching.

- 1. Cutting into the work of others by using sleeves, inserts, chases and similar items necessary for the installation is only acceptable when plans specify or such work is directed by the SCMSD.

E. Painting.

- 1. Any non-stainless-steel work erected for the support of electrical equipment shall be painted with one coat of iron oxide black paint, after cutting, drilling or welding.

F. Cleaning and Finishing.

- 1. After all tests have been completed, clean all equipment leaving everything in working order at the completion of this work.
- 2. All debris created by the execution of this work shall not be allowed to accumulate in or about the project area but shall be properly removed from time to time or as directed by the Engineer.

G. Incoming Electrical Service.

- 1. New, incoming electrical service shall be provided where indicated on the plans. The new incoming services shall have underground secondary conductors run in direct-buried, Schedule 80 PVC conduits.
- 2. The Electrical Contractor shall verify with the electric utility owner on the responsibilities required to be completed by the utility owner.
- 3. The responsibilities of the Electrical Contractor include, but are not limited to, the following:
 - a. Provide and install the secondary service conduits and conductors from the new or existing Electric Utility Company transformer to the meter socket.
 - b. Provide and install or clean and refurbish the main service disconnect switch.
 - c. Provide and install the meter socket/meter base/meter box. Provide and install the conduit and conductors from the meter socket/base/box to the line side of the main service disconnect switch.
 - d. Provide and install the secondary conductors from the load side of the main service disconnect as indicated on the Contract Drawings.

H. Excavation and Backfill.

1. Excavation and backfill for all underground electrical and communication installation shall be included in this contract, unless indicated or specified otherwise.
2. Excavation and backfill shall comply with applicable provisions under the section for Excavation and Backfill.

I. Workmanship.

1. Workmanship shall be in accordance with the best practices of the trade. Electrical work shall be installed by journeymen electricians under the supervision of a competent foreman.
2. Electrical Contractor shall take all field measurements necessary for his work and shall assume responsibility for their accuracy.
3. Work and material specifically required by State and/or local regulations, but not included in these Specifications nor shown on the Drawings, shall be furnished and installed by the Electrical Contractor at their expense.
4. Should any structural difficulties prevent the installation of the outlets, setting of cabinets or equipment, running of conduits, etc., at point shown on Drawings, the necessary minor deviations therefrom, as determined by the Engineer will be required at no additional cost.

6.0 QUALITY ASSURANCE. In addition to the requirements set forth herein, all material and workmanship shall conform to industry standards of safety and quality assurance in all phases of the work.

A. Testing.

1. The Electrical Contractor shall conduct such tests and adjustments of electrical equipment as required by the Engineer or necessary to verify performance requirements. Submit data taken during such tests to the Engineer.
2. The Electrical Contractor shall pay all engineering fees involved in required testing of equipment.
3. All tests shall be made before any circuit or main switch is electrically energized. Circuits shall be phased out and connected to the panel or main switch in proper manner. Loads shall be distributed as evenly as possible on all phases. All wires shall be entirely free from grounds and short circuits. All lighting panelboards shall have loads distributed between the various phases so that maximum variation in current readings of the different phases shall not exceed 5% when the entire load is in operation.
4. After completion of the work, the entire electrical system, both power and lighting, shall be thoroughly tested for their proper functioning. The testing of all electrical equipment and circuits shall be scheduled and performed to the satisfaction of the Engineer, and a record of all test results shall be supplied in triplicate and submitted to the Engineer prior to request for final payment.

Copies of the test results shall be included in the applicable section of the operating manuals.

5. All power and control wiring, including spares shall be given a continuity test and insulation resistance test.
6. The continuity test shall be made with a buzzer or lamp to assure proper splicing and identity of circuits. Resistance tests on the grounding system shall be done by using reference electrodes or by the fall-of-potential method.
7. The insulation resistance of all feeders on the secondary distribution system shall be measured and tabulated by the Electrical Contractor. The tabulation shall indicate the values of resistance between conductors, and between conductors and ground. The insulation resistance test shall be made with a 1000-volt meter used for one minute between all conductors and between all conductors and ground. The acceptable insulation resistance shall not be less than 1 MEG OHM per 1000-volts of service volts.
8. The following information shall be obtained and recorded:
 - a. Measure and tabulate the line voltage of each phase at the load terminals of the main switches or circuit breakers in each building.
 - b. Measure and tabulate the line current of each phase of each integral horsepower motor under load.
 - c. Energize and put into operation each and every electrical circuit and item of equipment requiring electrical connections.
9. The telemetry system, after the Contractor relocates and reworks the existing equipment including any necessary new conduit and wiring, shall be inspected and tested by a qualified field representative of the equipment vendor.
10. A report summarizing all of the above tests and tabulations shall be submitted to the Engineer indicating results of all final checkouts and tests.
Final payment will not be approved until such report is submitted.

B. Observation.

1. The SCMSD designated representative will visually observe the work performed. The representative will notify the Engineer of any discrepancies with the contract documents in the course of the Contractor performing the work. The progress observations by the SCMSD do not waive any rights or remedies, nor divest the Contractor of any responsibility for contract compliance or liability for damage.
2. All work involving relocating, disconnecting and reconnecting equipment, or otherwise requiring interruption of service, shall be accomplished at such times as directed by authorized representatives of the utility Owner. Such interruptions shall be as few and of short duration as possible and shall be at such times as to cause the minimum of interference with normal operation of the connected facilities.

C. Warranty. The Electrical Contractor shall provide the following guarantees on his workmanship and materials.

1. Standard Warranty. The Contractor shall provide a one (1) warranty on all

materials and workmanship for a period of one (1) year from the date of final acceptance of all work.

- a. Should any defects develop within the guarantee period, the Electrical Contractor shall, upon notice of same, remedy the defects and have all damages to other work or furnishings caused by the defects or the work of correcting same, repaired and/or replaced at his expense, to the condition before such damage. The date of final acceptance is defined as the date of signature of the Engineer on the final payment of this Contract.
 - b. Defects or failures shall be reported to the Contractor who will communicate with the Engineer within one week of the notification to prepare a repair schedule.
 - c. The Contractor shall make all repairs within the warranty period at no cost to SCMSD.
 - d. All repairs or replacement of the electrical system or its componentry shall be in accordance with these specifications and as determined by the *SCMSD* Engineer.
 - e. This GUARANTEE shall be supplied in writing and shall be attached to the Electrical Contractor's request for final payment.
2. Extended Maintenance Bond. In addition to all manufacturer and equipment warranties the Contractor shall provide a two (2) year maintenance bond on the entire system equal to the amount of the Contract.
 3. Field Quality Control. This section includes but is not limited to all electrical work and componentry utilized in the completion of this project.
 - a. All panels, electrical componentry and operations shall be as free as commercially practicable from visual defects and operate as intended by the plans and specifications.
 - b. During the one (1) year guarantee period, any defects that are discovered that will affect the integrity of the electrical system or its componentry shall be repaired at the Contractor's expense in a manner mutually agreed upon by the Engineer and the Contractor.
 - c. The Contractor shall provide/extend the warranty for a period of one (1) year on all repairs from the date of repair.

D. Close-out Submittals.

1. When the installation is complete, the Contractor shall furnish complete operation information including all manufacturer's service manuals, and competent instructions to the Owner's representative, for the operation of the entire installation to include the as-built control panel wiring diagram.
2. Note; as indicated above all control panel wiring diagrams are to be submitted to SCMSD with the shop drawings for approval and no deviations from the approved shop drawings will be accepted unless approved by SCMSD.
3. O & M Service manuals shall be assembled into one book, which shall include the following:
 - a. Provide written instructions for each system listed in the specifications.
 - b. Submit one copy to the Engineer for approval.

- c. After approval, submit two (2) hard copies and two (2) electronic copies on USB drives, as indicated below to the Engineer for delivery to the Owner.
- d. Bind the written operating instructions, shop drawings, equipment catalog cuts and manufacturer's instructions into a hard-backed binder where they can be accommodated into 8-1/2" x 11" size. Material to be assembled as follows:
 - i. First Page – Title of Job, Flow Site name and location, Owner, Address, Date of Submittal, Name of Electrical Contractor and Name of Engineer.
 - ii. Second Page – Index
 - iii. Third Page – Introduction to First Section containing a complete written description of the system.
 - iv. First Section – Written description of system contents, where actually located in building, how each part functions individually, and how system works as a whole. Conclude with a list of items requiring service and either state the service needed or refer to the manufacturer's data in the binder that describes the proper service.
 - v. Second Section -- A copy of each Shop Drawing with an index at the beginning of the section.
 - vi. Third Section -- A copy of each manufacturer's operating instructions with an index at the beginning of the section.
 - vii. Fourth Section -- A list of all equipment used on the job. Electrical Contractor's purchase order numbers, supplier's name and address.
 - viii. Fifth Section -- A copy of each wiring diagram utilized in the installation.
 - ix. Sixth Section -- Copies of all tests, recordings, Electrical Contractor tabulations and vendors reports, etc. A report summarizing all tests and tabulations described in these specifications shall be submitted to the Engineer indicating results of all final checks and tests.
 - x. Seventh Section -- Copies of all warranties, approvals, etc.
 - xi. Eighth Section -- Complete set of electrical contract specifications and electrical contract design drawings reduced to 1/16" = 1'-0" and the Electrical Contractor's setting and installation drawings.
 - xii. Deliver to the Owner all special tools and appurtenances for proper operation and maintenance of the equipment provided and request receipt for same and attach to the Electrical Contractor's request for final payment.

7.0 MEASUREMENT. The methodology for measuring electrical work shall be agreed upon between the Contractor and the SCMSD before work commences. A schedule of values shall be employed to accurately track progress.

8.0 PAYMENT. The price for this item shall be a lump sum price bid and shall include all material, labor, equipment, and appurtenances required to accomplish the work as specified herein:

<u>Item</u>	<u>Unit</u>	<u>Description</u>
29	LS	Electrical Work, Complete Per Plan

END OF SECTION