SECTION 260000

ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

101. GENERAL

101.1 This section covers the requirements for the engineering, design and installation of the electrical systems provided by the CONTRACTOR

PART 2 – PRODUCTS

201. GENERAL REQUIREMENTS

201.1 The electrical equipment provided by the CONTRACTOR shall be complete, including all accessories in order to provide a 100 percent functioning system. All electrical equipment and systems provided shall be supplied by industry recognized and established manufacturers. The equipment shall be technically supported by industry recognized documentation to be easy to operate, dependable in quality, of the latest n technology, and shall include features field proven to provide low auxiliary power consumption. All electrical equipment and systems shall be of proven design and not experimental or prototype, having been widely and successfully used on many power plant projects of equivalent or larger size as GGS. In addition, the equipment provided shall offer documented proof from power plants of equivalent size to GGS that it provides high reliability and low maintenance, and maximizes personnel safety.

201.2 The CONTRACTOR shall furnish all controls, instruments, and devices required for the operation of all equipment furnished by the CONTRACTOR. Such equipment shall include solenoids, flow switches, heaters, timing devices, temperature detectors, and any other required electrical devices.

201.3 Electrical components shall be designed, built and tested in accordance with applicable NEMA, ANSI and IEEE standards. IEC rated equipment will not be allowed.

201.4 All electrical equipment and devices furnished by the CONTRACTOR for separate mounting shall be checked and tested in the factory before shipment.

201.5 Whenever two or more pieces of electrical equipment are mounted by the CONTRACTOR in an enclosure or on a shipping section, they (except power and motor leads) shall be factory wired to one common termination box mounted on the equipment for connection of DISTRICT'S cables. Power and motor leads shall be terminated in separate equipment termination or motor conduit boxes for incoming cables.

201.6 Connections between shipping sections shall be arranged to require a minimum of field wiring. Terminal blocks shall be provided by the CONTRACTOR on one side of a shipping break, and coiled wires, properly tagged, shall be provided on the other side to facilitate these connections.

201.7 All assemblies shall be furnished by the CONTRACTOR completely wired. With the exception of control and ac power buses, all other alarm and control wiring for extension to remote equipment or for interconnection between compartments shall terminate at terminal blocks.

201.8 All control panels and termination cabinets by the CONTRACTOR shall be NEMA 4X stainless steel (outdoor or wash down areas), NEMA 12 (indoor areas), gasketed, hinged enclosures, complete with 3-point latch and handle and the required terminal blocks for external connections. All terminals and wires shall bear designations that correspond to the designations shown on

CONTRACTOR'S interconnecting diagrams. The interconnecting diagrams shall include the actual "as-built" arrangements of these terminal blocks. Electrical controls and other devices furnished by CONTRACTOR shall also be provided with NEMA 4X stainless steel unless otherwise indicated.

201.9 Indicating devices, relays, etc., supplied by the CONTRACTOR shall be mounted inside the panel. All equipment shall be wired by the CONTRACTOR to conveniently located terminal blocks arranged for cables entering from above or below.

201.10 All spare relay contacts shall be wired out to terminal blocks by the CONTRACTOR.

201.11 Pushbuttons and selector switches by the CONTRACTOR shall be of the heavy-duty type, NEMA Type 4X stainless steel watertight with the ability to be locked in the off position.

201.12 The CONTRACTOR shall furnish starters for all motors.

201.13 Circuit breakers furnished by CONTRACTOR shall have the following interrupting ratings:

a. 480 Vac, three-phase – 65,000 rms symmetrical amperes

b. 120 Vac, single-phase – 22,000 rms symmetrical amperes

c. 125 Vdc – 20,000 amperes

201.14 Each AC power circuit shall be properly protected by the CONTRACTOR with circuit breakers. Miniature breakers or fuses are not permitted.

201.15 Each DC control circuit shall be properly protected by the CONTRACTOR with circuit breakers. Miniature breakers or fuses are not permitted.

201.16 The CONTRACTOR furnished nonmetallic components and devices such as terminal blocks, wireways, wire troughs, wire cleats, cable ties, etc., shall be manufactured from "non-burning" materials as defined by ASTM D635.

201.17 The CONTRACTOR shall equip each panel with copper grounding bus bars minimum size of ¼" x 2" and isolated copper signal grounding bus bars. The grounding bus bar shall be properly labeled as to their use and tapped for 10/32.

201.18 Internal fluorescent light fixtures shall be mounted by the CONTRACTOR in the control cabinet to provide illumination for the control panel, and controlled by a door switch. A 120 volt, 20 amp, 3-wire grounding duplex receptacle with ground fault protection shall be mounted in the control cabinet.

201.19 Power feeds for receptacle and lights shall be from a separate power source than the control power and shall be wired to separate terminals.

201.20 Panels shall be heated, ventilated, or air-conditioned as required to prevent overheating and moisture condensation.

201.21 For low voltage motor requirement refer to Section 262950.

202. SKID AND PANEL WIRING REQUIREMENTS

202.1 In general, all devices furnished by the CONTRACTOR under these specifications and requiring electrical connections shall be designed for wiring into electrical enclosures with terminal blocks.

Terminal blocks shall be furnished for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment parts replacement and maintenance will be facilitated.

202.2 A maximum of two conductors only shall be terminated at any one terminal point. No solder terminal connections shall be used. Splicing of wires is prohibited.

202.3 Internal board wiring shall be accomplished in a neat and orderly manner. Where practicable, wiring trough or gutter with readily removable covers shall be used, and any two or more wires run together shall be clamped or tied in straight lay bundles. Ties or clamps shall be nonmetallic. Wiring shall be arranged so as to be readily accessible for inspection and maintenance, and in no case shall wiring arrangement impede access to board mounted devices or spaces for future equipment.

202.4 All 480V wiring shall be segregated from other control wiring and low voltage devices for personnel safety by means of an insulated barrier or other means.

202.5 Low voltage signal circuits shall be physically separated from other circuits.

202.6 Only one ground connection shall be provided for each instrument circuit. Ground connection for shield wiring shall be at the power source. All shield ends in the field shall be terminated on a dedicated terminal block.

202.7 All wiring leaving an enclosure shall leave from terminal blocks and not from other devices in the enclosure.

202.8 All control wiring internal to panels shall be 600V, Type SIS, No. 14 AWG minimum, tin-coated copper conductors per ASTM B33 with Class B stranding per ASTM B8. Individual conductors shall be labeled with opposite end termination point designations. Labels shall be in accordance with Article 203.2. All wiring internal to panels shall be capable of passing the flame test requirements of UL 44, section 56. Control cables external to panels shall be in accordance with Article 204.2.

202.9 When connections are made from a fixed panel or box to a swing panel or door, the conductors used across the hinge shall be Class K stranding per ASTM B174. These conductors shall have tinned copper wire per ASTM B33 with 600 Volt SIS insulation.

202.10 All power wiring internal to panels and CONTRACTOR supplied skids shall be 600V, No. 12 AWG minimum. Power cable shall be in accordance with Article 204.1. Power wiring internal to panels which is #10 AWG or #12 AWG shall be Type SIS with tinned copper conductors per ASTM B33 and Class B stranding per ASTM B8.

202.11 All thermocouple wire shall be solid conductor with twisted and shielded conductor pairs. Insulation shall be color coded in accordance with the requirements of ANSI/ISA MC96.1. These requirements also apply to thermocouple extension wire, which is furnished internal to CONTRACTOR-furnished equipment. The shield wire for each thermocouple furnished for external connections shall be terminated on an ungrounded terminal.

202.12 Wiring shall be neatly arranged and clamped securely to panels to prevent movement or breaking. Except as otherwise provided in standard vendor supplied packages, a maximum of 12 wires shall be in bundle in order to facilitate tracing wires. Wiring clamps and supports at hinge transition points shall be properly sized to prevent chafing of insulation when the cubicle door is opened and closed.

202.13 Terminal blocks shall be suitable for ring-tongue terminal lugs and shall meet or exceed the requirements of NEMA Standard ICS 4, "Terminal Blocks". The barriers between terminals shall be of such height that terminal screws or wiring lugs will not project above the barriers.

202.14 Terminal blocks shall be rated 600 volt, 20 amps. A permanent marking strip, identified in accordance with CONTRACTOR'S wiring diagrams, shall be furnished on each terminal block. At least 20 percent (two per 12-point terminal block) spare terminal points shall be furnished.

202.15 All terminal blocks for external control wiring shall be rated 600 volts minimum and shall have strap screw terminals suitable for #10 AWG and smaller 600 volt insulated conductors.

202.16 Terminal blocks for 120 volt ac and 125 volt dc power supply circuits shall be similar to the control wiring terminal blocks, but shall be capable of accepting two #10 AWG maximum wire size. Terminal blocks for 120 volt ac and 125 volt dc power supply circuits shall be separate from each other and from terminal blocks for control wiring.

202.17 Short-circuiting type terminal blocks shall be provided for all current transformer wiring. All leads from the transformers shall be terminated on CT shorting terminals. The minimum CT lead wire shall be #10.

202.18 Instrumentation wiring terminal blocks shall be sized to accept #16 to #12 AWG lugs and be rated for 300 V.

202.19 Control cables shall be in accordance with Article 204.2.

202.20 Instrument cable shall be in accordance with Article 204.3.

203. WIRE CONNECTOR REQUIREMENTS

203.1 The connectors shall be constructed from high-conductivity copper and shall be tin-plated.

203.2 Wiring shall be terminated using ratchet type indent-compression-type pre-insulated connectors with ring tongue lugs properly sized for the conductor and the terminal. The connectors shall be constructed of tin-plated copper. Both ends at each terminating point of each wire shall be uniquely identified with permanent, heat shrinkable wire markers (125 °C rated) (Rachem Thermofit) or DISTRICT approved permanent marker using indelible printing, white sleeve with black lettering. Adhesive wire labels are not acceptable.

203.3 To ensure positive electrical connection and to avoid damage to the ferrule it is mandatory that proper ratchet type crimping tools be used. Only those tools approved by the connector manufacturer shall be used. Crimping tools shall be calibrated.

203.4 In the case of required special instruments that are only available with plug in type connectors, the CONTRACTOR shall provide mating plug complete with connected cable. The cable end opposite the plug shall terminate on terminal blocks.

203.5 Coaxial and triaxial cable, if required, shall be furnished with a mating plug at each end, and shall be wired directly from the transmitting to the receiving instrument.

203.6 Thermocouple extension wires, where possible, shall be wired directly from the thermocouple to the terminal points on the instrument. If it is required to terminate thermocouple wires on terminal blocks, then blocks shall be Phoenix Contact Type MTKD or DISTRICT approved alternate, and be of the correct material for the specific type of thermocouple wire supplied.

204. 600V CABLE AND PANEL WIRING

204.1 Low Voltage Power Cables:

Voltage Rating (Volts):	600
Insulation Material:	Thermosetting cross-linked polyethylene (XLPE) meeting the requirements of ICEA S-66-524 (NEMA WC 70) for #10 AWG & larger & UL 44. Acceptable for use in wet or dry locations at 90 degree C. VW-1 Rated. The minimum insulation thickness in accordance with Table 12 of UL 44.
Jacketing Material:	Chlorinated Polyethylene (CPE) or chlorosulfonated polyethylene (Hypalon) meeting the requirements of ICEA S-95-658 (NEMA WC 70) and UL 1277. Thickness in accordance with Table 11.3 of UL 1277. A ripcord shall be placed under the overall jacket.
Construction:	UL type TC 600V OIL RES II SUN RES
Conductor Material:	Soft-drawn tinned copper wires per ASTM B33. Class B Stranding per ASTM B8
Flame Retardancy Requirements:	UL 1277 using CSA FT4/IEEE 1202 flame exposure for type TC VW-1 rated single conductors.
Cable Test:	Per NEMA WC 70

Special Requirements:

1. The cables shall conform to the following standards:
   a. NEMA WC-70 / ICEA S-95-658, Standard for Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy, 1999, National Electrical Manufacturers Association
   b. UL 44, Standard for Thermoset-Insulated Wires & Cables, Sixteenth Edition
   c. UL 1277, Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, Fourth Edition
2. The cables shall have demonstrated resistance to flame propagation in fires by having been type tested in accordance with UL 1277 using the CSA FT4/IEEE 1202 flame exposure.
3. The individual conductors of multi-conductor cables shall be identified by printing numbers (1, 2, 3, etc.) on single-color insulation or jacket (Method 4, Paragraph E.3.4, NEMA WC-57).
4. Conductor size #10 through 3/0 shall be 3/C with overall jacket only. Conductor size 4/0 and larger shall be triplex.
5. The cables shall be constructed with fire-retardant non-hydroscopic filler material and binder tapes. Cables shall not contain PVC or paper fillers.
6. Outer jacket of jacketed cable shall be permanently marked so as to identify the manufacturer, voltage, type of insulation and jacket material, number and size of conductors, year of manufacture and sequential footage. Identification markings shall be at intervals not to exceed 24 inches.

204.2 Control Cables:

Voltage Rating (Volts):	600
Insulation Material:	Thermosetting XLPE meeting the requirements of ICEA S-73-532 (NEMA WC 57) & UL. Acceptable for use in wet or dry locations at 90 degree C. VW-1 Rated. The minimum insulation thickness in accordance with Table 12 of UL 44.
Jacketing Material:	CPE or Hypalon meeting the requirements of ICEA S-73-532 (NEMA WC 70) and UL 1277. Thickness in accordance with Table 11.3 of UL 1277. A ripcord shall be placed under the overall jacket.
Construction:	UL type TC 600V OIL RES II SUN RES
Conductor Material:	Soft-drawn tinned copper wires per ASTM B33. Class B Stranding per ASTM B8
Flame Retardancy Requirements:	UL 1277 using CSA FT4/IEEE 1202 flame exposure for type TC VW-1 rated single conductors.
Cable Test:	Per NEMA WC 57

Special Requirements:

1. The cables shall conform to the following standards:
   a. NEMA WC-57 / ICEA S-73-532, Standard for Control Cables, 2004, National Electrical Manufacturers Association
   b. UL 44, Standard for Thermoset-Insulated Wires & Cables, Sixteenth Edition
   c. UL 1277, Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, Fourth Edition
2. The cables shall have demonstrated resistance to flame propagation in fires by having been type tested in accordance with UL 1277 using the CSA FT4/IEEE 1202 flame exposure.
3. The individual conductors of multi-conductor cables shall be identified by color compounds with tracers (Method 1, Paragraph E.3.1, NEMA WC-57), in accordance with Table E-2 (color sequence without white and green).
4. All cables shall be multi-conductor design with overall jacket only.
5. The cables shall be constructed with fire-retardant non-hydroscopic filler material and binder tapes. Cables shall not contain PVC or paper fillers.
6. Outer jacket of jacketed cable shall be permanently marked so as to identify the manufacturer, voltage, type of insulation and jacket material, number and size of conductors, year of manufacture and sequential footage. Identification markings shall be at intervals not to exceed 24 inches.

204.3 Instrumentation Cables:

Voltage Rating (Volts):	300
Insulation Material:	Thermosetting XLPE meeting the requirements of ICEA S-82-552 (NEMA WC-55) and UL 13. Acceptable for use in wet and dry locations at 90 degree C. The insulation thickness in accordance with Table 7.3 of UL 13.
Jacketing Material:	Thermosetting XLPE or Hypalon meeting the requirements of ICEA S-82-552 (NEMA WC 55) and UL 13. The thickness in accordance with Table 13.3 of UL 13. A ripcord shall be placed underneath the overall jacket.
Construction:	Twisted pair (or triad), 2 inch minimum lay length, with overall shield and tinned drain wire. UL Type PLTC and ITC
Conductor Material:	Soft-drawn, tinned copper wires per ASTM B33. Class B Stranding per ASTM B8
Flame Retardancy Requirements:	UL 1277 using CSA FT4/IEEE 1202 flame exposure.
No. of Pairs/Triads:	As required
Size (AWG)	16 minimum
Drain Wire Size (AWG)	18 minimum
Color Coding for Instrument Cables: Twisted Pairs: Triads: Group:	 White & Black White, Black & Red Each conductor pair (or triad) of a multi-group cable shall be sequentially numbered
Cable Test:	Per NEMA WC 55

Special Requirements:

1. The cables shall conform to the following standards:
   a. NEMA WC-55 / ICEA S-82-552, Standard for Instrumentation Cables and Thermocouple Wire, Revision 2, 1998, National Electrical Manufacturers Association
   b. UL 13 Standard for Power-Limited Circuit Cables, Second Edition
   c. UL 2250 Standard for Instrumentation Tray Cable, Second Edition
2. The cables shall have demonstrated resistance to flame propagation in fires by having been type tested in accordance with UL 1277 using the CSA FT4/IEEE 1202 flame exposure.
3. Shields shall be aluminum-polyester tape and 7 strand, 18 AWG min, tin-coated copper drain wire. Shield applied to achieve 100% coverage. Shield tape on pair (or triad) assembly shall be applied in such a way as to give electrical isolation from all other pair (or triad) shields.
4. The cables shall be constructed with fire-retardant non-hydroscopic filler material and binder tapes. Cables shall not contain PVC or paper fillers.
5. Instrument cables with twisted pairs shall have color compounds and printed pair numbers in accordance with Method 9 of NEMA WC-55. One conductor of each pair shall be "white" and the other conductor of each pair shall be "black." Pairs shall be identified in sequence by printed numbers on at least one conductor of each pair, beginning with the number 1.
6. Instrument cables with triads shall have color compounds and printed triad numbers in accordance with Method 9 of NEMA WC-55. One conductor of each triad shall be "white", one conductor of each triad shall be "red", and the other conductor of each triad shall be "black." Triads shall be identified in sequence by printed numbers on at least one conductor of each triad, beginning with the number 1.
7. Outer jacket of jacketed cable shall be permanently marked so as to identify the manufacturer, voltage, type of insulation and jacket material, number of pairs/triads and size of conductors, year of manufacture and sequential footage. Identification markings shall be at intervals not to exceed 24 inches.

205. RACEWAYS AND JUNCTION/PULL BOXES

Raceway and conduit systems used in supporting and protecting electrical cable shall be in accordance with the provisions of the NEC . by the CONTRACTOR

206. CONDUIT

206.1 All conduit supplied by the CONTRACTOR shall be rigid galvanized steel except as noted. Conduit should be sized one size larger than required by the NEC for conductor type and number installed; be a minimum size of ¾": maintain a minimum 6" clearance between conduit and piping; and maintain a minimum 12" clearance between conduit and heat sources.

206.2 Liquid-tight flexible metallic conduit shall be used for connections to accessory devices such as solenoid valves, limit switches, pressure switches, etc.; for connections to motors or other vibrating equipment; and across areas where expansion or movement of the conduit is required. Minimum size shall be limited as follows:

a. Length of 1' or less: ¾" to 1"

b. Length of 1' to 2': 1½" to 2"

c. Length of 2' to 3': 2½" to 6"

206.3 Suitable bonding jumpers shall be installed around liquid-tight flexible metallic conduit to establish absolute and adequate electrical conductivity for ground fault current. Minimum conduit size shall be ¾".

206.4 Conduit shall be routed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical conduit bends or fittings.

206.5 Conduits entering enclosures shall enter from the bottom.

206.6 Grounding type bushings shall be provided on all conduit containing power circuits and on all conduit on equipment to be located in hazardous areas.

206.7 All conduit fittings shall be constructed of malleable iron

206.8 Conduit fittings used on outdoor equipment shall be sealed and gasketed.

206.9 All conduit runs shall be rigidly supported. Each conduit shall be supported within 1 foot of junction boxes and fittings.

207. JUNCTION AND PULL BOXES

207.1 Boxes (except classified), provided by the CONTRACTOR shall be NEMA 4X stainless steel (outdoor and wash down areas) or NEMA 12 (indoor areas).

207.2 Junction boxes and pull boxes shall be furnished by the CONTRACTOR without knockouts.

208. HAZARDOUS AREAS

208.1 Nameplate Requirements:

All the CONTRACTOR'S electrical equipment and devices located in areas subject to conditions classified in the National Electrical Safety Code and the NEC as hazardous shall be furnished with a nameplate stating the equipment classification. The nameplate data shall include the class, group, division, and operating temperature designations (T-rating) as applicable, and the NEMA type. Classification identification nameplates and attachment pins will be corrosion-resistant metal.

208.2 Classification of Hazardous Areas:

a. CONTRACTOR shall identify the areas to be classified as hazardous.

b. Areas where flammable and combustible liquids, gases, and dusts are handled and stored will be classified for the purpose of determining the minimum criteria for design and installation of electrical equipment to minimize the possibility of ignition. The criteria for determining the appropriate classification are specified in the applicable NFPA standards. The application of these criteria to specific areas at generating stations is provided in the National Electrical Safety Code (ANSI C2).

c. In addition to defining hazardous areas by class and division, each hazardous element is also assigned a group classification (A, B, C, etc.). The group classifications of hazardous elements are specified in Article 500 of the NEC.

d. Electrical equipment in areas classified as hazardous shall be constructed and installed in accordance with the requirements of Article 500 of the NEC. Equipment shall be marked to indicate the location classification. This marking shall include the temperature range of the equipment. The temperature range markings shall not exceed the ignition temperature of the gas or vapor.

e. References for use in classification of areas, as well as specification of requirements for electrical installation in such areas, include the following:

e1. National Electrical Safety Code, ANSI C2

e2. National Electrical Code, NFPA 70/ANSI C1

e3. National Fire Codes and National Fire Protection Association codes, standards and recommendations

e4. Intrinsically safe or non-incendiary designs are acceptable as are explosion proof enclosures for use in hazardous areas.

209. NAMEPLATES

209.1 Nameplates of laminated phenolic material with 3/16 in. minimum engraved letters shall be furnished by the CONTRACTOR to designate the purpose of all circuits, power sources, operator interface devices, instruments, meters, relays and fuses.

209.2 All lettering by the CONTRACTOR shall be block type and square cut. The required wording shall be submitted to the DISTRICT for review. The nameplates shall be white with black letters.

209.3 Nameplates shall be fastened to the equipment with stainless steel machine screws.

END OF SECTION