SECTION E2

SELLER FURNISHED CONTROLS, WIRING AND RACEWAY

1. GENERAL: This Specification details the requirements for Seller furnished wiring and package control systems supplied with Seller furnished equipment when specified. Typical electrical parameters for Seller supplied equipment and controls are as follows:
   1. All DC electrical control devices shall be designed for continuous operation on an ungrounded station battery at any voltage from 90 to 140 VDC. Electrical devices served from this supply shall not impose any ground connections on it.
   2. All AC electrical control devices shall, unless otherwise specified, be designed to operate satisfactorily under the conditions listed below:

|  |  |
| --- | --- |
| AC Control Devices Operating Conditions | |
| 120 VAC supply voltage variation | +/- 10% |
| AC Frequency variation | +/- 5% |
| Dropout voltage for relays | < 75 V |
| Dropout voltage for contactors and starters | < 90 V |

Alternating current electrical control devices operating at nominal voltages other than 120 V shall be designed for continuous operation over proportional voltage variations.

* 1. All devices shall be guaranteed to operate satisfactorily under voltage conditions specified in the above paragraphs and at maximum ambient temperature or maximum indoor temperature (if devices are furnished indoors), whichever is greater, as specified in Section GR-A.
  2. All electrical equipment shall be designed and manufactured to meet seismic requirements as specified in Section S1.

1. AUXILIARY POWER: Auxiliary Equipment, such as motors, transformers, panels, and rectifiers, requiring electrical power shall be designed to operate from one of the nominal electrical power sources as follows:

|  |  |  |
| --- | --- | --- |
| Volts | Phase | Hertz |
| 13800 | 3 | 60 |
| 6900 | 3 | 60 |
| 4160 | 3 | 60 |
| 480 | 3 | 60 |
| 208 | 3 | 60 |
| 208 | 1 | 60 |
| 120 | 1 | 60 |
| 125 | DC | (Emergency, UPS and switchgear control) |

Terminations quantity and size shall be provided as indicated for all incoming 480 V and 4160 V/6900 V/13800 V power feeds:

600V Cable Termination Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Main Disconnect Rating (Amp min – Amp max) | QTY of Terminations per Phase | Cable Size per Phase | KAIC Rating |
| <25 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 25-49 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 50-99 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 100-149 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 150-199 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 200-249 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 250-300 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| (modify as needed) | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
|  | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
|  | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |

5000V/6900V/13800V Cable Termination Requirements:

|  |  |  |  |
| --- | --- | --- | --- |
| Main Disconnect Rating (Amp min – Amp max) | QTY of Terminations per Phase | Cable Size per Phase | KAIC Rating |
| <25 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 25-49 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 50-99 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 100-149 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 150-199 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 200-249 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| 250-300 | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
| (modify as needed) | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
|  | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |
|  | (per cable sizing calc) | (per cable sizing calc) | (per S.C. study) |

* 1. Motors shall be furnished in accordance with the requirement of Section E1 "Motors-Induction Squirrel Cage Type."
  2. Emergency motors shall be designed to operate from a nominal 125 VDC supply. Direct current motors shall be capable of continuous operation at any terminal voltage from 90 to 140 VDC.

1. RACEWAY: Unless specified otherwise, all raceway provided by the Seller for interconnection between devices, panels, boxes, and fittings shall conform to ANSI C80.1 and UL 6. All conduit connections shall be of the threaded type. Unless specified otherwise, all exposed conduit shall be hot dipped after fabrication rigid galvanized steel or aluminum. PVC coated rigid galvanized steel conduit shall be used in corrosive areas. Conduit embedded in a concrete floor will be PVC with galvanized steel risers. Conduits entering enclosures shall enter either from the side or bottom. Top entries are in outdoor areas not allowed. All conduit entering outdoor enclosures shall enter through hubs or threaded openings. Minimum conduit size shall be ¾” for exposed and 1” for embedded.
   1. Connections to all motors and other Equipment subject to vibration, thermal movement, or requiring the flexibility to be moved aside during maintenance shall be made with UL” listed liquid-tight flexible metallic conduit with proper end fittings. Length of liquid-tight flexible conduit will be limited to a maximum of 6 feet.
   2. Grounding type bushings shall be provided on all conduit containing power circuits and on all conduit on Equipment to be located in hazardous areas. Hazardous areas shall be as defined by the National Electrical Safety Code (NESC) and the National Electrical Code (NEC). Standard bushings shall be galvanized.
   3. Conduit fittings used on outdoor Equipment shall be sealed and gasketed.
   4. A run of conduit shall not contain more than the equivalent of four 90 degree bends, including those immediately at outlets and fittings. Bends in conduit shall be made without reducing the internal diameter of the conduit.
   5. All conduit runs shall be rigidly supported within the requirements of the NEC. Each conduit shall be supported within the NEC required distance of junction boxes and fittings. Piping shall not be utilized for conduit support.
   6. Conduit shall have the minimum separation distances listed below:

Separation in inches between above grade conduits:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Level | 400 | 300 | 200 | 100 |
| 400 | 0 | 3 | 12 | 12 |
| 300 | 3 | 0 | 3 | 6 |
| 200 | 12 | 3 | 0 | 1 |
| 100 | 12 | 6 | 1 | 0 |

* + 1. Circuit/Cable Level Definitions:

1. Level 400 - Instrumentation
   1. Includes circuits for analog 4-20mA devices, pulse signals, digital I/O less than 48VDC, thermocouples, and RTD’s
   2. Cables will be shielded twisted pairs or shielded triad
   3. Cables will be routed in level 400 raceway or tray
2. Level 300 - Control
   1. Includes circuits for 120VAC control, >48VDC control, 120/208VAC power circuit less than 5A (may be level 200), potential and current transformer secondaries
   2. Cables will be multiconductor, and cable may be shielded if required
   3. Cable will be routed in level 300 raceway or tray
3. Level 200 - Power ≤600V
   1. Includes power circuits ≤600V (AC or DC)
   2. Cables will be routed in level 200 raceway or tray
4. Level 100 - Power > 600V and ≤ 5kV
   1. Includes medium voltage power cables ≤5kV and greater than 600V
   2. Cables will be routed in level 100 raceway or tray
5. Level 000 - Power >5kV
   1. Includes medium voltage power cables greater than 5kV
   2. Cables will be routed in level 000 raceway or tray
   3. Moisture pockets shall be eliminated from conduits. Conduit in wet locations shall have provisions for moisture drainage (e.g., conduit “tee” fittings with bottom breather/drains at low points and panel entries).
   4. The raceway system provided for all interconnecting wiring shall be acceptable to the Engineer.
6. ELECTRICAL ENCLOSURES: Area classifications shall be in accordance with NEC/CEC.
   1. Electrical enclosures shall be NEMA type and shall be selected based on the installation environment as follows:

|  |  |
| --- | --- |
| NEMA Enclosure Type | Environment/Location |
| Type 1 | Indoor, conditioned locations |
| Type 12 | Indoor, unconditioned locations |
| Type 4 | Indoor/Outdoor, wet locations |
| Type 4X | All corrosive locations |
| Type 7 | Indoor, hazardous locations (engineer to determine if environment requires type 7 or type 9) |
| Type 9 | Indoor, hazardous locations (engineer to determine if environment requires type 7 or type 9) |

* 1. All metal electrical enclosures with hinged doors and electrical devices mounted on the door face shall have a grounding stud provided on the enclosure door with a door bonding jumper installed.
  2. All electrical enclosures shall be provided with a nameplate in accordance with the requirements of Section GR-A.
  3. Access and working clearance in front of all enclosures shall be provided and maintained per NEC Article 110.

1. JUNCTION BOXES AND PULL BOXES: Junction boxes and pull boxes shall be in accordance with the requirements of NEC, Article 314, and shall be furnished without knockouts.
   1. All junction boxes and pull boxes shall be provided with a nameplate in accordance with the requirements of Section GR-A.
   2. All junction boxes or pull boxes 4” trade size or smaller in any dimension shall be galvanized malleable iron, fiberglass, aluminum, stainless steel or acceptable equal cast ferrous metal with cover plate.
   3. All junction boxes and pull boxes larger than 4” trade size in all dimensions for use in indoor locations shall be sheet steel hot-dip galvanized after fabrication or fiberglass, and those for use in outdoor or damp locations shall be galvanized malleable iron, fiberglass, aluminum, stainless steel or acceptable equal cast ferrous metal, sheet steel hot-dip galvanized after fabrication, or sheet steel epoxy coated inside and outside after fabrication. Gasketed covers shall be provided.
   4. Junction boxes and pull boxes shall be furnished without knockouts.
   5. Access and working clearance in front of all junction boxes shall be provided and maintained per NEC Article 110.
2. CONTROL PANELS: This Article covers the design, fabrication, and installation of floor mounted, wall mounted, or skid mounted control panels.
   1. Control panels shall meet applicable requirements of NEMA as defined in this Section and shall be provided with NEMA enclosure type as specified in Article 4.1 of this Section.
   2. Panels shall be of all welded steel construction. Exterior surfaces shall be smooth and free of defects and imperfections. All welds shall be ground smooth. Exposed edges, corners, and edges of cutouts shall be smooth and rounded.
   3. Control panel doors taller than 36" shall be provided with full length piano type hinges and three point latching system fasteners with stainless steel locking handles. The locks shall be keyed alike. Panel doors 36" and shorter shall use stainless steel door clamps on three sides and have padlock hasps. Control panel doors shall be the double swing half type.
   4. Control panel doors shall be provided with a grounding bond jumper to the panel enclosure.
   5. Braces and stiffening members shall be provided as required to prevent any panel distortion. Braces and stiffeners shall not interfere with instrument locations.
   6. Panel tubing and wiring shall be neatly routed and supported and shall not block access to instruments. Tubing and wiring shall be terminated on tubing terminal plates or terminal strips, respectively. 20% spare terminals shall be provided.
   7. All control panels shall be provided with a nameplate in accordance with the requirements of Section GR-A
   8. Free-standing panels shall be provided with internal fluorescent lighting fixture and door switch, and (1) 120 VAC duplex GFCIR electrical outlet. Internal lighting fixture and GFCIR shall be wired to a junction box and fed from a separate external circuit.
   9. Ground fault circuit interrupting receptacles (GFCIR) shall be self-contained units manufactured for installation in conventional outlet boxes and installed within panel interiors. Each unit shall be designed and tested per UL 943 for a maximum 6 and a minimum 4 milliampere ground-fault trip level. Units shall have the capability of being tested and reset after tripping. Receptacles with ground-fault protection shall be UL listed with the receptacle portion conforming to UL 498. Each GFCIR shall be mounted in an outlet box of adequate size for the receptacle and wiring.
   10. Panels shall be heated, ventilated, or air-conditioned as required to prevent overheating and moisture condensation. These devices shall be fed from a separate external power circuit.
   11. Panels shall be designed to prevent overheating and moisture condensation. Panels located in areas subject to temperature variation shall be provided with thermostatically controlled condensation heaters.
   12. Control panels shall be cleaned, primed, and finish painted with the Seller's standard painting system. Interiors of the panels shall be white.
   13. Internal swing panels are not allowed in floor standing enclosures.
   14. Access and working clearance in front of all control panels shall be provided and maintained per NEC Article 110.
3. CLASSIFICATION IDENTIFICATION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS: All electrical Equipment and devices located in areas subject to conditions classified in the National Electrical Safety Code and the National Electrical Code as hazardous shall be furnished with a nameplate stating the Equipment classification. The nameplate data shall include the class, group, division, and operating temperature and “T-Rating” designations as applicable, and the NEMA type. Classification identification nameplates and attachment pins shall be corrosion-resistant metal.
4. WIRING: In general, all Equipment and devices furnished 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.
   1. Splices shall not be permitted in power, lighting, control wiring or instrument leads.
   2. Internal panel 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 outside of trough shall be clamped or tied in straight lay bundles at approximately 15” intervals. 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 panel mounted devices or spaces for future Equipment. All cables shall be identified with a permanent tag securely affixed to the cable termination point.
      1. Circuit/Cable tagging shall include the circuit number at minimum for all cables provided and installed by Seller.  Multi-conductor control and instrumentation cables shall include a circuit number tag on the main “trunk” and individual wire tags including circuit number and wire color/number as appropriate for multiple pairs. (e.g. 3BK, 5BK, etc) Cable tag shall be visible from cabinet or panel opening.
   3. Hinge wiring applications shall utilize Class K, stranded tinned copper switchboard wire secured on each side of the hinge and formed with sufficient slack to minimize strand fatigue and breaking. The hinge wire shall be protected by a spiral wrap or tape.
   4. All connections to panel mounted Equipment shall be made on one side of the terminal blocks, and not more than two wires shall be connected under a single terminal screw.
   5. All wiring leaving an enclosure shall leave from terminal blocks and not from other devices in the enclosure. Terminal blocks for external connections shall be grouped and identified for Customer use.
   6. Terminal blocks for each of the following signal types shall be separate from one another: instrument transformer (CT and VT) circuits; 120 VAC and 125 VDC power supply circuits; analog low voltage instrument circuits; and control circuits.
   7. All electrical cables shall be selected for the electrical and environment conditions of the installation. Oil-resistant and proper temperature application cable shall be used throughout. Except where required to be otherwise to perform satisfactorily in the service, all electrical conductors shall be Class B, stranded tinned copper switchboard wire, 16 AWG or larger with flame retardant cross link polyethylene (FRXLPE). Thermoplastic (THHN/THWN), PVC and asbestos insulations or coverings are not acceptable.
   8. General service wiring integral to the Equipment furnished but not part of the internal wiring of control cabinets or panels, shall be as follows.
      1. Power cables shall be rated for the maximum service voltage, but not less than 600 V.
      2. Control cables shall be rated for the maximum service voltage, but not less than 600 V.
      3. Instrument cables shall be rated for the maximum service voltage, but not less than 300 V.
      4. 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 MC96.1. These requirements also apply to thermocouple extension wire which is furnished internal to Seller-furnished Equipment. The shield wire for each thermocouple furnished for external connections shall be terminated on an ungrounded terminal, each being a separate terminal for each thermocouple.
   9. Control conductor terminal connectors for screw type terminals shall be solid ring type connectors with solid barrel type lugs and shall be properly sized for the conductor and the terminal except for DCS I/O cabinets and PLCs, which at these devices compression connections may be used. The connectors shall be constructed of copper and shall be tin-plated.
   10. Terminal Blocks. Terminal blocks shall be industrial duty, barriered, and shall be furnished with white marking strips and, where permitted by the safety codes and standards, shall be without covers. Not less than 20% spare terminals shall be furnished. All terminal blocks for external control wiring shall be rated for 600 V, 20 A minimum and shall have strap screw terminals suitable for #10 AWG and smaller 600 V insulated conductors except for the DCS I/O cabinets which will have Phoenix type terminal blocks or equivalent.
   11. Each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary device shall be permanently labeled to coincide with the identification indicated on the drawings. All terminals provided for termination of external circuits shall be identified by inscribing circuit designations acceptable to the Engineer on the terminal block marking strips with indelible black ink. Terminating a conductor shall include installing cable pre-fabricated termination kits for shielded cable, attaching the conductor at its designated location, and insulating the entire connection where specified or required by the application. Care will be taken to extend the continuity of the cable pair shields in all field junction boxes. At points of field termination, pair shields, and drain wires will remain on the pair as close to the termination point as is practical. Shields will be permanently taped to prevent unraveling and the drain wires will have insulating sleeves installed up to the point of termination.
   12. For conductors internal to Equipment, a flame-resistant conductor identification sleeve shall be provided on each end of each conductor. Each sleeve shall be marked with the opposite end destination identification. Wire sleeve shall be visible from cabinet or panel opening.
   13. The arrangement of connections on terminal blocks shall be acceptable to the Engineer.
   14. All temporary wiring installed in the factory for Equipment testing shall be removed prior to shipment of the Equipment.
5. TERMINATION OF 600 VOLT POWER CABLE: The capacities of conduit entrances, terminal enclosures, and conductor terminals for 600 V power cable terminations in Equipment furnished under these Specifications shall be as required to accommodate copper phase conductors and copper ground conductors which are sized in accordance with the requirements of this Article. An integral incoming power disconnect sized for at least 125% of the full load current shall be provided for each source of incoming power. Branch circuit breakers shall be sized in accordance with the NEC and shall provide thermal-magnetic over-current protection.
   1. Safety-type disconnecting switches shall be type "HD", heavy duty. Switches shall be rated at 240 or 600 V as required by the voltage of the circuit on which type are utilized and shall be rated in horsepower. Each switch shall be capable of interrupting the locked rotor current of the motor for which it is to be used, which current will be assumed as ten times the full rated load current.
   2. Disconnects shall be of the quick-make, quick-break type, and all parts shall be mounted on insulating bases to permit replacement of any parts from the front of the switch. All current-carrying parts shall be of high-conductivity copper, designed to carry rated load without excessive heating. Switch contacts shall be silver-tungsten type or plated to prevent corrosion, pitting, and oxidation and to assure suitable conductivity. Switch operating mechanisms shall be designed to retain effectiveness with continuous use at rated capacity without the use of auxiliary springs in the current path. Switches shall be capable of withstanding the available fault current or let through current before the fuse operates, without damage or change in rating.
   3. Fuses shall be UL listed or approved equivalent, rated for 600 V, and dual element type. Fuses shall have a thermal element that restricts the temperature rise and an element of low peak type which limits the let through fault current.
   4. Disconnects shall be located within panel interiors with operator handles located on panel exteriors. Mechanical interlocks shall be provided to prevent opening panel door when the disconnect handle is in the "ON" position. Disconnect handles shall be provided with padlock provisions. Mechanical interlock shall have defeat mechanism to allow qualified personnel to access while energized.
   5. If disconnects are furnished for locations remote from control panels, the disconnect enclosure shall be suitable for the environment and meet the requirements included in this Specification. Remote mounted disconnects shall have engraved nameplates.
   6. Conduit Entrances and Terminal Enclosure. The capacities of conduit entrances and terminal enclosures for phase conductors shall be as required for conductors sized in accordance with Article 2 of this Section.
   7. Compression type, double indent, two-hole copper lugs will be used for all power cables. Power cables rated 600V and smaller than #6 AWG will use one hole lugs for termination. Mechanical terminations require Engineer Approval prior to use.
6. CONTROL PANEL EQUIPMENT AND DEVICES: As a minimum, Seller supplied control panel Equipment and devices shall conform to these requirements.
   1. Relays: Auxiliary control relays shall be in accordance with NEMA ICS and shall be plug in, octal base type with contacts rated per Article 10.3 below. Relays shall have a minimum of two Form C contacts. All relays shall have 120 V, 60 hertz AC operating coils unless otherwise required by system design. Plug-in relays shall be provided with hold-down clips.
   2. Control Switches: Control switches shall be 600 V, 20 ampere, multistage, rotary type with a minimum of 10 contacts. Control switch contacts for engineered systems shall be dual rated for AC and DC operation. See minimum contact ratings in Article 10.3 below.
   3. Unless otherwise stated in this specification, all auxiliary relays and control switches, shall have the following minimum contact ratings:

Contact Closing Rating: 20 A

Continuous Current Carrying Rating: 10 A continuously

Interrupting Rating: see tables below

|  |  |  |
| --- | --- | --- |
| VDC | Non-Inductive Amps | Inductive Amps |
| 6-24 | 15.0 | 6.0 |
| 48 | 8.0 | 3.5 |
| 125 | 3.0 | 1.0 |
| 250 | 1.0 | 0.3 |

|  |  |  |
| --- | --- | --- |
| VAC | Non-Inductive Amps | Inductive Amps |
| 115 | 30.0 | 20.0 |
| 230 | 20.0 | 10.0 |
| 460 | 8.0 | 5.0 |

* 1. Pushbuttons, Selector Switches, Indicating Lights and Pushbutton Stations: Pushbuttons, selector switches, and indicating lights shall be heavy-duty oil-tight and shall be in accordance with NEMA ICS. Contact rating shall be 10 A continuous at 600 V, 60 hertz. Indicating lights shall be long-life LED type at a voltage rating appropriate for the application. Units shall be provided complete with contact blocks, legend plates, plastic caps, etc., for a complete installation. Emergency stop pushbuttons shall be of the red mushroom head type.

Indicating light lens colors shall be coordinated with indicated conditions as specified in the following table. Indicating lights shall be energized when the condition exists and shall be de-energized when the condition does not exist. Both red and green lights shall be energized for valve in intermediate position.

Lens Color Condition

Red Equipment in operation, such as motor running, valve open, or breaker closed

Green Equipment not in operation, such as motor stopped, valve closed, or

breaker open

Amber Status indication, such as power monitoring, trip coil monitoring, test.

White Equipment abnormality, such as motor trip or breaker trip

* 1. Control Power Transformers: Seller supplied control panels shall be provided with dry type control power transformers to supply all required control voltages which differ from the control panel, single point power input source. Control power transformers shall be adequately sized to supply all required control power plus 50 VA, and have both primary leads and one secondary lead fused. The other secondary side of the control power transformers shall be grounded.
  2. Power Supplies: Seller supplied control panels requiring DC control voltage or filtered power shall be provided with all necessary power supply Equipment, rectifiers or filters.

1. MOTOR CONTROL: When Seller is required to supply local starters and contactors for control of Seller supplied Equipment, motor controls shall conform to the following minimum requirements:
   1. Starters and contactors supplied with Seller furnished controls shall be located within Seller's control panels. Magnetic starters and contactors shall have 120 VAC operating coils. Coil power shall be supplied from Seller panel control power transformers provided in accordance with Article 10.5. Each magnetic starter or contactor shall be provided with line side short circuit protection consisting of a UL approved molded case thermal magnetic circuit breaker or motor circuit protector (MCP). Magnetic starters shall be provided with manual reset electronic solid state overload relays, sized to match motors furnished. Overload relay manual reset shall be operable from panel door. Magnetic starters shall be NEMA rated and selected to match the horsepower nameplate of the motors provided. Control transformer leads, starter overload relay contacts, contactor operating coils, and starter auxiliary contacts shall be wired to marked unit terminal blocks.
   2. Auxiliary contacts shall be provided as required by the Seller’s design, plus a minimum of two normally open and two normally closed spare contacts for Contractor use. Each contactor or starter provided in this Section for motor or Equipment operation shall be provided with the following hard wired functions.
      1. Equipment “running” or “on” indication available for connection to plant DCS.
      2. Ready signal to indicate power is available and the HAND-OFF-AUTO switch is in AUTO for connection to plant DCS.
      3. Overload tripped indication for connection to plant DCS.
   3. All AC and DC motor starters shall have red and green indicating lights and a HAND-OFF-AUTO switch on its motor control panel door.
   4. If a motor heater is required by Section E1 or by the drawings, it shall be controlled by an auxiliary contact of the motor starter or low voltage switchgear breaker and shall be energized when the motor is not running. This circuit shall be wired to be fed from an external source separate from the motor starter feeder circuit. Where Seller provides a control panel with motor starter(s), a separate local disconnect shall be provided at the panel for this circuit along with an NEC compliant warning label describing multiple sources of power.
2. ELECTRICAL DRAWING REQUIREMENTS: Seller supplied control systems shall be provided with detailed control schematics, wiring diagrams, wire list, loop diagrams, and termination information. Drawings shall meet the requirements specified in Section GR-A. Field wiring by others shall be clearly indicated on Seller schematics and shown using dashed lines. Dedicated terminal blocks for field wire terminations shall be arranged for field wiring to be landed at a common location. Interconnection drawings showing the physical arrangement and function of the terminals shall be provided as part of the drawing submittals for approval. Seller shall be responsible for engineering costs incurred if Seller revises this drawing after being approved.
3. ALARM INDICATION: Discrete alarm indication shall be provided on the front of Seller furnished control panels. Each discrete alarm shall be annunciated by a dedicated pilot lamp with nameplate or by other means such as LED readout or flashing annunciator plates. A “common alarm” relay shall be provided for each panel and shall activate for any of the discrete panel alarms. A dedicated N.O. auxiliary contact from each common alarm relay shall be provided for status output to the plant distributed control system.
4. EQUIPMENT SAFETY GROUNDING. All electrical Equipment that is part of a skid, integral shipping unit or assembly shall be furnished with a bare copper or stainless steel grounding pads drilled and tapped for connection to a NEMA 2-hole ground lug. The ground pads shall be located at opposing ends/corners of the skid and shall be suitable for field connection to the station ground grid.
   1. Isolated logic system or single-point ground connections required for proper operation of electronic Equipment shall be insulated from the Equipment safety ground. Such connections will be extended, using insulated cable, to a single termination point suitable for field connections to the appropriate ground system.
   2. Electrical Equipment shall include all enclosures containing electrical connections or bare conductors with the exceptions of control devices, such as solenoids, pressure switches, and limit switches, unless such devices require grounding for proper operation.
   3. Any skid mounted raceway system shall not be considered to be a ground conductor except for itself. All conduits containing power circuits shall be connected to the enclosure or Equipment grounding pad or grounding bus with bare copper conductor. Grounding bushing ground conductors shall be not less than #10 AWG bare copper conductor.
   4. Ground conductors shall be soft drawn bare stranded copper strand Class II. All clamps, conductors, bolts, washers, and nuts used with the grounding system shall be copper or tinned copper if required.
5. INSTRUMENTATION: See Section I2 for general instrumentation requirements for skid-mounted and Seller-engineered systems.

END OF SECTION