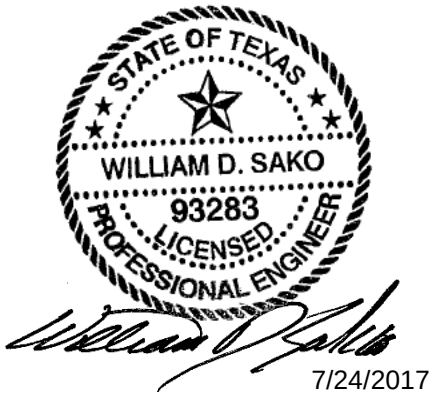

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SECTION 16195

POWER METERING AND PROTECTIVE RELAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for power metering and protective relays to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.02 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

1.03 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned without review. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision

B. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the meter or relay provides every specified requirement. Any options or exceptions shall be clearly indicated.

C. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall include the following information:

   a. Manufacturer’s contact address and telephone number for parts and service.

   b. Instruction books and/or leaflets

   c. Recommended renewal parts list

1.04 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA/ISCI – 109 Transient Overvoltage Withstand Test

2. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests

3. IEC 255.4 Surge Withstand Capability Tests

B. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

2.02 POWER QUALITY METER (PM1)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. GE Multilin PQMII Power Quality Meter

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. All circuit boards shall have a harsh environment conformal coating to resist H_2S gas and other corrosive agents, including humidity.

D. Monitoring and Metering

1. Metering Functions with accuracy of 0.2% for current and voltage and 0.4% for power parameters

a. A, V, VA, W, VAR, KWH, KVARH, KVAH, PF, Hz

b. W, VAR, A, VA Demand

c. A, V Unbalance

2. Power Analysis Functions.

a. Total Harmonic Distortion

b. Individual harmonics

c. Waveform capture

d. Historical data

e. Minimum and maximum metered values complete with time and date

f. Record of last 40 events

g. Two independent data logs

E. User Interface and Programming

1. Integrated keypad to access actual values and set points.

a. Two-line, 40-character illuminated display for use with keypad. The display shall have:

1) Variable scrolling rates.

2) Front mounted LEDs to display alarms, communication status, relay status, simulation mode, self-test failure, and set point access status.

3) Relay reset button to clear alarm and auxiliary conditions.

2. The meter shall have one alarm output relay with Form C contacts.

3. Relay output shall be through alarm, auxiliary and pulse output functions.

4. The meter shall provide a user configurable pulse output based on kWH, kVARH or kVAH.

5. The meter shall provide a pulse input for demand synchronization.

6. The meter shall include a simulation mode capability for testing the functionality and meter response to programmed conditions without the need for external inputs.

7. The relay shall include a power systems option consisting of harmonic analysis, triggered trace memory waveform capture, event record and data logger functions.

F. Control Power - The relay shall be suitable for High or Low ranges of available control power.

1. High Range: DC: 88-300 volts DC; AC: 70-265 volts AC, 48 to 62 Hertz.

2. Low Range: DC: 20-60 volts DC; AC: 20-48 volts AC, 48 to 62 Hertz.

G. Communication

1. For remote monitoring, the following communication ports shall be provided:

   a. One Industry Standard port for meter and relay programming using a laptop computer.

   b. One RS-485 port.

   c. One integral 10/100BaseT Ethernet port . The connection shall support Modbus TCP, Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.

   d. The manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

2. The protocol interface shall implement Modbus TCP Protocol with the following as minimum capabilities:

   a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.

   b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".

   c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.

   d. Software tools shall be configurable to write a single register as either function 6 or 16.

   e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.

3. The media protocol converter shall meet the following criteria:

   a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.

   b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30 volts DC at 0.5 amperes minimum.

   c. The converter shall have LED status for serial, signals, power, and Ethernet.

   d. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.

   e. Converter shall be GE MultiLin MultiNet, or approved equal.

2.03 PANEL AMMETER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Bitronics Model ATAIE1

B. True RMS current

C. Three phases displayed simultaneously

1. Three 4-digit red LED display

2. 0-5 A input; selectable scaling for current transformer ratio

3. Aluminum faceplate

D. Control power: 120 VAC

2.04 ELECTROMECHANICAL LOCKOUT RELAY (86)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. GE Model HEA

B. Electric operate, hand reset

1. 120 VAC coil

2. Oval operating handle

C. Six decks, two contacts each

1. Each contact rated 24A (inductive), 120V, 60 Hz

2.05 MOTOR PROTECTION SYSTEM (MP4)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. GE Multilin 469

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Minimum ANSI Functions

1. 14 Speed Switch

2. 19 Reduced Voltage Start

3. 27 Under voltage

4. 32 Jam/Acceleration

5. 37 Undercurrent/Under voltage
6. 38 Bearing Temperature
7. 46 Current Unbalance
8. 47 Voltage Unbalance / Phase Reversal / Phase Failure
9. 49 Stator Temperature
10. 50 Instantaneous Current
11. 50G Instantaneous Ground Current
12. 51 Overcurrent
13. 51G Ground Overcurrent
14. 55 Power Factor
15. 59 Overvoltage
16. 66 Starts per Hour
17. 81 Frequency
18. 86 Overcurrent Lockout
19. 87 Differential Protection

D. General

1. All circuit boards shall have a harsh environment conformal coating to resist H_2S gas and other corrosive agents, including humidity.

E. Protection and Control

1. Thermal model biased with RTD and negative sequence current feedback
2. Start supervision and inhibit
3. Locked rotor / mechanical jam
    a. The relay shall protect the rotor during stall and acceleration. The stall/acceleration curve shall be voltage compensated and a speed switch input shall be available. The stator protective thermal model shall combine inputs from positive and negative sequence currents and RTD winding feedback. The model shall be dynamic in nature in order to follow the loading and temperature of the motor.
4. Voltage compensated acceleration
5. Under voltage, overvoltage
6. Under frequency

7. Thermal overload
8. Over temperature 12 RTDs
9. Phase and ground overcurrent
10. Current unbalance
11. Power Elements
    a. Power factor
    b. Reactive power
    c. Under power
    d. Reverse active power
    e. Over torque
12. Torque protection
13. Reduced voltage starting control

F. Monitoring and Metering
    1. Metering Functions
        a. A, V, W, Var, VA, PF, Hz, kWh, VARh, and kW demand
        b. The system shall include complete power metering. An event record shall store the last 40 events. Sixteen cycles of waveform data shall be stored each time a trip occurs. A simulation feature shall be available for testing the function.
    2. Torque, temperature
    3. Event recorder
    4. Oscillography and data logger
    5. Statistical information and learned motor data
    6. Motor starting reports

G. Inputs and Outputs
    1. 12 RTDs, programmable
    2. Five predefined and four assignable digital inputs
    3. Six output relays
    4. Four analog inputs
    5. Four programmable analog outputs

H. Memory

1. Memory shall be non-volatile and programming shall remain intact upon power failure.

2. Interface software shall be provided in a Windows® format.

I. User Interface

1. A 40-character LCD display and associated keypad to provide access to actual values and set points.

J. Control Power - The relay shall be suitable for 120 VAC control power.

K. Communication

L. For remote monitoring, the following communication ports shall be provided:

a. One Industry Standard port for meter and relay programming using a laptop computer.

b. One RS-485 port.

c. One integral 10/100BaseT Ethernet port . The connection shall support Modbus TCP, Ethernet IP and SNMP.

d. The manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

2. The protocol interface shall implement Modbus TCP Protocol with the following as minimum capabilities:

a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.

b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".

c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.

d. Software tools shall be configurable to write a single register as either function 6 or 16.

e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 16482
MEDIUM VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish assemblies of Class E2 medium voltage motor control centers (MVMCCs), together with appurtenances, complete and operable, as specified herein and as shown on the drawings.

B. Motor control centers shall be sized to include all equipment, spares and spaces shown on the drawings.

C. Dimensions for motor control centers shall be equal to or less than the dimensions shown on the drawings.

1.02 RELATED WORK

A. Section 16195 Power Metering and Protective Relays

1.03 SUBMITTALS

A. Provide systems engineering to produce coordination curves, showing coordination between existing and breakers and/or fuses submitted, such that protective device coordination is accomplished. Such curves and settings shall be included as a part of these submittals.

B. The original MVMCC equipment manufacturer shall create all MVMCC shop drawings, including all wiring diagrams, in the manufacturer's engineering department. All MVMCC shop drawings shall bear the original equipment manufacturer's MVMCC logo, drawing file numbers, and shall be maintained on file in the manufacturer's MVMCC archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

C. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.

2. Conduit entrance drawings, including floor penetrations.

3. Bus arrangement drawings.

4. Unit summary tables showing detailed equipment description and nameplate data for each compartment.

5. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.

6. Schematic diagrams, wiring diagrams, and panel layout drawings for remote pushbutton station.

7. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between units and to remotely mounted devices. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.

8. Master drawing index

9. Front view elevation

10. Floor plan

11. Top view

12. Single line

13. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.

14. Nameplate schedule

15. UL Listing of the completed assembly.

16. Component list with detailed component information, including original manufacturer's part number.

17. Conduit entry/exit locations

18. Assembly ratings including:

    a. Short-circuit rating

    b. Voltage

    c. Continuous current

    d. Basic impulse level

19. Major component ratings including:

    a. Voltage

    b. Continuous current

    c. Interrupting ratings

20. Descriptive bulletins

21. Product data sheets.

22. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.

23. Switchboard floor mat

24. Instruction and renewal parts books.

25. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

D. Factory Tests. Submittals shall be made for factory tests specified herein.

E. Field Test Reports. Submittals shall be made for field tests specified herein.

F. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:

a. Manufacturer's contact address and telephone number for parts and service.

b. Instruction books and/or leaflets

c. Recommended renewal parts list

G. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.04 REFERENCE CODES AND STANDARDS

A. The medium voltage motor control centers and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

2. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus

3. NEMA SG 2, High Voltage Fuses

4. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems

5. NEMA ICS 1 – General Standard for Industrial Control Systems

6. NEMA ICS 3, Part 2

7. UL 347 – High Voltage Industrial Control Equipment

8. NFPA 70 – National Electrical Code (NEC)

9. NFPA 70E – Standard For Electrical Safety in the Workplace

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.05 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and “brand labeled” shall not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for three years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Eaton Cutler Hammer.
2. General Electric Co.
3. Square D
4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

A. The voltage, current and short circuit current ratings of the motor control centers shall be as shown on the Drawings.

B. Motor controller ratings, NEMA 1A, with current limiting fuses, shall be as follows:

2.3 kV
320A

1200 hp
50 kA

C. The vacuum contactor (NEMA 1A) shall be as:

Maximum Operating Voltage		7200V
Maximum Interrupting Current (3 Ops)		6000 Amperes
Rated Current – Enclosed		320 Amps
Rated Current – Open		400 Amps
Short Time Current	30 Seconds	2400 A
	1 Second	6000 A
Impulse Withstand		60kV

D. Feeder and Main load break switch NEMA 1A ratings shall be as follows:

Maximum Voltage (Kv)		5.5
BIL Rating (Kv)		60
Continuous Current (Amperes)		540
Interrupting Capacity (Amperes)	At 0.8 PF	600
	At 1.0 PF	600
Momentary Current	10 Cycles Asym. Amps	61,000
	4 Seconds Sym. Amps	25,000
Fault Closing Current (Asym. Amps.)		61,000

E. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.

F. For additional ratings and construction notes, refer to the Drawings.

2.03 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

2. Units shall be arranged as shown on the Drawings.

3. Nameplates

    a. External

        1) Furnish nameplates for each device as specified herein and as indicated on the Drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.

    b. Internal

        1) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

        2) The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer’s suppliers and sub-suppliers.

    c. Special

        1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

4. Control Devices and Indicators

    a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.

    b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:

        1) Red for ON, Valve OPEN, and Breaker CLOSED.

        2) Green for OFF, Valve CLOSED and Breaker OPEN.

        3) Amber for FAIL.

        4) Blue for READY

        5) White for POWER ON.

c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.

d. Pushbuttons, shall be as follows:

1) Red for STOP and mushroom Red for EMERGENCY STOP.

2) Green for START

3) Black for RESET.

e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

5. Control and Instrument Power Transformers

a. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100VA.

b. Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded and the other leg shall be fused.

B. Enclosures

1. Enclosures shall be 90 inches high, 22 to 48 inches wide (each vertical section) and 30 inches deep, completely front connected.

2. Final complete lineup shall not exceed the overall dimensions shown on the drawings.

3. Controllers shall be mounted not more than one high or be provided with a truck to handle the controller, if in a two-high construction. Controllers shall not be more than two high.

4. The MVMCC shall be supported on a heavy gauge, welded steel channel base extending around all four sides, constructed to exclude rodents, vermin, and dust.

5. Interlocks shall be furnished to prevent operation of the isolating mechanism under load, operating of the high voltage compartment before the controller is isolated, and closing of the line contactors while the door is opened.

6. All non current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

7. Equipment shall be finish painted with one coat of the manufacturer’s standard electrocoated heat cured enamel.

8. Each vertical section shall have heavy duty, 120 VAC, space heaters, thermostat controlled, of sufficient capacity to prevent condensation with the equipment de-energized, while operating at half their rated voltage. Heaters shall be provided with

perforated metal guards and a circuit breaker disconnect. 120 VAC control power shall be provided from the MCC.

9. Each cubicle shall have an exhaust fan, thermostatically controlled, for heat dissipation.

10. Each starter shall have a print pocket containing a laminated copy of all schematics related to the starter.

11. All cables shall enter and exit underground from the bottom of the cubicle, unless otherwise shown on the Drawings.

12. Where the motor control center is shown outdoors the construction shall be NEMA 3R, as shown on the Drawings, and shall be as follows:

    a. The MVMCC shall be non-walk-in of basic indoor equipment enclosed in a weatherproof enclosure. Gasket all covers, provide filters for ventilation louvers and a sloped roof.

    b. Roof structure shall be watertight with a continuous drip edge channel on the front. Roof shall slope to the rear for water drainage. Holes for lifting eyes shall be blind tapped.

    c. Provide tamper resistant, padlockable, weathertight, gasketed cubicle doors and switch handle covers, with stainless steel hinge pins.

    d. Finish shall be ANSI Z55.1, No. 61 light gray enamel over rust resistant primer

C. Construction

1. Isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design with a minimum amount of interconnecting cables. The isolating switch shall be easily removable from the enclosure. Line and load cable terminations shall be completely accessible from the front.

2. The isolating switch shall be an externally operated manual three-pole drawout type, such that in the open position it grounds and isolates the starter from the line connectors with an isolating shutter leaving no exposed high-voltage components. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for padlocking in the open position. The isolating switch shall have a mechanical blown fuse indicating device.

3. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling as is typical with motor starting. The fuses shall include visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be mounted to permit easy inspection and replacement without starter disassembly.

4. Each vacuum contactor shall be of the draw-out, magnetically-held and latched design, rated for the load it serves. Contactor shall have single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be such that the gap can be checked with the use of a “go/no-go” feeler gauge.

5. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high voltage de-energized and isolated, and the contactor in its normal position or in the drawout position. The control circuit shall be capable of being energized through a polarized plug connector from an external 120-volt supply while in the test mode.

6. The low voltage control compartment shall be isolated and barriered from the high voltage area and mounted on a panel with a separate low voltage access door. Mount all low voltage control components in the low voltage control compartment.

7. Each starter cell shall contain a vertical and horizontal low voltage wireway.

D. Busses

1. When starters are grouped together in a lineup, the horizontal main bus shall be located in its own separate, 12-inch high enclosure and isolated from the starters. Each phase shall be insulated. To allow for ease of maintenance or extension of lineups without disassembling starters, the main bus shall be front, top and side accessible.

2. Starters shall be connected by an insulated vertical bus.

3. All bus bars shall be tin-plated copper, rated as shown on the Drawings

4. Provide a 1/4 x 2-inch ground bus throughout the entire lineup. Ground bus shall also be supplied in upper compartments of two-high starters and be bus connected to the ground bus supplied in the lower compartments.

E. Wiring

1. All control wire shall be UL/CSA approved.

2. Standard control wire shall be #14 AWG, stranded, tin-plated, red, dual-rated type XLPE (3173) 125 degrees C, SIS 90 degrees C.

3. Current transformer circuits shall utilize #12 AWG wire with the same characteristics as above. Provide shorting blocks for all current transformers.

4. Provide “plug-in” terminal blocks, rated 600 V, 50 A with clamping collar.

5. Wire markers shall be a molded plastic “clip-sleeve” type.

6. Clamping-collar type terminals shall be used to terminate control wiring. Current transformer circuits shall be provided with ring-type terminals where applicable.

7. All field wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.

8. Provide a single terminal block for all external wiring. Internal wiring and terminal block shall be clearly labeled for field connections.

9. Terminations shall be completely accessible from the front.

2.04 MAIN SECTION

A. General

1. The MVMCC main sections shall include the main switch, metering and power feeder entrance to the MVMCC. Where a power feeder entrance is shown on the Drawings, the power feeder entrance section shall be provided. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings.

2. Power quality meter as shown on the drawings and specified in Section 16195.

B. Main Switches and Feeder Switches

1. Furnish, where shown on the contract drawings, three-pole manually operated quick-make, quick-break load break switches or integrated metal enclosed breakers.

2. The fixed-mounted switches shall fit in one-half of a standard 90-inch high, 36-inch wide vertical structure. Provide mechanical interlocks such that the switch door cannot be opened when the switch is on, and when the door is open the switch cannot be closed. A

C. Lightning Arresters and Surge Capacitors

1. Provide one intermediate type lightning arrester and surge capacitor on each incoming phase where shown on the Drawings. Arresters and capacitors shall be factory installed.

D. Furnish lugs for incoming line feeders, sizes as specified. Allow adequate clearance for bending and terminating of cable size and type specified.

2.05 MOTOR CONTROLLERS

A. General

1. The starters shall be designed to accommodate motors of the size and type as shown on the Drawings.

2. The starters shall accommodate the following motor types:

a. Induction Motor Full-Voltage Start

3. All induction motor controllers shall have integral three-phase power factor correction capacitors with inductors connected on the load side of the run contactor. Manufacturer shall coordinate with motor manufacturer to supply power factor capacitors sufficient to correct PF to .95 lag.

B. Assemblies

1. The following equipment shall be provided for the starter types shown on the Drawings.

a. Each induction motor full voltage starter shall include:

1) Medium Voltage Section

a) One – Fixed portion isolating switch with shutter mechanism

b) One – Removable portion isolating switch with blown fuse indication

c) Three – Clip-in Current-limiting power fuses

d) One – Stab-in three-pole main vacuum contactor assembly

e) One – Control circuit transformer

f) Two – Control circuit primary current limiting fuses

g) One – Control circuit secondary fuse

h) One – Run-test circuit

i) Four – Electrical interlocks

j) One 3-phase current transformer suitable for use with the motor protection relay

k) Three – Current transformers

l) One – Zero sequence ground fault current transformer]

2. Low Voltage Compartment and Door

a) One – Motor Protection Relay as specified in Section 16195

b) One – Interposing control relay

c) One – Set of control circuit terminal blocks

d) Two – PTs, Open Delta,

e) Isolation switch viewing window to verify switch position

f) One – CT shorting terminal block

2.06 REMOTE PUSHBUTTON STATION

A. General

1. Provide remote pushbutton station as shown on the drawings.

2. Control devices and indicators as specified above.

3. Wiring as specified above.

B. Enclosure

1. Size shall be as required for the components included.

2. NEMA 4X, 316 stainless steel.

3. Cover hinged with continuous stainless steel hinge on one side

4. Three-point latch, lockable

2.07 SPARE PARTS

A. Provide the following spare parts:

1. Three – Control fuses of type used.

2. One dozen each of cover bolts, spring nuts and door fasteners.

3. One quart of touch-up paint.

B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.08 FACTORY TESTING

A. The Motor Control Center shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Prior to factory testing, the manufacturer shall check to see that all selections and settings required by the Power System Study Engineer have been performed.

C. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

E. The manufacturer shall provide three certified copies of factory test reports as specified in Paragraph 1.03D.

PART 3 - EXECUTION

3.01 MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist the Owner in installation and start-up of the equipment specified under this Section for a period of not less than two working days. The manufacturer's field engineer shall provide technical direction and assistance to the Owner in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The manufacturer's field engineer shall provide three copies of the manufacturer's field testing report.

3.02 FIELD TESTING

A. The manufacturer's field engineer shall make all electrical field tests recommended by the manufacturer, and including the following tests.

1. Verify tightness of all bolted connections by calibrated torque-wrench in accordance with manufacturer's published data.

2. Confirm the correct application of manufacturer's recommended lubricants.

3. Perform a contact resistance test.

4. Perform an insulation-resistance test on all control wiring at 1000 volts dc. Disconnect all connections to solid-state equipment prior to testing.

5. Perform an insulation-resistance test on all other wiring and current carrying parts at a minimum dc test voltage of 2500 volts dc, pole-to-pole, pole-to-ground, and across open poles. Minimum values shall not be less than 5,000 Megohms. In no case shall the manufacturer's maximum test voltages be exceeded.

B. The tests shall adhere to manufacturer's testing recommendations for the proper testing methods and test voltage levels for each piece of equipment. Readings that fall below manufacturer's recommended values will not be acceptable and the manufacturer shall be required to perform any necessary remedial action before the busing is energized. A data sheet shall be submitted to the Owner/Engineer for the MVMCC. The test report shall include the following equipment information:

1. MVMCC Name and Number:

2. MVMCC Manufacturer:

3. MVMCC Nameplate Data:

    a. Volts:

    b. Horizontal Bus Amps:

    c. Main Switch Amps:

    d. Insulation Test (measured):

        1) Phase A-B:

        2) Phase B-C:

        3) Phase C-A:

        4) Phase A-G:

        5) Phase B-G:

        6) Phase C-G:

    e. Equipment disconnect during test:

    f. Date of Test:

g. Tested by:

C. Where test reports show unsatisfactory results, the Owner/Engineer may require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Manufacturer shall bear all cost for any retesting.

3.03 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.

B. The training shall be for a period of not less than one eight-hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner’s use.

END OF SECTION