SPECIFICATIONS

Medium Voltage Controller

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PART 1 GENERAL

1.01 SUMMARY

A. Section includes
   1. This specification covers the design, manufacture, test, supply and delivery of medium voltage controllers

B. Related Sections
   1. _____
   2. _____
   3. _____

1.02 QUALIFICATIONS

A. Manufacturer
   1. The manufacturer shall have a minimum of 20 years experience in the manufacture of medium voltage controllers for use in similar applications at the specified voltage and power ratings. A user list, complete with contact names and telephone numbers, shall be furnished upon request.
   2. The approved manufacturers are:
      a) Rockwell Automation, Allen-Bradley brand
      b) Substitutions: None permitted

B. Support
   1. The manufacturer shall maintain factory trained and authorized service facilities within 100 miles of the project and shall have a demonstrated record of service for at least the previous ten years.
   2. Support personnel are to be direct employees of the manufacturer.
   3. The manufacturer shall provide all required start-up and training services.
   4. The approved support organizations:
      a) Rockwell Automation, Global Manufacturing Services (GMS) Division
      b) Substitutions: None

C. Quality Assurance
   1. The controller shall be factory pre-wired, assembled and tested as a complete package by the controller supplier.
   2. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
   3. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.
   4. All sub-assemblies shall be inspected and/or tested for conformance to Supplier's engineering and quality assurance specifications.
   5. All printed circuit boards with active components shall be burned-in for a minimum of 48 hours at 60ºC (140°F).

1.03 REFERENCES

A. Controller
   1. Canadian Standards Association (CSA) "Industrial Control Equipment C22.2 No. 14"
   2. American National Standards Institute (ANSI) "Instrument Transformers C57.13"
   3. Institute of Electrical & Electronic Engineers (IEEE) (IEEE C37.20.7, Guide for Testing Arc Resistant Medium Voltage Switchgear)
   4. Electrical & Electronic Manufacturers Assoc. of Canada (EEMAC)
   5. National Electrical Manufacturers Association (NEMA) "Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)"
   6. Underwriters Laboratories, Inc. (UL) (High Voltage Industrial Control Equipment 347)
   7. European Directives for Safety and EMC
   8. National Electrical Code (NEC)
   9. Occupational Safety & Health Act (OSHA)

1.04 ENVIRONMENTAL REQUIREMENTS

A. Confirm to specified service conditions during and after installation of products
B. Maintain area free of dirt and dust during and after installation of products

1.05 PRE-MANUFACTURE SUBMITTALS

A. Refer to Section _____ for submittal procedures
B. Drawings
   1. Elevation drawings showing dimensional information
   2. Structure Descriptions showing
      a) Enclosure ratings
      b) Fuse ratings
      c) Load/line cable size and entry/exit direction
      d) Other information as required for approval
   3. Conduit locations
   4. Unit Descriptions including amperage ratings, frame sizes, pilot devices, etc.
   5. Nameplate Information
   6. Schematic wiring diagrams

C. Product Data
   1. Publications related to the controller(s)
   2. Data Sheets and Publications on all major components such as the following
      a) Contactors
      b) Circuit Breaker and Fuse information including time current characteristics
      c) Control Power Transformers
      d) Pilot devices
      e) Relays
      f) Operator Interface

D. Spares
   1. Recommend spare parts list and list prices shall be supplied.
   2. Critical Spares - Spare parts that are identified as being associated with long lead times and/or are critical to the unit's operation. These spares should be held in reserve by the Purchaser to limit unforeseen downtime.
   3. Maintenance Spares - Spare parts that are identified as being required to regularly perform scheduled maintenance on their equipment. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

E. Specification Response
   1. Detailed response to this specification showing where in the literature and drawings each requirement is satisfied.
   2. All clarifications and exceptions must be clearly identified.

F. Testing and Test Reports
   1. Testing shall be per manufacturer's standard.
   2. A copy of the test reports shall be provided as part of the Closeout documentation, if requested.

1.06 CLOSEOUT SUBMITTALS

A. Refer to Section _____ for procedure on submittal of closeout documentation.
B. Contractor shall provide certification that the controller has been installed in accordance with the manufacturer's instructions.
C. The Contractor shall provide certification that the Contractor has properly adjusted any timing devices required in the starting circuitry.
D. Final Drawings. The manufacturer shall provide final drawings reflecting the "As-Shipped" status of the controller. The Contractor shall be responsible for making any changes to the "As-Shipped" drawings from the manufacturer to reflect any field modifications.
E. Maintenance Data
    1. Controller installation instructions and User Manual
    2. Installation / Operation instructions for major components such as circuit breakers, contactors, isolation transformers, etc.
    3. Field Service report from start-up service
    4. Spare parts listing and pricing
    5. Include name and phone number for a local distributor of spare parts.

1.07 DELIVERY, STORAGE AND HANDLING

A. Contractor shall coordinate the shipping of equipment with the manufacturer.
B. Contractor shall store the equipment in a clean and dry space according to manufacturer's specification.
C. The contractor shall protect the units from dirt, water, construction debris and traffic.
D. During storage the contractor shall connect internal space heaters (if specified) with temporary power.

1.08 FIELD MEASUREMENTS

A. The Contractor shall verify all field measurements prior to the fabrication of the controller(s).

1.09 SPARE MATERIALS BILL OF MATERIAL

A. Fuses
   1. Provide a minimum of one set (3) of each type of medium voltage fuse supplied with the controller for each set of five installed.
   2. Provide a minimum of one set of each type of low voltage fuse supplied with the controller for each set of five installed.

B. Contactors
   1. Provide one set of 3 contactor vacuum bottles for each size of medium voltage vacuum contactor supplied with the controller.
   2. Provide one spare vacuum contactor control module (IntelliVAC - optional).

C. Isolation Switch
   1. Provide one spare isolation switch blade assembly for each amp rating installed.
   2. Provide one spare isolation switch auxiliary contact for each set of five installed.
   3. Provide one spare isolating switch cam follower for each type installed.
   4. Provide one spare isolating switch stationary stab for each amp rating installed.

D. Provide one spare motor protection relay for each type supplied with the controller.
E. Provide one spare overload relay supplied with the controller.
F. Provide one spare control relay for each type of relay supplied with the controller.
G. Provide one spare MOV assembly of each type supplied with the controller.

1.10 WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.
B. The manufacturer shall confirm this warranty as part of the submittal.

PART 2 PRODUCTS

2.01 RATINGS

A. Voltage
   1. The controller shall accept nominal plant power of [2400V], [3300V], [4200V], [4800V], [6600V], [6900V], [7200V], [Other_____] at [50Hz] [60Hz].
   2. The supply input voltage tolerance shall be plus or minus 10 percent of nominal line voltage.
   3. The supply frequency tolerance shall be plus or minus 3 percent.

B. Environmental Ratings
   1. Storage ambient temperature range: -20°C to 75°C (-4 to 149°F).
   2. Operating ambient temperature range: 0°C to 40°C (32 to 104°F) without derating.
   3. The relative humidity range is 0% to 95% non-condensing.
   4. Operating elevation: up to 1,000 Meters (3,300 ft) without derating.

C. Sizing
   1. Load data shall be as shown on the dimensional drawings, if data is provided.

2.02 STRUCTURE

A. The structure shall consist of a metal enclosed free-standing dead-front vertical steel assembly.
B. The structure shall also have a non-removable base channel and removable lifting means for ease of installation.
C. The controller(s) shall be designed for front access to allow for installation with no rear access. Equipment that requires rear or side access for installation shall not be accepted.
D. Enclosure
   1. Controller enclosures shall be NEMA Type 1
      Optional: [NEMA Type 1A, with door gaskets] or [NEMA Type 12, oil and dust tight]
   2. Optional: Arc resistant structure (selected units), tested per IEEE C37.20.7™, Type 2 Accessibility, which shall provide the following benefits:
      - Reinforced structure, to contain arc flash material, at faults up to 40 kA, 0.5 seconds
      - Arc vent to exhaust arc flash material
      - Plenum to redirect arc flash material
      - Reinforced low voltage panel, sealed to prevent entry of arc flash material

3. The enclosure shall be properly sized to dissipate the heat generated by the controller at its full ratings within the limits of the specified environmental operating conditions.
4. LV door latches shall be heavy-duty ¼-turn type units.
5. Medium Voltage doors shall be held closed using 3/8" bolts.
6. All back plates shall be removable.

E. Low Voltage Wireway [optional]
1. A low voltage wireway, if specified, shall be available across the roof at the front of the structure.
2. The low voltage wireway shall provide a convenient method of interconnecting control wire from one controller to another.
3. Low voltage wireway shall be separated from MV and LV control compartments.

F. Structure Finish
1. All exterior metal parts (except for low voltage panel and power cell back plates) shall be painted with hybrid epoxy powder paint ANSI 49 medium light gray [ANSI 61 light gray]
2. All mounting plates in the power cell and low voltage compartments shall be painted high gloss white for enhanced visibility.
3. Painting shall be done on a continuous paint line through air-atomized electrostatic spray. All parts shall be painted before assembly.
4. The preparation shall be Alkaline wash/rinse; iron phosphate rinse; iron-chrome sealer rinse; re-circulated de-ionized water rinse and virgin deionized water rinse
5. Total paint thickness – 0.002" (0.051 mm) minimum
6. Baking process shall be by Natural gas oven at 179°C (355°F) minimum.
7. All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

G. Nameplates
1. Provide master nameplate for controller.
2. Provide unit nameplates.
3. Provide legend plates for all pilot devices.
4. Nameplates plates shall be engraved phenolic (1.125 inches x 3.625 inches) with black background and white lettering.

H. Cabinet Space Heater [optional]
1. Provide cabinet space heaters and thermostat rated for 100W at 120V (85W at 110V, 330W at 220V) to help prevent condensation inside the enclosure during periods of inactivity.
2. For two-high units, provide one space heater for each unit.
3. The space heater shall be energized whenever power is removed.
4. Provide a white “Enclosure Space Heater On” pilot light mounted on the enclosure door.
5. Power for the space heater shall be provided remote from controller. The power source shall be [120V] [220V].

I. Seismic Qualifications
   1. The equipment shall be bolted down (mounted) per the Seller's recommended installation instructions.
   2. The properly installed equipment shall be capable of withstanding horizontal and vertical accelerations (seismic zones 1, 2, 3, and 4) without overturning or lateral movement.

2.03 POWER AND GROUND BUS

A. Bus Bracing
   1. The horizontal/vertical buswork and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347.
   2. The bus work and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.
   3. The horizontal bus fault withstand current rating shall be 60 kA RMS symmetrical for 10 cycles.
   4. The vertical bus fault withstand current rating shall be 50 kA RMS symmetrical for one half cycle.

B. Horizontal Bus
   1. The main horizontal power bus shall be located in the center, at the back of the structure, to provide optimum heat distribution, ease of maintenance and splicing.
   2. To provide better short-circuit withstandability and to protect against the accumulation of dust and tracking between phases, the power bus shall be mounted on edge to a molded bus support insulator in a common vertical plane.
   3. The power bus shall be made of tin-plated [Silver plated] copper and shall have a continuous current rating of [1200A] [2000A], [3000A]. The main power bus will be non-insulated [insulated].
   4. Access plates shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.
   5. The horizontal buswork, the cabling/bus from the main power cell shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347 (paragraph 30).
   6. When optional insulated power bus is specified for the main horizontal bus, a sleeve-type, heat shrink insulating material with good flame resistance and self-extinguishing properties, shall be used. This material shall have a minimum wall thickness of 1.4 mm (0.055 in.), and a minimum dielectric strength of 49.5 kV.

C. Vertical Bus
   1. Provide vertical power bus risers from the main horizontal power bus to the isolating switch line terminals.
   2. The vertical risers shall be tin-plated copper.
   3. Cabling from the main horizontal power bus to the isolating switch is not acceptable.

D. Ground Bus
   1. A continuous copper ground bus shall be provided along the entire length of the controller line-up.
   2. A mechanical lug for #8 to #1/0 AWG or #6 to 250 MCM cable shall be supplied at the incoming end of the line-up.
   3. The ground bus shall be 1/4" x 2" (6.4 x 51 mm), bare [tin-plated] copper.

2.04 DEVICENET COMMUNICATIONS

A. The controller shall have DeviceNet wiring incorporated into its design.
   1. The controller shall have DeviceNet cabling integrated throughout the sections.
   2. Each controller shall be supplied with a means to communicate via DeviceNet and shall be capable of monitoring at least two input points.

B. DeviceNet Cabling
   1. All units shall be interwired and tested as a NEMA Class II controller
   2. Cable Ratings
      a) The trunk line and drop lines shall be flat cable rated eight amperes, 600V, Class 1.
      b) The cable used to connect a unit to a DeviceNet port shall be round cable rated eight amperes, 600V, Class 1.
      c) The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

   3. Layout
      a) A DeviceNet trunkline shall be routed through a 6" x 6" (153 mm x 153 mm) low voltage wireway located on the top of each section to prevent accidental mechanical damage during controller installation.
      b) A DeviceNet dropline shall be routed into the low voltage control panel of each unit.
      c) Two DeviceNet ports shall be provided in the low voltage control panel of each unit to simplify installation of DeviceNet products.

4. Power Supplies
   a) The controller manufacturer shall check the user's design to ensure that adequate power supplies have been specified to conform to DeviceNet requirements.
   b) The power supply shall provide 24 VDC for the DeviceNet system and shall be rated no less than eight (8) Amps.
   c) The power supply for the DeviceNet system can be supplied within the line-up of controllers if acceptable for the overall DeviceNet system layout.

C. DeviceNet Interfaces
   1. Motor Controllers
      a) Each motor controller shall have an electronic overload relay that can be monitored using DeviceNet communications.
      b) The relay shall incorporate the following features.
         i. On-board DeviceNet communications
         ii. LEDs for status indication
         iii. Test / Reset Button
         iv. Adjustable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation.
         v. Four inputs and two outputs. Refer to the drawings for connection requirements.
         vi. Protective Functions
            a. Functions shall provide a programmable trip level, warning level, time delay, and inhibit window.
            b. Protective functions shall include thermal overload, underload, jam, current imbalance, stall, phase loss, zero sequence ground fault (if specified) and PTC thermistor input (if specified on drawings).

         vii. Current Monitoring Functions shall include phase current, average current, full load current, current imbalance percent, percent thermal capacity utilized and ground fault current (if specified).
         viii. Diagnostic Information shall include device status, warning status, time to reset, trip status, time to overload trip and history of last five trips.

   2. Solid-State Controllers
      a) DeviceNet Communication interface shall be supplied to allow for communications between the solid-state component and the DeviceNet system.
      b) The communication interface shall have four input points to allow for the monitoring of additional unit points.
      c) Refer to wiring diagrams for points to be monitored.

3. Miscellaneous Units
   a) Provide a DeviceNet interface for miscellaneous units as indicated on the drawings.
   b) The DeviceNet interface shall have four inputs and two outputs.
   c) Refer to the wiring diagrams for points to be monitored.

D. Programming and Testing
   1. The controller manufacturer shall load the DeviceNet MAC ID number (node address) into each unit.
   2. The DeviceNet MAC ID number shall be as indicated or as provided by the Contractor.
   3. The DeviceNet System components shall be preconfigured to operate at the appropriate baud rate.
   4. The controller manufacturer shall test the controller to insure that each unit communicates properly prior to shipment.

2.05 MAIN DISCONNECT

A. Provide main overcurrent protection as indicated on the drawings.
B. The withstand rating of the main shall be greater than or equal to the bus bracing for the controller.
C. Provide lugs to accommodate the line conductors as indicated on the drawings.
D. If no overcurrent protection is indicated, provide a main incoming lug compartment.
E. Provide metal oxide station type surge arrestors [optional].
F. Main Fusible Disconnect
   1. The main disconnect shall utilize a three-pole gang-operated load break switch with an external operating handle.
   2. A quantity of (3) current limiting power fuses shall provide the overcurrent protection.
   3. The operating handle shall be fully interlocked with the power cell door.
   4. Provisions shall be provided on the operating handle for key interlocking.
   5. The power cell door shall be provided with a viewing window to examine the switch position.
   6. Inside the power cell, provide a protective guard to isolate the medium voltage line terminals when the power cell door is open.

2.06 FEEDER DISCONNECT

A. Provide feeder disconnects with overcurrent protection as indicated on the drawings.
B. The disconnect shall be a fused load break switch.
C. A quantity of (3) current limiting power fuses shall provide the overcurrent protection.
D. Units shall be provided in two high construction for units rated 400 Amps and below.
E. The feeder disconnect unit shall consist of three isolated compartments.
    1. Power Bus Compartment
    2. Power Cell
    3. Low Voltage Panel (Optional Item)
    4. The functional compartment specifications shall follow the motor specification where applicable.

F. Provide (3) load cable terminals

2.07 ACROSS THE LINE CONTROLLER

A. Provide the quantity of across the line motor starters and/or transformer feeders, as indicated on the drawings.
B. The structure shall be divided isolated compartments
    1. Main power bus and ground bus compartment
    2. Power cell compartment
    3. Low Voltage compartment
    4. Low voltage wireway across the roof of the structure if specified

C. Power Cell Compartment
    1. Main Isolating Switch
        a) The main power cell shall have an externally operated, 3-pole, gang operated, fixed mounted non-load-break isolating switch.
        b) The isolating switch shall isolate the power bus compartment from the power cell by means of a positively driven shutter mechanism to prevent accidental contact with line terminals in the power bus compartment.
        c) The main power cell door shall have a viewing window through which the operator can verify that the isolating switch position.
        d) The isolating switch shall only have the ability to interrupt the no-load (magnetizing) current of the control power transformer(s) (CPT) and/or potential transformers (PT) supplied inside the controller power cell.
        e) In the open position, the isolating switch and contactor shall provide a means of grounding appropriate medium voltage power cell components, bleeding off hazardous stored energy, thus providing safe operation and maintenance.

f) One or more N-O and N-C auxiliary contacts shall be arranged to open the secondary circuit of the CPT and/or PT, de-energizing the control circuit. This is to ensure there is no load on the isolating switch when it is opened or closed. The contacts shall also prevent backfeeding through the CPT and/or PT, and isolate the power cell when the control circuit is in the TEST mode. It shall only be possible to operate the TEST control circuit when the isolating switch is in the open position. The auxiliary contacts shall have a NEMA contact rating of 2 x A600 and 2 x P600.
g) The isolating switch shall remain connected to the external operating handle at all times. The isolating switch shall also be mechanically and electrically interlocked with the main contactor.
h) The external isolating switch operating handle shall have provisions to be padlocked, with up to three (3) padlocks in the open position, and one (1) padlock in the closed position. The closed position shall be located and marked, but shall be drilled out by the USER to allow insertion of the padlock.
i) The power cell door on each controller shall be interlocked with the isolating switch such that any medium voltage door(s) cannot be opened when the isolating switch is fully closed, and the isolating switch cannot be closed with the door(s) open (without defeating the safety interlock).

2. Interlocking
   a) Provide mechanical interlocking (including cable interlocks, horizontal ram interlocks and vertical ram interlocks) to prevent the opening of any power cell door or medium voltage compartment until the non-load-break isolating switch is fully in the open position and power is removed (the external operating handle must be in the “OFF” position).
   b) Optional key interlocks, configured to operate with the operating handle or power cell door, shall be available when interlocking is required with another specified device, i.e. main breaker, load-break switch, starter, etc.

3. Power Fuses and Fuse Holders
   a) The power cell shall be designed to accept bolt-on or clip-on current limiting power fuses.
   b) The medium voltage product shall have fixed power fuse holders that are separately mounted in the power cell, not on the contactor, and are located to allow easy inspection and replacement without any disassembly or removal of other components.
   c) The power fuses shall provide visual condition indication by way of a spring-actuated blown fuse indicator.
   d) The power fuse size shall be selected based on load data provided by client. If the data is not provided, assumed data will be used to size protective devices.

4. Current Transformer
   a) The medium voltage power cell shall include three (3) current transformers of sufficient VA capacity to meet the requirements of all the devices connected to them.
   b) Each current transformer shall have the primary rating sized appropriately in relation to the full load current rating of the motor or feeder. The secondary of the current transformers shall have a 5 amp output and accuracy suitable for the type and quantity of protection or metering devices connected to it. All current transformer control wiring shall be terminated on the current transformer with locking-type, fork tongue lugs.
   c) An appropriate load termination location shall be provided to accommodate lugs with single or two-hole mounting, for connection of the load cables.
   d) The power cell shall have provisions to locate a toroid (donut) style, ground fault sensing current transformer, when the zero sequence ground fault protection feature is required.

5. Control Power Transformer
   a) The control power shall be 120 VAC and shall be obtained from a control power transformer (CPT) located in each controller power cell.
   b) The dry-type CPT shall be 500 VA in size, providing approximately 350 VA extra capacity for the customer's use when the standard control circuit is supplied.
   c) The secondary circuit of the transformer(s) shall be disconnected from the control circuit by means of the isolating switch auxiliary contacts. This is to ensure the isolating switch does not make or break load current, to prevent backfeeding through the transformer(s) and to isolate the power cell when the control circuit is in the “TEST” mode.
   d) The standard control power transformer used in the controller shall be a compensated type with output accuracy of approximately 4% over nominal at no load.
   e) Appropriately sized primary and secondary fuses shall be supplied.
      i. The primary side of the control power transformers and/or potential transformers shall be protected by current limiting fuses sized according to requirements. The interrupting rating of the primary fuses shall be 50 kA symmetrical.
      ii. The secondary side of the control power transformer and/or potential transformers shall be fused appropriately to protect the transformer(s) from overloads. The standard control circuit shall have one leg of the secondary grounded.

6. Vacuum Contactor Specifications
    a) The electrically (magnetically) held medium voltage contactor shall be the Allen-Bradley Bulletin 1502 vacuum type or equivalent.
    b) The open current ratings shall be used 400 [800] Amps
    c) The contactor shall have visual contact wear indicators. No special tools or gauges are required for checking contact wear.
    d) Vacuum bottle and coil maintenance shall not require removal of the vacuum contactor.
    e) To ensure solid, continuous contact while lowering maintenance requirements, the vacuum contactor shall be fixed mounted inside the power cell. The contactor shall be interlocked with the nonload-break isolating switch, both electrically and mechanically, to provide the following safety features:
        i. Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
        ii. Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
        iii. Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
        iv. Removal of control power from the control power transformer (CPT), potential transformers (PTs) or external power source to the control circuit when the isolation switch and contactor are in the open position.

D. Low Voltage Compartment
1. Each controller shall have a separate, front accessible, low voltage control compartment. The compartment shall be completely isolated, using metal barriers between the low voltage compartment and the power cell and/or main power bus compartments.
2. The low voltage panel shall allow for front access without turning the controller OFF when opening the low voltage panel door.
3. The panel shall be of a swing-out design to provide easier access to the power cell for bus splicing, to make load cable connections and to provide easier access to extra medium voltage components. The panel shall be interlocked with the power cell compartment to prevent the panel from swinging open until the power cell is OFF and isolated from the main power bus.
4. Meters, protective relays, selector switches, operators, indicating lights, etc., shall be mounted on the front of the low voltage control panel, and arranged in a logical and symmetrical manner.
5. Provide space for low voltage control devices, transducers and metering.
6. Provide necessary quantity of terminal blocks.
7. All remote low voltage cable shall be able to enter from the top or bottom of the structure. Access to the wireways shall be by means of removable entry plates on the top and bottom of the structure.
8. Pilot control relays (or optional IntelliVAC control module) shall be used to operate and economize the vacuum contactor.

9. Optional IntelliVAC control shall be available with the following features:
   - Universal input voltage (110-240 VAC, 50/60 Hz or 110-250 VDC)
   - Consistent vacuum contactor pick-up time
   - Selectable and repeatable vacuum contactor drop-out time
   - Altitude compensation (400 Amp contactors)
   - Power loss ride-through (TDUV)
   - Temporary motor jog function
   - Delayed motor re-start
   - Anti-kiss and anti-plugging protection
   - Status indication (LEDs and relay outputs)

10. The control panel supply voltage shall be 110/120 or 220/230 VAC. It shall be rectified to provide a DC operating voltage for the vacuum contacor coils and economizing relay.
11. There shall be a 2-pole, 3-conductor (with a grounding prong) male plug to provide a means of connecting a 2-pole, 3-conductor receptacle from a remote 120 VAC, 60 Hz supply to operate the control circuit when it is in the TEST position (for North American power cords only).

E. Control Wire
   1. The control wire shall be insulated with a flame retarding thermoplastic (TEW) compound, flexible, stranded, tinned copper wire supported and neatly bundled.
   2. Red wire shall indicate AC control, blue wire shall indicate DC control, and green wire shall indicate ground. Other colors or combinations shall be used for specific applications.
   3. The control wire shall be isolated from high voltage components in the power cell (whenever possible), and wire markers which are numbered according to the electrical diagram, shall be provided.
   4. All of the control wire terminations shall be a screw-type, copper compression-type terminal block or connector which firmly grips the conductor.
   5. Non-insulated, locking-type, fork tongue lugs shall be provided on the control wire terminating on the control power transformer(s) and current transformers.

2.08 REDUCED VOLTAGE AUTOTRANSFORMER CONTROLLER

A. Provide the quantity of reduced voltage autotransformer controllers as indicated on the drawings.
B. Incorporation of the reduced voltage autotransformer controller into the controller shall comply with the specifications for across the line starters.
C. The reduced voltage autotransformer controllers shall be a closed transition design and include three fixed mounted vacuum contactors (1S, 2S and Run).
D. Provide a three winding autotransformer
   1. The transformer shall be rated for medium duty.

2. The transformer shall be three winding.
3. The transformer shall have taps for 50, 65 and 80 percent. Unless indicated, factory wired using the 65 percent tap.

E. Protection and control arrangement will be the same for all motor controllers.

2.09 UNIT MODIFICATIONS (OPTIONS)

A. Motor Protection Options
1. For across the line and reduced voltage auto-transformer controllers, provide a solid state overload motor protective relay.
a) The motor protective relay shall be Allen-Bradley Bulletin 825P.
b) The relay shall provide the following protective features
i. Electronic motor overload
ii. Phase imbalance
iii. Jam
iv. Underload
v. Ground (Earth) fault
vi. Starting time monitor
vii. Limited starts per hour

c) Standard RS 232 communication shall be available via the front of the relay to enable programming.
d) An optional communication interface DeviceNet [Modbus RTU] shall be available.
e) The relay shall be provided with a current converter module, to provide CT isolation, mounted on the low voltage panel.
f) An optional voltage input card shall be provided, to enable the following metering functions: Volts, kW, kVA, kVAR, PF
g) Optional RTD inputs (12) shall be provided.

B. Motor Run Time Meter
1. Provide a digital, non-resettable, door-mounted elapsed time meter.
2. The meter shall have six digits with tenths.
3. The meter shall be electrically interlocked with the contactor to indicate actual motor operating hours.

C. Motor Heater Control
1. Motor Heater Control
2. Provide control circuitry to interface with a remote 120 VAC / 2700W power source to energize the motor heater whenever the motor is not running.
3. The heater shall be interlocked with the motor run relay and shall be energized whenever the motor is not running.
4. Provide a white pilot light mounted on the enclosure door for indication of Motor Heater On.

D. Low Voltage Surge Suppressors
1. Provide low voltage surge suppressors across each 120V coil in the control circuit.

E. Metering
1. Main Switch or Incoming Section
a) Provide a digital metering system.
b) The metering system shall consist of a monitoring unit and display module. The unit shall be shipped with the necessary current transformers and potential transformers.
c) Monitoring Unit
i. The monitoring unit shall Rockwell Automation Allen-Bradley Powermonitor 3000 [Powermonitor II].
ii. The monitor shall have the following metering capability
a. Phase current (A-B-C) with plus or minus 0.2 percent accuracy
b. Average three phase current and neutral current with plus or minus 0.2 percent accuracy
c. Phase to phase and phase to neutral voltages with plus or minus 0.2 percent accuracy
d. Current and voltage unbalance
e. Power functions kW, kVA and kVAR with plus or minus 0.4 percent accuracy
f. Demand functions kW and kVA with plus or minus 0.4 percent accuracy
g. Energy functions kWH and kVAH with plus or minus 0.4 percent accuracy
h. Power factor with plus or minus 0.4 percent accuracy
i. Frequency with plus or minus 0.05 percent accuracy
j. Distortion analysis with THD, Crest Factor (I, V) and Distortion Power Factor
k. Maximum metering update rate of 50ms.
iii. The monitor shall have a control relay output.
iv. The monitor shall be ANSI/IEEE tested to meet or exceed the Surge Withstand Capability (SWC) C37.90.1 – 1989 for protective relays and relay systems on all power connection circuit terminations.

d) Display Module
i. The display module shall be as manufactured by Rockwell Automation Allen-Bradley.
ii. The display module shall have a highly visible LED display.
iii. The display shall be five inches square and designed to fit into a circular cut-out that is four inches in diameter.
iv. The display shall be utilized for viewing data and for programming of the monitoring unit.

e) Potential Transformers
i. A common set of two (2) PTs can provide voltage reference for one MCC line-up.

2. Controllers
   a) Provide switchboard type (4 ½ inch) metering.
   b) Provide analog ammeter with ammeter switch.
   c) Provide analog voltmeter with voltmeter switch.
   d) Provide (3) current transformers.
   e) Provide (2) potential transformers with primary and secondary fusing.

3. Feeder Units
   a) Provide switchboard type (4 ½ inch) metering.
   b) Provide analog ammeter with ammeter switch.
   c) Provide analog voltmeter with voltmeter switch.
   d) Provide (3) current transformers.
   e) Provide (1) potential transformer with primary and secondary fusing.

F. Pilot Devices
   1. Pilot devices shall be Allen-Bradley Bulletin 800H (NEMA Type 4/4X/13) and shall be mounted on the enclosure door.
   2. For motor starters, provide a “Hand/Off/Auto” selector switch for start-stop control and pilot lights for indication of the “Hand” and “Auto” modes.
   3. For motor starters, provide Start and Stop push buttons. For solid-state reduced voltage starters also provide either a Pump Stop or Soft Stop push button.
   4. For motor starter provide pilot lights, mounted on the enclosure door, for indication of ON, OFF and OVERLOAD. Pilot lights shall be transformer type.

G. Terminal Blocks
   1. Provide ten additional unwired terminal blocks in each unit.
   2. Must be Allen-Bradley type 1492.

H. Auxiliary Relays
   1. Provide auxiliary control relays as indicated on the drawings.
   2. The relays shall be Allen-Bradley 700P or 700CF relays.

PART 3 – EXECUTION

3.01 MANUFACTURE TESTING AND INSPECTION

A. Standard Testing
   1. The following tests shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), European Standard (EN), and International Electrotechnical Commission (IEC).
   2. Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.
   3. A “HI-POT” dielectric withstand test shall be performed on all buswork and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product’s nominal AC voltage.
   4. Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
   5. Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.
   6. Medium Voltage starters shall be inspected for the following:
      a) Electrical interlocking
      b) Motor protection and ground fault if applicable

B. Physical Inspection
   1. The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.
   2. All bus and bus connections shall be checked for proper clearance, creepage, phasing, and torque.
   3. Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
      a) Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
      b) Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
      c) Operation of isolation switch handle and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.

C. Factory Inspections
   1. Visual Inspection of Equipment
      a) The cost of Visual Inspection of the equipment shall be included as a separate line item in the proposal.
      b) The visual inspection shall consist of a Purchaser visit to the factory, with prior notification and coordination with the Customer Service Coordinator or the Project Manager, with the intent to view the customer-specific equipment at the various stages of build during the visit.
      c) There is no preparation of the equipment for this inspection. This inspection allows the Purchaser to verify the progress of the order without any disruption to the manufacturing cycle.
      d) If requested, a review of the electrical and mechanical drawings for the purchased equipment shall be done with the Supplier's Application Engineer or Project Manager prior to commencing the inspection.

   2. Witness Testing
      a) The cost of Witness Testing of the equipment shall be included as a separate line item in the proposal.
      b) The Application Specialist will shall host the Purchaser for the duration of the actual testing. At the conclusion of testing, the customer shall reconvene with the Application Specialist or Project Manager to discuss any concerns or issues that arose during the test. Any modifications or changes requested by the Purchaser will be documented and discussed at this meeting. The Project Manager or Applications Specialist shall respond to the Purchaser at the earliest possible time with an outline of the financial and/or schedule impact of the changes.
      c) If requested, a review of the electrical and mechanical drawings for the purchased equipment shall be done with the Supplier's Application Specialist or Project Manager prior to commencing the tests. Any questions or clarifications, prior to commencing the test, shall be addressed at this time.
      d) The medium voltage starter testing shall consist of demonstrating an AC high pot test to the customer. No medium voltage shall be applied to the controller.
         i. While in the TEST position, control power at the rated voltage shall be applied to the equipment and a functional demonstration of the purchased options and control devices shall be completed. The operation of the vacuum contactor shall be demonstrated.
         ii. The starter shall be placed in the NORMAL position and the operation shall be demonstrated.
      e) A Certified Test Report shall be issued to the Purchaser, if requested.

3.02 MANUFACTURER'S FIELD SERVICES

A. The service division of the controller manufacturer shall perform all start-up services. The use of third party supplier start-up personnel is not allowed.
B. Start-up personnel shall be direct employees of the controller manufacturer.
C. At a minimum, the start-up service shall include:
    1. Pre-Installation Meeting
        a) The start-up plan
        b) The start-up schedule
        c) Installation requirements

    2. Pre-Power Check
        a) Inspect the starter's mechanical and electrical devices enclosed
        b) Perform a tug test on all internal connections within the starter and verify wiring.
        c) Verify critical mechanical connections for proper torque requirements.
        d) Verify and adjust mechanical interlocks for permanent location.
        e) Confirm all sectional wiring is connected properly.
        f) Re-verify control wiring from any external control devices.
        g) Set up auxiliary equipment with customer supplied parameters.
        h) Confirm cabling of starter to motor and line feed.
        i) Megger motor resistances.

    3. Power-up and Commissioning
        a) Apply medium voltage to the starter and perform operational checks.
        b) Exercise the starter in Test Mode (combination controllers).
        c) Run the starter motor system throughout the operational range to verify proper performance.

    4. Record of all measurements

3.03 TRAINING

A. Manufacturer to provide one (1) session of on-site instruction for a maximum of eight (8) participants.
B. The service engineer may perform training.
C. The manufacturer shall outline the training session duration and content.
D. The basis of the training shall be the controller, the engineered drawings and the user manual.
E. The instruction shall include the operational and maintenance requirements of the controller.

F. At a minimum, the training shall:
   1. Review of the engineered drawings identifying the components shown on the drawings.
   2. Review starting / stopping options for the starter.
   3. Review starter and contactor hardware.
   4. Review the maintenance requirements of the controller.
      a) Hardware replacement procedures
      b) Power device replacement procedures
      c) Fault analysis and troubleshooting
      d) Preventative maintenance procedures

   5. Review safety concerns with operating the controller.

END OF SECTION