SECTION 16345

MEDIUM VOLTAGE REDUCED VOLTAGE SOLID-STATE MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. This specification covers materials, equipment and start-up services required to place into operation an integrated medium voltage solid-state reduced voltage (MV-SSRV) motor controller.
2. Each MV-SSRV system shall consist of all components required to meet the performance, protection, safety, and certification criteria of this specification.
3. Include all material and labor necessary to interconnect any MV-SSRV system elements, even if shipped separately.

B. MV-SSRV applications include:

C.

D. Related Sections

1. _____
2. _____
3. _____

1.2 QUALIFICATIONS

A. Manufacturer

1. The manufacturer shall have a minimum of 10 years experience in the manufacturer of medium voltage smart motor controllers (SMCs) 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
   b.

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 manufacturers are:
   a. Rockwell Automation Global Manufacturing Services (GMS)
   b.

C. Certification

1. The SMC shall be factory pre-wired, assembled and tested as a complete package by the SMC supplier. Customer specific motor and application data shall be pre-loaded into the operator interface and tested prior to shipment.
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 per the manufacturer's standards.
6. Third party manufacturers and brand labeling shall not be allowed.

1.3 REFERENCES

A. Smart Motor Controllers
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)
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. UL 347A Medium Voltage Power Conversion Equipment Preliminary Standard
8. European Directives for Safety and EMC
9. National Electrical Code (NEC)
10. Occupational Safety & Health Act (OSHA)

1.4 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

1.5 PRE-MANUFACTURE SUBMITTALS

A. Refer to Section _____ for submittal procedures

B. Shop Drawings
1. Elevation drawings showing dimensional information
2. Structure Descriptions showing
   a. Enclosure ratings
   b. Fault ratings
   c. Other information as required for approval
3. Conduit locations
4. Unit Descriptions including amperage ratings, frame sizes, trip settings, pilot devices, etc.
5. Nameplate Information
6. Schematic wiring diagrams

C. Product Data
1. Publications on smart motor controllers
2. Data Sheets and Publications on all major components
   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

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section _____ for procedure on submittal of closeout documentation

B. Contractor shall provide certification that the smart motor 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 smart motor 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. Smart motor controller installation instructions and User Manual
2. Installation / Operation instructions for major components such as circuit breakers, contactors, isolation transformers, etc.
3. SMC Parameter Listing
4. Field Service report from drive start-up service
5. Smart motor controller spare parts listing and pricing
6. Include name and phone number for a local distributor for the spare parts.

1.7 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.

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.

1.8 FIELD MEASUREMENTS

The Contractor shall verify all field measurements prior to the fabrication of smart motor controller.

1.9 SPARE MATERIALS

The manufacture shall furnish recommended spare parts for each size SMC to be furnished.

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.

C. This warranty applies to smart motor controller systems.

PART 2 PRODUCTS

2.1 RATINGS

A. Voltage
   1. The SMC shall accept nominal plant power of 4160V (2400V, 3300V, 6600V, Other) at 60Hz (50Hz).
   2. The supply input voltage tolerance shall be ± 10% of nominal line voltage.

B. Displacement power factor
   1. The SMC system shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of .95 at 100% load, using the (optional) power factor correction capacitors provided.

C. Environmental Ratings
1. Storage ambient temperature range: -40 degrees C to 70 degrees C.
2. Operating Ambient temperature range: 0 degrees C to 40 degrees C without derating.
3. The relative humidity range is 5% to 95% non-condensing.
4. Operating elevation: up to 1000 Meters (3,300ft) without derating.

D. Audible Noise Level
1. The maximum audible noise from the SMC shall comply with OSHA standard 3074, Hearing Conservation, which limits noise level to 80dB(A).
2. The smart motor controller shall comply with the OSHA standard at a distance of one meter from the front of the equipment (with doors closed).

E. Motor Compatibility
1. The smart motor controller shall be capable of operating a standard AC squirrel cage induction motor.
2. SMC induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

F. Sizing
1. Loads shall be as shown on the drawings.

2.2 SMC UNIT DESIGN

A. The controller shall be manufactured by a single vendor. The medium voltage, solid-state controller shall consist of a metal-enclosed, free-standing, dead front, vertical steel structure.

B. Each structure shall be suitable for future expansion at each end. Each structure shall also have two (2) non-removable base sill channels and removable lifting angles or brackets for ease of handling and installation.

C. The controller shall be of modular design to provide for ease and speed of maintenance. The modules are to be manufactured by one supplier, designed to allow ease of maintenance, including removal of medium voltage components and power electronic components.

D. The structure shall be divided into isolated compartments as follows:

- Main power bus and ground bus compartment
- Power cell compartment
- Low voltage compartment

E. Metal or glass polyester barriers shall be provided between the low voltage compartment and the power cell and/or main power bus compartment, and between the power cell and main power bus compartment. Personnel shall have access to the low voltage compartment, with the controller energized, without being exposed to any medium voltage.

2.3 STRUCTURE AND CONTROLLER

Each structure shall contain the following items:

A. Combination Controller (Includes isolating controller)

- Tin-plated copper horizontal power bus (optional)
- A continuous bare copper ground bus
- Power electronics
- A non-load-break isolation switch and operating handle, complete with ground connection when open
- A vacuum isolation contactor
- A vacuum bypass contactor
- Three (3) current limiting power fuses for NEMA Class E2 operation
- Three (3) current transformers
- A control power transformer
- A low voltage control panel complete with microprocessor-based control module
- Space for necessary auxiliary control and metering devices
- Top and bottom plates to accommodate cable entry/exit

B. ENCLOSURE TYPES

The medium voltage product line shall be available in a NEMA Type 1 (IEC IP10) general purpose enclosure as standard. Optional enclosures are NEMA Type 1 with door gaskets (IEC IP21), NEMA Type 12 dust tight and drip proof (IEC IP52) or NEMA Type 3R outdoor (IEC IP34) non-walk-in styles. Each enclosure shall be properly sized to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions.

C. STRUCTURE FINISH

As standard, all exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted ANSI 49 medium light gray (3R shall be ANSI 61). All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility. Optional field touch-up spray can(s), matching the enclosure color, shall be supplied when requested.

Description ..... Hybrid epoxy powder paint -high gloss.
Standard Color ..... ANSI 49 medium light gray (optional ANSI 61 light gray)
Procedure ..... Continuous paint line. All parts are painted before assembly.
Preparation ..... Alkaline wash/rinse/iron phosphate rinse/iron-chrome sealer rinse/re-circulated de-ionized water rinse and virgin de-ionized water rinse.
Painting .....Air-atomized electrostatic spray. Total paint thickness …….. 0.002” (0.051 mm) minimum
Baking..... Natural gas oven at 179°C (355°F) minimum.

Notes:

1. When optional custom paint color is specified (including ANSI 61), all external surfaces shall be painted to the custom color requirement, except for the external isolating switch handle assembly, lifting angles and lifting brackets .
2. All unpainted steel parts shall be plated with a zinc plate/bronze chromate

process for corrosion resistance.

D. MAIN POWER BUS (OPTIONAL)

The main horizontal power bus shall be located at the center rear of the structure to provide for optimum heat distribution, ease of maintenance and splicing. The power bus shall be mounted on edge to a molded bus support insulator in a common vertical plane. This shall provide better short circuit withstand ability and protect against tracking between phases and the accumulation of dust. The power bus shall be made of tin-plated copper and be available in one of the following continuous current ratings: 1200, 2000 or 3000 amps.

Access 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.

The horizontal bus work, 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).

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.)

E. BUS BRACING

The horizontal/vertical bus work 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. The bus work and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.

F. VERTICAL BUS

Vertical power bus risers shall be provided from the main horizontal power bus to the isolating switch line terminals. Cabling from main horizontal power bus to isolating switch is not acceptable. If cabling must be used, the cable shall be braced to withstand a fault condition.

G. GROUND BUS

A continuous copper ground bus shall be provided along the entire length of the controller line-up. 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. The ground bus shall be 6.4 x 51 mm (1/4 in. x 2 in.) bare copper.

2.4 EQUIPMENT DESIGN AND SELECTION

A. VACUUM CONTACTOR SPECIFICATIONS (INPUT AND BYPASS)

The electrically held medium voltage contactor shall be the Allen-Bradley model 1502 vacuum type or equivalent

The following current ratings shall be available:

- 400 A
- 800 A

The contactor shall have visual contact wear indicators. No special tools are required for checking contact wear.

Vacuum bottle and coil maintenance shall be performed on the contactor while it is mounted. Removal of contactor is not required.

B. ISOLATION VACUUM CONTACTOR

The vacuum input contactor shall be fixed mounted inside the power cell. Fixed mounting provides solid, continuous contact, lowering maintenance requirements considerably. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, which shall provide the following safety features:

- Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
- Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
- Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
- Remove control power from the control power transformer (CPT), power transformers (PTs) or external power source to the control circuit when the isolating switch and contactor are in the open position.

C. BYPASS VACUUM CONTACTOR

A contactor shall be provided to bypass the SCRs once the motor is up to full speed. When a stop option is selected, the bypass contactor will open, bringing the SCRs back into the power circuit. It shall be fixed mounted in the main power cell.

[Optional: The bypass contactor shall be capable of providing a full voltage start in case of emergency bypass. A separate overload relay shall be provided to protect the motor while in emergency bypass.]

D. CONTROL WIRE SPECIFICATION

1. The control wire shall be an insulated (with a flame retarding thermoplastic compound), flexible stranded, tinned copper wire supported and neatly bundled.

Red wire shall indicate AC power, blue wire shall indicate DC power and green wire shall indicate ground. Other colors or combinations may be used for specific applications. The control wire shall be isolated from high voltage components in the power cell (whenever possible), and wire tube markers which are numbered according to the electrical diagram, shall be provided at each end of the wire.

2. All of the control wire terminations shall be a screw-type, copper-compression-type terminal block or connector which firmly grips the conductor. Non-insulated, locking-type, fork tongue lugs shall be provided on the control wire terminating on the control power transformer(s) and current transformers.

E. LOW VOLTAGE WIREWAY

An optional low voltage wireway shall be available across the top of the structure. There are two (2) sizes of low voltage wireway available: 51 mm x 102 mm (2 in. x 4 in.) or 152 mm x 152 mm (6 in. x 6 in.) The low voltage wireway shall allow a convenient method of interconnecting control wire from one controller to another, when interfacing with a master panel or with programmable controller circuits.

F. LOW VOLTAGE CONTROL PANEL

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 for utmost safety.

Optional meters, motor protection 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. The low voltage panel shall provide the following features:

- Space shall be provided for low voltage control devices, transducers and metering.
- There shall be necessary terminal blocks supplied. Extra terminal blocks can be supplied as an option.
- There shall be low voltage control panel access without turning the controller “OFF” when opening the low voltage control panel door.
- All remote low voltage cables 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.
- As standard, the combination controllers shall incorporate a swing-out low voltage panel which provides easier access to the power cell to make bus splicing and load cable connections. All products shall have a swing-out low voltage panel, which is interlocked with the power cell compartment (the panel shall not have the ability to swing open until the power cell is “OFF” and isolated from the main power bus) to allow easy access to medium voltage equipment, i.e. power stacks, power bus, power factor correction capacitor, or other similar equipment.
- Pilot control relays shall be used to operate and economize the vacuum contactor.

- The control panel supply voltage shall be 120 V AC or 240 V AC, 50/60 Hz. It shall be rectified to provide a DC operating voltage for the vacuum contactor coils and economizing relay.
- There shall be a two-pole, three-conductor (with a grounding prong) male plug to provide a means for connecting a two-pole, three-conductor receptacle from a remote 120 V AC, 50/60 Hz supply to operate the control circuit when it is in the TEST position (combination controllers only).
- The low voltage control panel door shall have a viewing window, allowing the user to monitor the MV SMC-Flex controller operation via the built-in display.

G. INTELLIVAC CONTROL (OPTIONAL)

Optional IntelliVAC contactor control shall be available with the following features:

1.– Universal input voltage (110-240 V AC, 50/60 Hz or 110-250 VDC)
2.– Consistent vacuum contactor pick-up time
3.– Selectable and repeatable vacuum contactor drop-out time
4.– Altitude compensation
5.– Power loss ride-through (TDUV)
6.– Temporary motor jog function
7.– Delayed motor re-start
8.– Anti-kiss and anti-plugging protection
9.– Status indication (LEDs and relay outputs)

H. MAIN ISOLATING SWITCH

The main power cell shall have an externally operated, three-pole, gang-operated, fixed-mounted, non-load-break isolating switch providing the following features:

- 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.
- The main power cell door shall have a viewing window through which the operator can verify that the isolating switch is open.
- 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 (PTs) supplied inside the controller power cell.
- In the OFF position, the isolating switch shall provide a means of grounding appropriate medium voltage power cell components, bleeding off hazardous stored energy, thus providing safe operation and maintenance.
- Three rating sizes shall be available: 400 A, 600 A, and 800 A. (some 600A units may use an 800A isolation switch).
- One or more normally open (N-O) and normally closed (N-C) auxiliary contacts shall be arranged to open the secondary circuit of the control power transformer (CPT) and/or potential transformers (PTs), to de-energize 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 PTs 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 isolating switch shall remain connected to the external operating handle at all times.

- The isolating switch must be mechanically and electrically interlocked with the main contactor.
- 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.
- The power cell door on each controller shall be interlocked with the isolating switch such that the 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 circumventing the interlock using a tool).

I. INTERLOCKING

1. Mechanical interlocking, including cable interlocks, horizontal and vertical ram interlocks, shall be provided 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).

2. 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.

K. POWER FUSES AND FUSE HOLDERS

1. R-rated current limiting power fuses shall be provided. R-rated fuses shall be used for the short circuit protection of medium voltage motors and motor controllers.

2. The medium voltage product shall have fixed power fuse holders that are separately mounted in the power cell, not on the contactor, and be located to allow easy inspection and replacement without any disassembly. The power fuses shall have a spring actuated blown fuse indicator. The power fuse size shall be selected when motor data and the protective device characteristics are known.

L. CONTROL POWER TRANSFORMER

1. The control power shall be 110/120 V AC or 220/240 V AC, and shall be obtained from a control power transformer (CPT) located in each controller power cell, or from a separate control source. As standard, the dry-type CPT shall be 500 VA in size with 350 VA extra capacity for the customer’s use when the standard control circuit is supplied and shall have primary and secondary fuses. Optional sizes of 1000 VA, 2000 VA and 3000 VA control power transformers shall also be available.

2. 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 prevent backfeeding through the transformer(s) and to isolate the power cell

when the control circuit is in the TEST mode.

3. The standard control power transformers used in the controller shall be a compensated type with an output accuracy of approximately 4% over nominal at no load. They shall be designed to maintain voltage at in-rushes of up to 600%, which results in a 2% overvoltage at full load.

M. PRIMARY FUSES

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.

N. SECONDARY FUSES

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.

O. CURRENT TRANSFORMERS

1. 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.

2. 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 five (5) amp output and an 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.

3. An appropriate load termination location shall be provided to accommodate lugs with single or two-hole mounting, for connection of the load cables, when either bar or donut type current transformers are supplied.

4. 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 (Combination Controller only).

P. CONTROL MODULE • LOGIC DESIGN FEATURES

1. Mechanical

The control module shall be designed for mounting within the low voltage panel (for safety reasons) and shall be compatible with the full range of current and voltage ratings.

The control module shall consist of a power supply, logic control circuitry, silicon controlled rectifier (SCR) firing circuitry, I/O circuitry, a digital

programming keypad, a backlit LCD display, and a serial communication port.

2. Programming and Display

Digital parameter adjustment shall be provided through a standard built-in keypad. Analog potentiometer adjustments are not acceptable. A built-in backlit LCD display shall be provided for controller set-up, diagnostics, status, and monitoring. The display shall be three-line, 16-characters minimum.

The display shall be capable of depicting alphanumeric characters in any of the following languages, by adjustment of a single parameter:

- English
- French
- Spanish
- German
- Portuguese
- Mandarin

3. Communications

A serial communications port DPI (Drive Programming Interface), shall be provided as standard. Optional communications protocol interface modules shall be available for connection to Remote I/O, DeviceNet™, ControlNet™, Ethernet, RS-485, and Profibus-DP.

4. Electrical

The control module shall provide closed-loop digital microprocessor control and supervision of all controller operations, including SCR pulse firing control. The control module shall be the same as used for the SMC-Flex low voltage product family.

5. SMC-Flex Control Modes

The control module shall offer the following functions:

- Soft Start -with Selectable Kickstart
- Soft Stop
- Current Limit Start -with Selectable Kickstart
- Linear Speed Acceleration* -with Selectable Kickstart
- Linear Speed Deceleration*
- Dual Ramp -with Selectable Kickstart
- Full Voltage
- Preset Slow Speed

  *- requires motor tachometer
- Pump Control (Optional)
  - The Pump Control option shall be implemented to provide closed loop control of a motor to match the specific torque requirements of

centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomena commonly referred to as "water hammer". Methods utilizing Soft Start and Soft Stop shall not be acceptable.

- Closed loop control shall be achieved without using external sensors or feedback devices.
- The Pump Start time shall be user adjustable from 0 to 30 seconds.
- Pump Stop shall be initiated by a dedicated Pump Stop input. A coast-to-rest stop shall still be possible with a separate stop input.
- The Pump Stop time shall be user adjustable from 0 to 30 seconds.
- Extended Pump Start or Stop times may be made available, upon consultation with qualified factory personnel.

- Kick-start shall provide an adjustable time pulse of current prior to the normal start mode. The current shall be controlled to provide 0-90 % of locked rotor torque for a time between 0.0 and 2.0 seconds. This feature shall be field selectable.

6. SMC-Flex Monitoring

The controller shall provide the following monitoring functions indicated though the built-in LCD display; or remotely via the communication port:

• Phase-to-phase supply voltage
• Three-phase line current
• Three-phase power (MW, MWh, power factor)
• Elapsed time
• Motor thermal capacity usage
• Motor speed (with optional use of tachometer input)

7. SMC-Flex Protection and Diagnostics

The following protection and diagnostics shall be provided as standard with the controller:

- Power loss (with phase indication; pre-start)
- Line fault (with phase indication; pre-start) advising: –Shorted SCR
- Missing load connection
- Line fault (running protection) advising: –Power loss –Shorted SCR
- Voltage unbalance *
- Phase reversal *
- Undervoltage *
- Overvoltage *
- Stall *
- Jam *
- Overload *
- Underload *
- Excessive starts/hour *
- Open gate (with phase indication)
- Overtemperature (power stack, with phase indication)
- Communication loss
- Motor temperature (via PTC input)

* These protective features shall be selectable.

Overload Protection shall include:

- The control module shall meet applicable standards as a motor overload protective device
- Three-phase current sensing shall be utilized; the use of two current transformers shall be unacceptable.
- Overload trip classes of 10, 15, 20 and 30 shall be provided and user-programmable.
- Electronic thermal memory shall be provided for enhanced motor protection
- Protection shall be available through the controller while in bypass configuration
- Separate overload relay shall be provided for emergency bypass operation

Q. SCR POWER CIRCUIT DESIGN

1. The SCRs shall be protected from voltage transients with an R-C snubber network to prevent false SCR firing.

2. The SCRs shall be protected from overvoltage with voltage threshold gating circuitry.

3. The SCR firing circuitry shall be fully isolated from the control circuits. Fiber optic cables shall be used for isolation from the logic circuits.

4. Self-powered gate driver boards shall be utilized to increase efficiency of the controller, reducing power consumption and heat (powered gate driver boards may be used for pump control and stop control).

2.5 DEVICENET AND INTELLICENTER OPTIONS

A. GENERAL

The MV SMC shall have DeviceNet cabling integrated throughout the sections.

Each MV SMC in the line-up shall be supplied with a means to communicate via DeviceNet, and have the capability of monitoring at least 2 devices in each starter.

B. DEVICENET CABLE

The DeviceNet cable used for the trunk line and drop lines shall be *flat or round* cable rated 8 amperes, 600V, Class 1.

The DeviceNet cable used to connect a DeviceNet unit to a DeviceNet port shall be round cable rated 8 amperes, 600V, Class 1.

The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

C. DEVICENET CABLE LAYOUT

A DeviceNet trunkline shall be routed through the low voltage wireway, located on the top of each MV SMC section to prevent accidental mechanical damage during MV SMC installation.

A DeviceNet dropline shall be routed into the low voltage control panel of each MV SMC unit.

A minimum of two (2) DeviceNet ports shall be provided in the low voltage control panel of each unit to simplify installation of DeviceNet products.

D. POWER SUPPLIES

The MV SMC manufacturer shall check the user's design to ensure adequate power supplies have been specified to conform with DeviceNet requirements. The power supply shall provide 24Vdc for the DeviceNet system and be rated no less than 8.0 amperes.

E. DEVICENET SYSTEM PERFORMANCE

The DeviceNet system shall be designed to operate at 500k Baud to maximize the system performance, unless precluded by the cumulative length of the trunk and drop lines.

The DeviceNet system is to be qualified to communicate and perform under normal and adverse MV SMC electrical environments, e.g. vacuum contactor electrical operation and unit short circuit fault.

F. Solid-State Controllers

Each solid-state controller unit shall have a DeviceNet communication module to communicate the status over DeviceNet.

G. PROGRAMMING OF PARAMETERS

The DeviceNet MAC ID number (node address) shall be loaded into each unit per the drawings. All other parameters shall be left at the factory default setting.

The DeviceNet System components shall be preconfigured to operate at the appropriate baud rate.

H. SOFTWARE

The DeviceNet MV SMC shall be provided with pre-configured software. The software shall be capable of viewing multiple MV SMC line-ups. The software communication driver shall allow the software to be installed and located on Ethernet, ControlNet, or DeviceNet. The software shall be capable of displaying the following:

- Elevation View
  - Dynamically configured based on reading data from devices in MV SMC line-up
  - Sizeable view to allow ease of viewing multiple MV SMC line-ups
  - Unit nameplate information
  - Unit status indicators (ready, running, warning, fault, no communication)
- Unit Monitor View
  - Pre-configured for specific unit
  - Real time monitoring via analog dials and trending
  - Data configurable for customized monitoring
  - Modifying device parameters
- Spreadsheet View
  - User configurable for customized monitoring
  - Sorting and cascading functions
  - Custom user fields
- Event Log
  - Track history of MV SMC unit
  - Automatic logging of trips, alarms, and changes
  - Manual entry of events
- Documentation
  - Front elevation drawings
  - One-line drawings
  - Unit wiring diagrams
  - User manuals
  - Spare parts lists

I. TESTING

The interwired DeviceNet MV SMC line-up shall be powered up, configured and tested in an ISO9001 facility to ensure each unit communicates properly prior to shipment.

PART 3 EXECUTION

3.1 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 (cULus), 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 Smart Motor Controllers shall be inspected for the following:
   a. Control Power Failure Test
7. Cycle Testing
   a. Drives shall be accelerated to the test motor's nominal frequency, under load.
   b. Drives shall be decelerated to 10 Hz and then accelerated back to test motor's nominal frequency with a ramp time of approximately ten seconds.
   c. This cycle shall be repeated continuously for up to one hour.
8. Load Testing
   a. SMCs shall be tested under load at the test motor's nominal frequency.

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 Engineer will then host the Purchaser for the duration of the actual testing. At the conclusion of testing, the customer will reconvene with the Application Engineer 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 Engineer will 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 Engineer or Project Manager prior to commencing the tests. Any questions or clarifications, prior to commencing the test, will be addressed at this time.
d. The witness test shall include a SMC Run Test that shall consist of operating the SMC connected to a dynamometer. During the testing of the SMC, a demonstration of the operator interface and functionality will be provided as well as demonstration of the operation of the SMC.
e. The SMC will be tested up to rated horsepower.
f. The following equipment, if purchased, shall be tested at the base cost of the standard tests:
1.) Isolation devices
2.) Contactors
3.) Bypass starters
4.) Remote communications options
g. A Certified Test Report shall be issued to the Purchaser.

3.2 MANUFACTURE'S FIELD SERVICES

A. The service division of the SMC 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 SMC manufacturer and shall be degreed engineers.

C. Provide a minimum of (__) hours of on-site start-up service for each SMC.

D. At a minimum, the start-up service shall include:
1. Pre-Installation Meeting
a. The start-up plan
b. The start-up schedule

c. The drive's installation requirements

2. Pre-Power Check
   a. Inspect the drive's mechanical and electrical devices enclosed
   b. Perform a tug test on all internal connections within the drive 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.
3. Drive Power-up and Commissioning
   a. Apply medium voltage to the SMC and perform operational checks.
   b. Bump motor and tune SMC to the system attributes
4. Record all measurements
5. Provide SMC Parameter Listing

3.3 TRAINING

A. Manufacturer to provide one (1) session of on-site instruction for a maximum of eight (8) participants.

B. The service engineer shall perform training.

C. The manufacturer shall outline the training session duration and content.

D. The basis of the training shall be the SMC, the engineered drawings and the user manual.

E. The instruction shall include the operational and maintenance requirements of the SMC.

F. At a minimum, the training shall:
   1. Review of the engineered drawings identifying the components shown on the drawings.
   2. Review starting / stopping
   3. Review operation of the Operator Interface for programming and monitoring
   4. Review the maintenance requirements of the SMC.
   5. Review safety concerns with operating the SMC.