

SECTION [26 24 19][16443] [40 69 11][13436]

This specification section should be numbered 26 24 19 or 16443 if it is to be furnished by the electrical contractor or numbered 40 69 11 or 13436 if it is to be furnished by the process Control System Integrator. It is recommended that intelligent MCCs (iMCCs) be supplied by the specification division entity with automation expertise and/or responsibility for the overall Process Instrumentation and Control System. If there is to be a mixture of MCC types furnished by multiple entities edit specification appropriately and provide in both specification divisions.

[INTELLIGENT]MOTOR CONTROL CENTERS

Square D Model 6™ Motor Control Centers by Schneider Electric

Schneider Electric Editor's Note:

This guide specification is written in accordance with the Construction Specifications Institute (CSI) Master Format. This section must be carefully reviewed and edited by the architect or the engineer to meet the requirements of the project. Coordinate this section with other specification sections within the Contract Documents and Drawings.

To properly use / edit this document, show formatting and hidden text by selecting ¶ on the menu or by typing (Ctrl+*) simultaneously. Except for these introductory and closing paragraphs, green hidden text will not print. Text in red is optional. Red text in [brackets] denotes multiple options where one or more should be chosen. All red text should be edited and changed to black for final project conformation. In addition, these introductory paragraphs should be deleted or changed to hidden text. Additional guidance and specifications can be found at <https://www.schneider-electric.us/e2e>

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for low voltage motor control centers (also identified as MCC, intelligent motor control centers or iMCC) as required for the complete performance of the Work, as shown on the Drawings, as specified herein.
- B. Related Sections: Related sections include, but shall not be limited to, the following:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.
 3. The following MCC information is typically depicted on the Drawings: bus configuration, bus ratings, [interrupting ratings,] component size and type, power line and feeder connections, application specific unit control wiring, elevation and footprint, etc. Where not shown on or able to be derived from the Drawings, the minimum requirements specified herein shall be provided.
 4. Refer to the following specifications for additional requirements:
 - a. Section 26 27 13.13 Power and Energy Meters
 - b. Section 26 27 13.16 Power Quality Meters
 - c. Section 13 34 23.11 Fabricated Electrical Houses
 - d. Section 26 28 11.11 Molded Case Circuit Breakers
 - e. Section 26 28 11.12 Insulated Case Circuit Breakers
 - f. Section 26 43 13 Surge Protective Devices for Power Circuits
 - g. Section 26 09 13 Electrical Power Management Systems
 - h. Section 26 29 13.16 Reduced Voltage Motor Controllers
 - i. Section 26 29 23.23 Variable Frequency Motor Controllers - Process

Specifications for VFDs and RVSSs within MCCs are provided within this specification. The following sections may be referenced but the specific requirements referenced must be listed herein since not all VFD or RVSS options and sizes are available within MCCs. Check with the manufacturer for availability before specifying or referencing these specifications.

Keep the following referenced related specification sections and coordinate content if Intelligent Motor Control Centers (iMCCs) are to be provided.

5. Process controllers or remote I/O devices shall include the inputs and outputs listed within this specification. [Refer to Section [40 61 93][13440 S01] Process Control System Input / Output Schedule for a list of required MCC inputs and outputs for the Process Control System.]
6. Process and / or motor controllers in conjunction with the Process Instrumentation and Control System shall include the functions specified within this specification. [Refer to Section [40 61 96][13400 S01] Process Functional and Control Descriptions for required Process Instrumentation and Control System functionality.]
7. Process controller types, configuration, and communication requirements are depicted on the Process Instrumentation and Control System drawings.

1.2 REFERENCES

- A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
1. American National Standards Institute (ANSI)
 - a. ANSI Z55.1, "Gray Finishes for Industrial Apparatus and Equipment"
 2. ASTM International (ASTM)
 - a. ASTM B117, "Standard Practice for Operating Salt Spray (Fog) Apparatus"
 3. Canadian Standards Association (CSA)
 - a. C22.1, "Canadian Electrical Code, Part I" (CEC)
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - a. IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters"
 - b. IEEE 1584, "Guide for Performing Arc Flash Hazard Calculations"
 - c. IEEE C37-20-7, "Guide for testing metal-enclosed switchgear rated up to 52kV for internal arcing faults"
 5. International Code Council (ICC)
 - a. IBC, "International Building Code"
 6. International Electrotechnical Commission (IEC)
 - a. IEC 60947, "Low Voltage Switchgear and Control Gear - Part 2: Circuit Breakers"
 7. International Organization for Standardization (ISO)
 - a. ISO 9001, "Quality Management Systems – Requirements"
 - b. ISO 14001, "Environmental management systems -- Requirements with guidance for use"
 8. National Fire Protection Agency (NFPA)
 - a. NFPA 70, "National Electrical Code (NEC)"
 - b. NFPA 70E, "Standard for Electrical Safety in the Workplace"
 - c. NFPA 79, "Electrical Standard for Industrial Machinery"
 9. National Electrical Manufacturer Association (NEMA)
 - a. NEMA 250, "Enclosures for Electrical Equipment"
 - b. NEMA ICS 18, "Motor Control Centers"
 10. Society of Automatic Engineering (SAE)
 - a. SAE H1738-2, "Specification for Mini, Micro, and Nano Plugs and Receptacles"
 11. Underwriters Laboratories, Inc. (UL)
 - a. UL 50, "Enclosures for Electrical Equipment, Non-Environmental Considerations"

- b. UL 498, "Standard for Attachment Plugs and Receptacles"
 - c. UL 508, "Standard for Industrial Control Equipment"
 - d. UL 508A, "Standard for Industrial Control Panels"
 - e. UL 508C, "Standard for Power Conversion Equipment"
 - f. UL 845, "Motor Control Centers"
12. USA Military Standard (MIL)
- a. MIL-STD-202, "Test Methods for Electronic and Electrical Component Parts"

1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
1. AFIE: Arc Flash Incident Energy
 2. CDR: Closed Door Racking
 3. ELM: Earth Leakage Module
 4. EPMS: Electrical Power Management System
 5. FAT: Factory Acceptance Testing
 6. GFM: Ground Fault Module
 7. iMCC: Intelligent Motor Control Center
 8. IMPR: Intelligent Motor Protection Relay
 9. MCC: Motor Control Center
 10. MCCB: Molded Case Circuit Breaker
 11. MOV: Metal Oxide Varistors
 12. OIT: Operator Interface Terminal
 13. PIV: Peak Inverse Voltage
 14. RSTP: Rapid Spanning Tree Protocol
 15. RVSS: Reduced Voltage Solid State motor controller
 16. SCR: Silicon-Controlled Rectifier
 17. SNMP: Simple Network Management Protocol
 18. VFD, AFD: Variable Frequency Drive

1.4 SUBMITTALS

Most submittal requirements including those for electrical equipment of all types are specified elsewhere. Additional requirements should only be listed if they pertain to the herein specified equipment and not to electrical equipment in general.

- A. General: Submittals shall be in accordance with the requirements of Section [01 33 00][01300] Submittals and Section [26 00 10][16010] Electrical Requirements, in addition to those specified herein.
1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
 2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
 3. Refer to referenced specification sections of components provided within MCC for additional submittal requirements.

4. Submit required product data and shop drawings specific to each product and accessory proposed. In addition, include the following information:
 - a. Electronic 2D dimensional drawing and 3D model CAD files for standard units shall be provided upon request if not available from the manufacturer's website.
 - b. Equipment assembly. Indicate dimensions, shipping section dimensions, weights, foundation requirements, required clearances, location and size of each field connection, and mounting and installation instructions.
 - c. Include elementary and interconnection diagrams for power, signal, control, and communications wiring. Diagrams shall provide the minimum detail as shown for drawings in the appendix of NFPA 79. All field terminals shall be identified and updated later within the O&M data to include actual field connection information. Drawings shall not be typical but be provided for each MCC and MCC units furnished.
 - d. Where applicable the following additional information shall be submitted to the Engineer.
 - 1) Bus connection
 - 2) Connection details between close coupled assemblies.
 - 3) Composite floor plan of close coupled assemblies.
 - 4) Key interlock scheme drawing and sequence of operations.
 5. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which, the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Required working clearances and required area above and around MCC's
 - b. Show support locations, type of support, and weight on each support
- B. Harmonic Analysis Report: Provide project-specific calculations and manufacturer's statement of compliance with IEEE 519, latest revision. Owner shall supply detailed electrical power system characteristics to support harmonic calculations.

Note to Specifier: Guidelines for voltage and current distortion are addressed in IEEE Standard 519-2014 titled "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems", which suggests distortion limits dependent upon the electric power distribution system for industrial and commercial consumers. Collectively, all facility loads and the building electrical distribution network determine the harmonic levels at the user & electric utility interface. The Electrical Power Research Institute (EPRI) recognizes the 'Point of Common Coupling' or PCC as the interface between user and electric utility (energy meter) in the electrical distribution network

- C. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section [01 78 23][1780] Operation and Maintenance Data, [Section [26 00 10][16010] Electrical][Section [40 60 00][13400] Process Instrumentation and Control System] Electrical Requirements and additional requirements specified herein.
1. Submit required Operations & Maintenance data specific to each product and accessory proposed. In addition, include the following information:
 - a. Manufacturer, supplier, support, and repair center specific contact information.
 - b. Manufacturer's standard operation and maintenance data assembled for each size and type of equipment furnished.
 - c. [All construction, installation, schematic, and wiring diagrams updated to an as-installed and commissioned state.] [All submittal information updated to an as-installed and commissioned state.]
 - d. All configured settings/parameters for adjustable components updated to an as-installed and commissioned stated if different from the factory default. Electronic copies of configuration files shall be provided, on media acceptable to the Owner (e.g. CD, USB stick, etc.), where these configurations can be saved as an electronic file for future upload into replaced or repaired components.
 - e. List of furnished and recommended spare parts.

- f. Statement of standard Warranty. [Statement of extended warranty options and costs.]
- 2. O&M manuals shall be submitted prior to arrival of equipment on site.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.
 - 1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
 - 2. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.
 - 3. The manufacturer shall have the Environment Certification ISO 14001 for EcoDesign.
- B. Installer Qualifications: Installer shall be a firm that shall have a minimum of [10] years of successful installation experience with projects utilizing equipment similar in type and scope to that required for this Project [and shall be approved by the manufacturer's representative].
- C. All work performed and all materials used shall be in accordance with the [National Electrical Code], [Canadian Electrical Code] and with applicable local regulations and ordinances. Equipment assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.7 WARRANTY

- A. General: Refer to [Section 01 77 00 - Closeout Procedures] [Section 01770 - Closeout Procedures].
Schneider Electric extends the warranty of most equipment by 12 months at no additional cost when their service technicians perform functional testing, commissioning, and first parameter adjusting of the installed equipment.
- B. The manufacturer shall warrant products against defects in material and workmanship for [12 months from the date of commissioning or 18 months from the date of shipment – whichever comes first.][24 months from the date of commissioning or 36 months from the date of shipment, whichever comes first, provided that the manufacturer performs functional testing, commissioning and first parameter adjusting of equipment.] During the warranty period the manufacturer shall repair or replace defective products. This warranty shall be in addition to any provided by the Contractor. The warranty shall exclude normal wear and tear under normal usage and any damage caused by abuse, modification, or improper maintenance by entities other than the manufacturer or its approved representative.

- C. **Additional Owner Rights:** The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
- D. **Extended Warranty:** The manufacturer shall provide an [18][30][42] month warranty for the MCC. The warranty period shall commence on the date of shipment from Schneider manufacturing facility. The terms of the warranty shall provide for replacement of defective components, free of charge, at any time during the warranty period.

1.8 SPECIAL TOOLS AND SPARE PARTS [- NOT USED]

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
 1. Contact information for the closest parts stocking location to the Owner.
 2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
 3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- B. Spare parts shall be provided for each type and size of unit installed. At a minimum, the following shall be provided:
 1. Provide the minimum spare parts recommended by the manufacturer.
 2. [1] set of each type of power and control fuse installed within equipment
 3. [1] control power transformer of each size installed
 4. [2] control relays of each size and type installed. Provide an additional spare for every [25] of a specific type installed.
 5. [2] indicating pilot lights, if not LED type, of each color and type installed
 6. [1] control operators (e.g. selector switch, pushbutton, etc.) complete with contact blocks for each type, color, size, installed
 7. [1] intelligent motor protection relay of each type and size installed
 8. [1] closed door racking unit handle for each lineup with closed door racking
 9. [1] closed door racking unit remote racking operator and control pendant for each installation with closed door racking
- C. Any manufacturer specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished. **At a minimum the following shall be provided:**
 1. If available from manufacture, provide PC-based configuration software tool and a minimum of [one] communication interface cable for each type of cable required to connect a PC-based computer to the devices specified herein for configuration and programming.
 2. Electronic configuration files, in a media format acceptable by the Owner (e.g. CD, USB stick, etc.), updated to an as-installed and commissioned state.
- D. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide Square D Model 6 Motor Control Center by Schneider Electric.
- B. **Acceptable Products:** Motor Control Centers specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:
 - 1. Square D Model 6 Motor Control Center by Schneider Electric [with
 - a. ArcBlok Line Side Isolation
 - b. PowerLogic Meters
 - c. Altivar Variable Frequency Motor Controllers
 - d. Altistart Soft Starters]
 - 2. [2nd manufacturer and model]
 - 3. [3rd manufacturer and model]
- C. Modifications or additions to existing MCCs shall be the same as the original manufacturer for model series still in production; otherwise the original manufacturer or an above listed acceptable manufacturer may provide these modifications and assemblies with proof of prior experience furnishing these types of modifications.

2.2 GENERAL REQUIREMENTS

- A. The following MCC information is typically depicted on the Drawings: bus configuration, bus ratings, [interrupting ratings,] component size and type, power line and feeder connections, application specific unit control wiring, elevation and footprint, etc. Where not shown on or able to be derived from the Drawings, the minimum requirements specified herein shall be provided.
- B. Motor Control Centers (MCCs) shall be 600 VAC class suitable for operation on three-phase, 60 Hz system. MCCs and their components shall conform to the applicable requirements of NEMA ICS 18-2001 and UL-845.
- C. The system operating voltage and number of wires shall be [as shown on the Drawings][208Y/120V 3Ph 4W at 60Hz][240V 3Ph 3W at 60Hz][380Y/220V 3Ph 4W at 50Hz][380V 3Ph 3W at 50Hz][480Y/277V 3Ph 4W at 60Hz][480V 3Ph 3W at 60Hz][600Y/347 3Ph 4W at 60Hz][600V 3Ph 3W at 60Hz].

Arc resistant MCCs may not be available in all current interrupting ratings. Use arc resistant MCCs interrupting ratings of [42,000] [65,000] rms amperes for up to 600 VAC or check with manufacturer for availability.
- D. MCCs shall be rated for an available short circuit capacity of [42,000][65,000][85,000][100,000] amperes rms.
- E. All motor control centers furnished shall be arc resistant to meet the requirements of ANSI C37.20.7 with Type 2 accessibility when protected by an upstream device with a maximum clearing time of 50ms. The internal arcing event shall be DEVICE LIMITED, the maximum short circuit current shall be 65,000A RMS symmetrical, and the arc duration is equal to or less than 100ms.
- F. [All motor control centers furnished shall be Intelligent Motor Control Centers (iMCCs).][Motor control centers shall be provided as Intelligent Motor Control Centers (iMCCs) as shown on the Drawings. Where not shown as iMCCs, MCCs shall utilize the same communications ready components (metering, circuit protection, IMPRs, VFDs, etc.) as intelligent motor control centers without interconnecting networking components such as network gateways, switches, cabling and power supplies for those devices.]

2.3 CONSTRUCTION

A. MATERIALS

1. Steel material shall comply with UL 845 and CSA requirements.
2. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, freestanding assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. Removable 7 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly shall be formed from a minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 gauge and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

B. STRUCTURES

1. Structures shall be NEMA/EEMAC Type [1 (general purpose)] [1A (gasketed general purpose)] [12 (industrial duty)] [3R non-walk-in (rainproof)].
2. Structures shall be totally enclosed, dead-front, freestanding assemblies. Structures shall be capable of being bolted together to form a single assembly.

MCCs may be provided with a reduced height in 1 foot increments. Consult manufacturer for availability.

3. The overall height of the MCC shall not exceed 90 in (2286 mm), not including base channel or lifting angle, baffle, or plenum. Base channels of 1.5 in (38 mm) in height shall be provided. Lifting angles of 3 in (76 mm) in height shall be provided and shall be removable. The total minimum width of one section shall be 20 in (508 mm). Widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) may be used for larger devices or vertical wireways.
4. Each standard section for drawout type units shall have all the necessary hardware and bussing to add or move units within section. All unused space shall be covered by [hinged blank doors][cover plate]. All space equipped to accept future units and include hinged blank doors. Vertical bus openings shall be covered by manual bus shutters.
5. Each section shall include a top plate (single piece or two-piece). [NEMA Type 12 MCCs shall also include a bottom plate. These plates shall be removable for ease in cutting conduit entry openings.]
6. MCCs rated for arc resistance shall have a Gas Management System that redirects and exhausts all arc fault yielding pressures and gases through a chimney chute out of the top of the MCC. The internal portion of the Gas Management System shall include unit midshelves fitted with breathable openings that redirect arc fault pressures and gases out of the unit towards the arc exhaust chimney. The external portion of the Gas Management System shall include single piece MCC top plates designed with hinged flaps that allow for exhausting of arcing gases out of the top of the MCC. The Contractor shall furnish a field-installed plenum assembly with continuous reinforced duct for directing arc flash energy outside MCC room.
7. [For motor control centers with a main breaker or switch, the main structure or the one immediately next to the main structure shall include an Absence of Voltage tester. The Absence of Voltage tester shall provide positive indication that voltage is not present on the motor control center load bus.][For motor control centers without a main breaker or main switch, the incoming structure or the one immediately next to the incoming structure shall include an Absence of Voltage tester. The Absence of Voltage tester shall provide positive indication that voltage is not present on the motor control center bus.]

C. WIREWAYS

1. Structures shall contain a minimum 12 inch (305 mm) high horizontal wireway at the top of each section and a minimum 6 inch (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.

2. A full-depth vertical wireway shall be provided in each MCC section that accepts modular drawout units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be [4 in (102 mm)][9 in (228 mm)] wide minimum with a separate hinged door.
3. There shall be a minimum of 60 in² (387 cm²) of cabling space available for 15 inch (381 mm) deep sections and 80 in² (516 cm²) of cabling space available for 20 inch (508 mm) deep sections.
4. Access to the wireways shall not require opening control unit doors.
5. Structures that house a single, full section control unit shall not be required to have vertical wireways. Those control units shall open directly into the MCC horizontal wireways.
6. Vertical wireway doors on MCCs rated for arc resistance shall be 12 gauge steel and have additional fasteners/receptacles installed for reinforcement from arc blast pressure
7. A steel barrier for communication cabling and I/O wiring shall be provided in each vertical wireway to provide separation from motor cables.

D. INSULATION AND ISOLATION

1. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass-filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without using tools or having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.
2. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and shall brace the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (76 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.
3. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.4 BUSSING

Silver plated bus should not be used where the presence of H₂S or other corrosive gases may be present due to whiskering.

- A. All bussing and connectors shall be [tin-plated copper] [silver-plated copper].

Arc resistance MCCs may not be available in all bus current ratings above . Use horizontal buses rated at [600 A] [800 A] [1200 A] [1600 A] [2000 A] [2500 A] for only NEMA/EEMAC Type 1 enclosures or check with manufacturer for availability.

- B. The main horizontal bus shall be rated at [as shown on the Drawings] [600 A] [800 A] [1200 A] [1600 A] [2000 A] [2500 A NEMA Type 1 only] [3200 A NEMA Type 1/1A only] continuous and shall extend the full length of the MCC. Bus ratings shall be based on 65°C maximum temperature rise in a 40°C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.
- C. Horizontal bus splice bars stack shall be installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts shall not be required when splicing higher amperage bus. The splice bolts shall secure to self-clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool.
- D. MCCs shall be fitted with insulated horizontal bus. The horizontal bus joints shall be covered by an insulating box consisting of tabs and slots which can be opened and closed without tools for ease of joint maintenance.

- E. Three-Phase Four-Wire systems must contain a neutral provision at the main incoming cable compartment. [A neutral bus system should be installed that is rated to [50][100]% of the main bus rating up to 1600A. Neutral vertical bus must be provided in the main structure and in each in vertical section requiring a neutral connection]
- F. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus, and shall be rated at [300 A] [600 A] [1000 A (NEMA/EEMAC Type 12 enclosures only)] [1200 A (NEMA/EEMAC Type 1 and 1-Gasketed enclosures only)] continuous current. The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. Nut-and-bolt bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.
- G. A [tin-plated] [silver-plated] copper ground bus shall be provided that shall run the entire length of the MCC. [The ground bus shall be 0.25 inch (6.35 mm) by 1 inch (25 mm) and shall be rated for 300 A] [The ground bus shall be 0.25 inch (6.35 mm) by 2 in (51 mm) and shall be rated for 600 A]. A mechanical lug shall be provided in the MCC for a #8-250 kcmil ground cable. The ground bus shall be provided with six 0.38 inch (9.65 mm) holes for each vertical section to accept user-supplied ground lugs for any loads requiring a ground conductor.
- H. Each vertical section shall have a tin-plated copper vertical ground bus that shall be connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

Automatic shutters should be specified for Arc Resistant MCCs but may also be provided for standard MCCs.

- I. Automatic shutters shall be installed on the vertical bus that will isolate the vertical bus when the unit is removed. These shutters shall be included on all installed units and provisions

2.5 UNIT CONSTRUCTION

- A. Units with circuit breaker disconnects through 400 ampere frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

6 inch units are not available with Closed Door Racking (CDR) or Intelligent Tesys T Motor Overload Relays.

- B. [Units with circuit breaker disconnects through 250 ampere frame and fusible switch disconnects through 100 A shall be available in a 6 inch (152 mm) unit size.. Stab-on plug-on units shall be cable connected to the unit disconnect. Six inch (152 mm) fusible units shall accept Class J fuses only.]
- C. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.
- D. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal.
- E. All plug-on units 12 inches or greater shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment. Six inch (152 mm) plug-on units shall be installable without the assistance of a camming device so as to allow maximum accessibility with the unit installed
- F. A lever handle operator shall be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall include, but shall not be limited, a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped

circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

1. Handle ON position shall be up or to the left and within 45° of being parallel to the face of the equipment.
 2. Handle OFF position shall be down or to the right and within 45° of being parallel to the face of the equipment.
 3. The minimum separation between the ON and OFF positions shall be 90°.
 4. On circuit breaker disconnects, the handle TRIPPED position shall be perpendicular to the face of the equipment $\pm 30^\circ$. For visual distinction, the minimum separation between ON and TRIPPED shall be 30°. Minimum separation between TRIPPED and OFF shall be 45°.
- G. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.
- H. A non-defeatable interlock shall be provided to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.
- I. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.
- J. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.
- K. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.
- L. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.
- M. Units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type, 250 volts, and rated for 10 A. Current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and shall remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.
- N. Surfaces (back, side, and bottom plates) of the unit interior shall be painted white.
- O. Every unit shall include a thermal monitoring system that will monitor the connection points of the unit. These monitoring points include the plug-in connection at the primary of the disconnect and the load cable connection point. The thermal monitoring system shall have a LED indicator mounted on the door of the unit that will indicate a warning or alarm if the temperature exceeds factory provided set points.

The Closed Door Racking (CDR) units may reduce hazards by allowing the door to act as an additional barrier during adverse racking events. When provided within an arc resistant MCC they can provide a lower risk category per IEEE 1584 and NFPA 70E. Remote racking operations can occur outside of the arc-flash boundary by using a remote operator. Some MCC manufacturers other than Schneider Electric require special MCC construction, only offer low amperage MCC bus ratings, and require larger unit spacing over non-CDR units. Confirm with manufacturer that the types and sizes of the CDR units specified are available. Include specification language on existing spacing and compatibility when replacing existing non-CDR units with CDR units in existing MCCs.

2.6 CLOSED DOOR RACKING (CDR) UNITS [- NOT USED]

- A. Closed door racking units shall be provided to rack the disconnect stabs to and from the vertical bus while keeping the unit door closed. CDR units shall meet/maintain the NEMA enclosure rating of the MCC they are installed within. CDR units shall not increase the unit size. Where CDR units are installed

within an arc-resistant type MCC they shall meet/maintain the arc resistant rating of the MCC. CDR units within arc-resistant MCCs shall lower the NFPA 70E risk category associated with the insertion and removal of MCC units compared to non-CDR type units as verified by IEEE1584P testing.

Additional CDR unit types and sizes may be available as an Engineer to Order item (e.g. fusible switch units). Check with manufacturer for availability.

1. Unless otherwise specified or shown on Drawings, CDR units shall be supplied for all MCCs units furnished meeting the following criteria:
 - a. Unit spacing of 12 inches or greater
 - b. 15A thru 250A (80% rated) circuit breakers units (no key interlocks)
 - c. NEMA 1 thru 5 size FVNR starter units and NEMA 1 thru 4 size FVR starter units
 - d. Reduced Voltage Solid State starter units up to [50 hp at 208V][60 hp at 240V][125 hp at 480V][150 hp at 600V]
 - e. Variable Frequency Drives up to [20 hp at 208V][25 hp at 240V][50 hp at 480V][30 hp at 600V]
2. The CDR mechanism shall be of a robust design with all metal components from the internal mechanism to the pushbutton enabling racking operations. The CDR mechanism shall not require any adjustment or regular maintenance. The CDR unit shall be interlocked to prevent racking operation if the unit door is open, the disconnect is not in the OFF position, or if the CDR pushbutton is not engaged prior to the start of racking operations. It shall not be possible to withdraw a unit without first racking out the assembly. Each racking mechanism shall have provisions to padlock it in the racked in or racked out position.
3. Racking operations shall be accomplished using a racking handle to crank the mechanism to engage or disengage the unit from the bus. The mechanism shall complete the operation in 12 revolutions or less. Tactile feedback shall be provided through the handle to indicate either full engagement or disengagement of the mechanism in addition to a mechanical display of RED for racked in and GREEN for racked out visible when the door is opened or closed. In the event that a racking handle is not available, it shall be possible to use a standard hex head tool to drive the racking mechanism. Provide one racking handle per MCC furnished with CDR units.
4. Provide one remote racking operator [per electrical room with CDR units]. The operator shall perform the function of a racking handle remotely by using a motorized driver controlled from a corded tandem station operable from a distance of at least 30ft from the unit. The remote racking operator shall be powered from a standard 120VAC receptacle.
5. Except where specified or shown, CDR units provided to replace units (CDR or non-CDR) of an existing MCC shall utilize the same mounting space of each existing unit. No modifications to the existing MCC bus or structure shall be required for these modifications.

2.7 MAIN AND FEEDER MOLDED CASE CIRCUIT BREAKERS

Additional advanced features of circuit breakers and trip units may be selected by either editing/referring to specification Section 26 28 11.11 Molded Case Circuit Breakers, Section 26 28 11.12 Insulated Case Circuit Breakers or by copying those requirements into this specification.

- A. Circuit breakers shall have voltage and interrupting ratings that meet the application requirements. Interrupting rating shall be available up to 200 kAIR without fuses.
- B. From 125 A to 600 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to limit let-through energy on the installation
- C. MCCBs shall be designed to trip the circuit breaker in the event of high-level short-circuit currents. This design shall be independent of the thermal-magnetic or electronic trip unit.
- D. For frame ratings, higher than 250 amperes, MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption.

- E. The P and R-frame circuit breakers shall be equipped with a safety interlock which keeps the circuit breaker open if the trip unit is not installed.
- F. Energy Reduction Maintenance Setting Switch (ERMS)
 - 1. For Main Circuit Breakers (1200A Frame and Above), provide a Maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
 - 2. Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
 - 3. Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.
 - 4. Contacts shall be wired on all ERMS switches to a common alarm input to plant control system.
- G. MCCB's with frame ratings 150 to 400 amperes shall be equipped with [thermal magnetic][electronic] trip units. MCCB's with frame rating 125 amperes shall be equipped with thermal magnetic trip units.
- H. MCCB's with ratings over 400 amperes shall be equipped with electronic trip units.
- I. Thermal Magnetic (400 Ampere Frame and Below):
 - 1. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 °F (40 °C) ambient temperature.
 - 2. Circuit breaker frame sizes 250 amperes and above shall have a single magnetic trip adjustment located on the front of the circuit breaker
 - 3. Where indicated on drawings, circuit breakers shall be equipped with a ground fault module (GFM) with 20 to 200 amperes sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equivalent.
- J. Electronic Trip Circuit Breakers
 - 1. Electronic trip unit shall be true RMS sensing.
 - 2. Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments shall be 1 ampere. Fine increments for delay adjustments shall be one second
 - 3. Trip units shall be available to provide real time metering. Metering functions shall include, but shall not be limited to, the following:
 - a. Current (phases, neutral, average, maximum)
 - b. Voltage (phase-to-phase, phase-to-neutral, average, unbalance)
 - c. Power (active [kW], reactive [kVAR], apparent [kVA], power factor)
 - d. Energy (active [kWh], reactive [kVAR], apparent [kVA])
 - e. Total harmonic distortion (current, voltage)
 - f. Metering accuracy shall be 1.5 percent current (above 600 amperes), 1.0 percent current (600 amperes and below), 0.5 percent voltage, and 2 percent energy. This accuracy shall be total system, including, but not limited to, CT and meter.

2.8 LINE-SIDE ISOLATION ARCBLOK™ BY SCHNEIDER ELECTRIC

- A. A Line-Side Isolation Main Breaker section shall be included that provides energy reducing line side isolation and is tested to C37-20-7.
- B. The Line Side Isolation shall not be device limited, and not dependent upon the design, current duration or trip level setting of any upstream protective device; in addition, it shall be rated to the full voltage and interrupting rating marked on the equipment. Adding Arcblok will reduce incident energy on the line side to

level 1. Maximum incident energy of the equipment will be determined by the load side of the main breaker. Main-tie-main design would require ArcBlok on each main.

- C. Remote continuous thermal monitoring shall be provided by the Line-Side Isolation Main section. Thermal monitoring of each bus on the line side of the line-side isolation main section shall be provided as a design control to eliminate the need for exposure to energized line side conductors for thermal scans.

2.9 COMPONENTS FOR TYPICAL UNITS

A. Combination Starters:

Solid state overloads should be selected

1. All combination starters shall use a unit disconnect as described in Typical Unit Construction article above. Magnetic starters shall be furnished in all combination starter units.
2. All starters shall utilize NEMA/EEMAC rated contactors.
3. When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads. The transformer rating shall be fully visible from the front when the unit door is opened.
4. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
5. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
6. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
7. Units provided in MCCs rated for arc resistance shall be fitted with 12 gauge steel doors and control station panels. Each unit shall have additional door hinges, arc latches, and fasteners that have been tested and provide additional rigidity and support in the event of an internal arc fault.

B. Terminal Blocks:

1. When Type B wiring is specified, starter units shall be provided with unit control terminal blocks.
2. Terminal blocks shall be the pull-apart type with a minimum rating of 250 volts and 10 A. All current carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail-mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
3. When Type C wiring is specified, all starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for size 1-3 starters. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit terminals so that all field control connections can be made at the terminal compartments.

- C. Provide engraved phenolic nameplates for each MCC and unit compartment. Nameplates shall be gray background with white letters, measuring a minimum of 1.5 in (38 mm) high by 6.25 in (159 mm) wide total outside dimensions.

- D. Pilot Device Panel: Each combination starter unit shall be provided with a hinged/removable control station plate, which can accommodate up to five 22 mm pilot devices or three 30 mm pilot devices. The control station plate may be deleted if no local unit pilot devices are required.

E. Motor Overloads: Motor overload protection shall be provided by a [3-pole, external manual reset, overload relay with [eutectic melting alloy overloads (NEMA rated units only)][solid state overloads (NEMA rated units only)][Intelligent Motor Protection Relay]][solid state overloads for units under [5 hp] (NEMA rated units only and Intelligent Motor Protection Relay for all others)].

E. Intelligent Motor Protection Relays (IMPR) OPTIONAL

1. Overloads shall be fully programmable electronic relays.
2. Overloads shall provide a 4.5:1 adjustment range matched to NEMA contactor sizes 00-6. Overload relays shall monitor all 3 phases for current. Parameter setting of the overload via network communications shall be supported.
3. The overload shall feature a Test/Reset button.
4. [The overload shall feature General Purpose I/O – 6 Inputs, 3 Outputs.]
5. Inputs powered by 120VAC.
6. Outputs shall be 120VAC.
7. Automatic, network, electronic and manual reset functions shall be supported.
8. The following protective functions shall be provided based on user configurable parameters:
 - a. Overload / Underload / Jam
 - b. Current Unbalance
 - c. Ground fault
 - d. Rapid cycling
 - e. Motor Thermal Capacity
9. The overload shall provide the following user configurable parameters:
 - a. Trip Class (5, 10, 15, 20, 25, 30)
 - b. Command (Trip, Reset/Run, Display Lock, Network Configuration Enable)
 - c. Rapid Cycle Timer
 - d. Overload Restart Delay
 - e. Underload Restart Delay (Dry Well Recovery Timer)
 - f. Number of restarts after faults (Automatic Reset Mode)
 - g. Number of restarts after Under Load fault (Automatic Reset Mode)
 - h. Underload Trip Delay
10. The overload shall provide the following diagnostic and operational information:
 - a. Error and Trip Indicators
 - b. Ground Fault, L1, L2, L3 and 3 Phase Average Currents
 - c. Current Unbalance
 - d. Thermal Capacity Remaining
 - e. Fault History (Last 4 faults)
 - f. Product Identifier / Scale Factor
 - g. Restart delay timer values
 - h. Run time accumulator
11. [IMPR DISPLAY UNIT] OPTIONAL
 - a. Overload information and faults shall be viewed from the front of each starter unit.
 - b. The display unit shall provide the capability of changing overload settings.
 - c. Each Starter unit shall have a door mounted display. The display unit shall be capable of replacing all pilot lights and pushbuttons and shall include a 4X20 liquid crystal, extended temperature range, backlit display. The display shall be provided with password protect functionality to prevent tampering of set points.

- d. Ten membrane pushbuttons shall be an integral part of the display unit. The pushbuttons shall provide the following functionality:
 - 1) Motor Start
 - 2) Motor Stop
 - 3) Overload Reset
 - 4) Local/Remote Operation
 - 5) Menu navigation (scroll/select/enter)
- e. The liquid crystal display shall display the following motor data information:
 - 1) Average current, individual line currents, and current unbalance
 - 2) Current to ground
 - 3) Stores last five faults with time and date stamp, including [voltages /] currents at time of trip
 - 4) Frequency
 - 5) [Average voltage, line-line voltages, and voltage unbalance]
 - 6) [Instantaneous power]
 - 7) [Power factor]
- f. The liquid crystal display shall display the following motor management information:
 - 1) Total motor run-time (re-settable)
 - 2) Time and date of last five faults, along with voltage and current at time of trip
- g. Number of motor starts/hour
 - 1) I/O status
 - 2) Start duration
 - 3) Starting current
 - 4) Date/Time
 - 5) [kWh consumed (re-settable)]
- h. The unit display shall have two communication ports: one for communications to the solid state overload and one shall be capable of communicating to overload programming and monitoring software. The Upstream Modbus port network speed shall be selectable at 9600 or 19,200 baud.

2.10 VARIABLE FREQUENCY AC DRIVE UNIT CONSTRUCTION [- NOT USED]

In paragraph below select input and select type of AC drive.

- A. The AC drive controller unit shall be a combination disconnect-drive MCC style unit. The input [circuit breaker][fusible switch] shall provide NEC required branch circuit protection. The branch circuit protection shall have an external operator.
- B. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard NEMA design A or NEMA design B motors.
 - 1. The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes.
 - 2. The heavy-duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes.
- C. Units shall be of modular construction so that it shall be possible to readily interchange units of the same size without modifications to the MCC structure.
- D. Conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.
- E. AC drive controller units up to 50 horsepower variable torque shall be plug-on units which shall connect to the vertical bus through a spring-reinforced, stab-on connector. Units larger than 50 horsepower

variable torque shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

- F. AC drive controller unit interior mounting panels shall be white for better visibility.
- G. A disconnect operator shall be provided per Typical Unit Construction Article above.
- H. The AC drive controller unit shall incorporate a self-contained, air-based cooling system. Air exhaust vents shall be louvered to help direct air flow away from personnel operating the AC drive controller unit. Fans, ductwork, or filters shall be easily accessible for maintenance.
- I. The AC drive controller unit cooling system shall be sized to cool the drive regardless of mounting location within the MCC. The AC drive controller unit shall not be restricted to a specific location in the MCC.
- J. An internal overtemperature trip shall be provided to detect cooling system failure or blockage. Upon occurrence of an overtemperature trip, the cooling system fans shall continue running to provide a rapid cool down.
- K. Power for the cooling system shall be provided internal to the AC drive controller unit by use of a control power transformer that shall include, but shall not be limited to, two primary fuses and one secondary fuse (in the non-ground secondary conductor).
- L. Graphic User Interface
 - 1. A detachable UL Type 12/IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel shall be provided for monitoring, annunciation, and configuration. The graphical display shall change to a red backlit color when an alarm occurs. The door mounting for the user interface shall be done with a 22 mm hole.
 - 2. The keypad shall be capable of storing the configuration for the motor overload to ease replacement and service continuity
 - 3. A "Simply Start" menu for fast and easy commissioning shall be provided and parameter setting shall be easily accessible and user friendly with plain text messaging and actual setting range.
 - 4. The keypad shall be capable of providing password protection.
 - 5. The user interface shall be capable of saving and downloading configurations of the VFDs, as well as porting them to other VFDs.
 - 6. The user interface shall offer a Mini-USB port for mass storage or PC device connection.
 - 7. The mechanical mounting for the user interface on the cabinet shall be done with a 22 mm hole.
 - 8. The VFD shall have self-diagnostic capabilities to display alarms, errors, and warnings as they occur and be able to store at least 15 last messages into the memory. These shall be accessible by PC maintenance tools or web server with flash record for data logging expertise
 - 9. The user interface shall be identical throughout the power range to avoid confusion amongst the users and need for training in several different units.
- M. Control:
 - 1. VFD shall interface with automation systems to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory.
 - 2. The speed command and reference may come from different control sources:
 - a. I/O terminals
 - b. Communication network
 - c. Web server
 - d. Remote graphic display terminal

3. A minimum of the following standard inputs / outputs shall be provided to interface with control systems and instrumentation:
 - a. Analog Inputs: [3][5] programmable 0(4)-20 mA or 0-10 vdc
 - 1) 2 analog inputs shall also be programmable for temperature sensors (PTC, PT100, PT1000, KTY84)
 - b. Analog Outputs: 2 programmable 0(4)-20 mA or 0-10 vdc
 - c. Discrete Inputs: [6][12] programmable isolated logic inputs as either sink or source
 - 1) 2 discrete inputs shall also be programmable as 0-30 kHz pulse inputs
 - 2) 2 discrete inputs shall be dedicated Safe Torque Off safety function in accordance with IEC/EN 61508-1 SIL3
 - d. Discrete Outputs: [3][6] programmable relay contacts [and 1 open collector output]
 - 1) 1 discrete output shall be dedicated to product watchdog logic
4. Pilot devices shall be industrial rated [0.87 inch (22 mm)] [1.18 inch (30 mm)] type control operators and used independently of the keypad display. Software assignments for control inputs and outputs to operate factory-supplied controls shall be pre-configured from the factory. The following basic controls shall be provided:

Review and edit the next eight sub-subparagraphs to suit the Project.

- a. Hand-off-auto selector switch. The hand mode shall allow manual operation of start, stop, and speed control. The AC drive shall start when the control operation is in the hand mode. A door-mounted, manual speed potentiometer shall be used to control speed in the hand mode. The AC drive shall run at the low speed setting or higher as required by the position of the manual speed potentiometer. This mode shall function as 2-wire control and automatically restart after a power outage or auto restart after a fault. The off position of the control operation shall stop the AC drive and prevent it from restarting. The auto (automatic) mode shall receive an [auto start contact] [serial link command] to control starting and stopping of the AC drive. This contact shall also start and stop bypass (if used) when both the automatic and bypass modes of operation are selected. Speed control shall be from an user supplied [4–20 mAdc] [serial link communication] signal.
- b. Start-stop pushbuttons. Start-stop pushbuttons shall provide 3-wire start/stop control.
- c. Power on pilot light, red.
- d. Fault pilot light, yellow, push-to-test.
- e. Run pilot light, green, push-to-test.
- f. Stopped pilot light, red, push-to-test.
- g. Hand/auto pilot lights, yellow, push-to-test.

Note, Additional controls can be found on the equipment electrical diagrams.

- h. Two-wire or 3-wire control strategy shall be defined within the software.
- i. The control power for the digital inputs and outputs shall be 24 volts DC.
- j. Logic connections shall be furnished on pull-apart terminal strips.

N. Communications

1. The VFD shall provide at a minimum 1 Modbus and 1 Ethernet Modbus TCP communications ports. [In addition the following communications options shall be provided as necessary for communications. Refer to communication requirements specified elsewhere within the Contract Documents.]
 - a. [Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain]
 - b. [Profibus DP V2, SUB-D9 connection, compliant with Drive Profile networking]
 - c. [Profinet, RJ45 dual port for daisy chain]
 - d. [DeviceNet, 5 terminal points]

e. [CanOpen Open terminals, 5 terminal points]

2. VFD Ethernet ports shall be IPv6 compliant, allow for web server access and provide network management via SNMP and clock synchronization.
3. The VFD shall provide an embedded web server for enhanced diagnostic, configuration, parameter access, and energy management. There shall be the capability to create a user-defined custom dashboard for viewing drive and process status through tables, charts, and graphical views. It shall be possible to export data in standard table format using the webserver, for information around energy consumption as well as error and warning history.
4. VFD communications modules shall be [capable of being] remotely powered by a separate external 24 VDC to allow for continued communications when the drive power supply is off.
5. The VFD shall provide integration connectivity via
 - a. DHCP protocol for Fast Device Replacement
 - b. DTM library in compliance with standard FDT technology

O. Diagnostics and Configuration

1. The VFD Supplier shall have Windows based PC software for configuring and diagnosing the VFD. It shall be possible to set and modify parameters, control the drive, read actual values and make trend analysis using the software. The PC-tools may be connected to the VFD by wired or wireless connection.
2. The VFD shall display all faults in plain text and help screens shall be available to guide the user in the troubleshooting. Codes are not acceptable.
3. The VFD shall provide a Real Time Clock management for time stamping of detected errors.
4. The VFD shall display detected errors with QR codes to guide the user in the troubleshooting.
5. The VFD must have the ability to dynamically display I/O status.

The next two subparagraphs are optional network communications specifications. Retain, review, and edit if applicable to the Project.

P. Isolation/Bypass Contactors OPTIONAL

1. As a UL listed option, the AC drive controller unit shall include, but shall not be limited to, [isolation and bypass contactors packaged as a separate MCC unit with steel barriers segregating the AC drive from the bypass starter] [isolation and bypass contactors integrated with the AC drive as one MCC unit to reduce space].
2. The isolation and bypass contactors shall be mechanically and electrically interlocked complete with a Class 10 thermal overload relay, disconnect interlocked with the door, control circuit transformer, AFC/off/bypass switch, and bypass/run and AFC run lights.
3. The operator shall have full control of the bypass starter by operation of the door-mounted selector switch.
4. When the drive is supplied with a hand-off-auto selector switch, the auto mode shall also control the run/stop of the bypass operation.

Q. Harmonic Study OPTIONAL

1. A harmonic distortion analysis shall be performed and priced as a separate line item by the AC drive manufacturer based upon system documentation supplied by the Contractor. The documentation shall consist of one-line diagrams, distribution transformer information (kVA, %Z, and X/R ratio), and emergency standby generator performance specifications. The harmonic distortion analysis report shall be part of the shop drawing process, submitted to the Architect/Engineer for review and acceptance. If the calculations determine that harmonic distortion values are higher than the voltage and current values specified in IEEE 519, the drive manufacturer shall provide the equipment specified in Optional Harmonic Equipment Paragraph below to meet the IEEE specified values.

R. Harmonic Equipment:

Select one of the following four subparagraphs.

1. All drives shall include 3% effective impedance. If integral to the AC Drive, a DC choke shall be used. External line reactors must be used if no DC Choke is integral to the AC Drive.
2. All drives shall include 5% effective line impedance. If integral to the AC Drive, a DC choke may be used in series with a 3% reactor. An external 5% impedance reactor must be used if no DC Choke is integral to the AC Drive.
3. An active harmonic filter shall be provided to perform electronic cancellation of load produced harmonic currents such that the upstream power harmonic current and voltage shall be reduced below the IEEE 519 guidelines for load demand and voltage distortion limits. Filter shall be Square D® brand Accusine or equivalent. Performance of the filter shall be independent of the impedance of the power source, AC lines or back-up generator. Necessary current transducers, reactors, and operator interfaces shall be supplied with the MCC. A factory certified start-up technician shall be used to start up each harmonic filter to achieve optimum system performance.
4. For AC Drives rated 480 volts, [50 to 400 horsepower variable torque] [40 to 350 horsepower constant torque], the AC drive manufacturer shall supply an 18-pulse design using a multiple bridge rectifier with integral reactor and phase shifting transformer. The 18-pulse configuration shall result in a multiple pulse current waveform that approximates near sinusoidal input current waveform. The power section shall be insensitive to phase rotation of the AC line.

S. Load Filters: The AC drive controller unit shall include, but shall not be limited to, a motor protection filter unit designed to limit peak voltages and reduce electrical stress on the motor insulation. This option shall be required for motor lead lengths above 150 feet (45.72 m). The filter unit shall be ventilated to limit heat buildup within the MCC.

2.11 SOLID STATE REDUCED VOLTAGE STARTER UNIT CONSTRUCTION [- NOT USED]

- A. The soft start controller unit shall be a combination disconnect/soft starter, MCC-style unit. The input [circuit breaker][fusible switch] shall provide NEC required branch circuit protection. The branch circuit protection shall have an external operator. Wiring between the soft starter and disconnect shall not be disturbed when removing or installing the soft start controller unit from the MCC. Units shall be of modular construction so that units of the same size can be interchanged without modifications to the MCC structure.
- B. Conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.
- C. Soft start controller units rated for standard duty (up to 156 A) shall be plug-on units which connect to the vertical bus through a spring-reinforced stab-on connector. Units rated higher than 156 A shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.
- D. Soft start controller unit interior mounting panels shall be white for better interior visibility.
- E. A disconnect operator shall be provided per Typical Unit Construction Article.
- F. Plug-on soft start controller units shall have a grounded stab-on connector which shall engage the vertical ground bus prior to, and shall release after, the power bus stab-on connectors engage/release.
- G. The enclosure shall include, but shall not be limited to, a door-mounted digital keypad for adjusting the soft start parameters and viewing the motor, soft start, and fault status without opening the enclosure door.
- H. A shorting contactor shall be supplied in each soft start controller unit to reduce temperature rise within the unit and MCC enclosure. The shorting contactor shall be rated to carry the motor full load current during steady state after full voltage has been applied to the motor by the soft starter.

I. Electrical Ratings:

1. The soft start controller unit shall be designed to operate from an input voltage between -10% and +10% of nominal voltage rating.
2. The soft start controller unit shall operate from an input voltage frequency range of $\pm 5\%$.
3. The soft starter shall be capable of supplying 350% of rated full load current for 20 seconds at the maximum ambient temperature.
4. Soft start controller unit power and control devices shall be rated for [standard duty capable of three evenly spaced starts per hour at 300% of full rated current for 20 seconds per start without tripping] [severe duty capable of three evenly spaced starts per hour at 350% of full rated current for 24 seconds per start without tripping].
5. The silicon-controlled rectifiers (SCRs) shall have a minimum peak inverse voltage (PIV) rating of 1800 volts AC. Lower rated SCRs with protection by metal oxide varistors (MOVs) shall not be accepted.

J. Protection:

1. A microprocessor-based thermal protection system shall be included that shall continuously calculate the temperature rise of the motor and soft starter and shall provide the following:
 - a. A motor overload pre-alarm that shall indicate by relay contact or logic output that the motor windings have exceeded 110% of their rated temperature rise. This function shall be for alarm only.
 - b. A motor overload fault shall stop the motor if the windings have exceeded 125% of their rated temperature rise.
 - c. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant that shall ensure memorization of the thermal state even if power is removed from the soft starter.
2. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.
3. The soft start controller unit shall include, but shall not be limited to, a shorting contactor which shall close after full voltage has been applied to the motor by the soft starter to reduce the current carrying duty on the SCRs. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.
4. Units and options shall be constructed with protection provisions to pass UL 845 short circuit testing criteria at a minimum of 100,000 A short circuit current.
5. Diagnostic faults and soft start status shall be displayed on the door-mounted keypad after a fault condition.
6. The motor shall be automatically protected from solid state component failure by one of the following means:
 - a. Shunt trip coil to trip disconnect in the event of a soft start fault condition, including, but not limited to, a shorted SCR.
 - b. Isolation contactor that shall open when the motor is stopped or when the controller detects a fault condition, including, but not limited to, a shorted SCR.

K. Adjustments and Configurations:

1. Programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.
2. Digital indication shall provide, as a minimum, the following conditions:
 - a. Soft starter status; ready, starting/stopping, run.

- b. Motor status; current, torque, thermal state, power factor, operating time, power in kW.
 - c. Fault status; motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.
3. The starter shall be preset to the following for operation without adjustment in most applications:
 - a. Linear (torque-controlled) acceleration ramp of 10 seconds.
 - b. Current limitation to 350% of the motor full load current rating.
 - c. Class 10 overload protection.
 - d. Motor current preset per NEC Table 430.150 for standard horsepower motors.
 4. A digital keypad shall be used to configure the following operating parameters as required:
 - a. Motor full load amperes adjustable from 40 to 100% of the controller's rating.
 - b. Current limitation on starting adjustable from 200 to 700% of the motor current rating, not to exceed 350% of the soft start rating.
 - c. Voltage ramp adjustable from 1 to 60 seconds.
 - d. Initial voltage adjustable from 10 to 50% of nominal motor torque.
 - e. Maximum start time adjustable from 1 to 250 seconds.
 - f. Voltage boost duration adjustable from 0.1 to 1 second.
 - g. Selection of freewheel or soft stop.
 - h. Linear (torque-controlled) deceleration ramp time adjustable from 1 to 60 seconds.
 - i. Threshold to change to freewheel following a soft stop from 0 to 10% of the nominal motor torque.
 - j. Selection of Class 10, Class 20, or Class 30 motor thermal overload protection.
 5. A digital keypad shall be used configure the following controller parameters as required:
 - a. Assignment of soft start inputs and outputs.
 - b. Activation of phase reversal protection.
 - c. Reset of motor thermal state.
 - d. Return to factory parameter settings.
 - e. Activation of self test mode.
 - f. Indication of elapsed time in hours of starting, running, and stopping.
 6. Output relays shall provide the following status indications:
 - a. One Form A (normally open) minimum for indication of trip.
 - b. One Form A (normally open) for indication that soft start is running.
 7. Additional inputs and outputs shall be available to provide the following status indications:
 - a. Two assignable control inputs for the following functions: external fault input, disable serial link control, second set of parameters, or general fault reset.
 8. Relay and I/O functions listed above shall be isolated with respect to common.

L. Controls

1. The soft starter's control circuit shall be fed from a fused line supply and shall be completely independent of the power circuit and separate from relay control logic.
2. The peripheral soft starter control circuitry shall be operated from a control power transformer included within the enclosure.
3. Operator devices shall be door-mounted and shall be as follows:
 - a. Black start and red stop pushbuttons.

- b. Three position hold-open-auto switch which shall provide for manual (hand) start or remote signal.
- c. Auto start from user-supplied relay contacts.
- d. Three position forward/off/reverse selector switch mounted on the door control island (available with reversing starter only).
- e. Red run pilot light illuminated whenever the soft starter is provided a run command and no fault condition is present.
- f. Green off pilot light illuminated whenever the soft starter is supplied with control power and no run command is present.

Paragraph below is option, retain if applicable to the Project.

M. Full Voltage Emergency Starter OPTIONAL

- 1. The soft start controller unit shall include, but shall not be limited to, full voltage starting capability to start and control the motor instead of the reduced voltage soft start method of starting the motor.
- 2. The full voltage emergency starter shall be UL listed and shall include, but shall not be limited to, a contactor capable of carrying the motor inrush and motor full load current.
- 3. A door-mounted bypass/normal selector switch shall be provided to enable the user to manually select the motor starting method. Normal mode shall provide a reduced voltage start using the soft starter. In bypass mode, the soft starter shall be left inactive and the motor shall be started using an across-the-line full voltage starting method.
- 4. An overload provision independent of the soft starter shall be provided to protect the motor in the bypass mode.
- 5. The full voltage emergency starter components shall be integrated inside the soft start controller unit and shall be fully tested by the MCC manufacturer.

2.12 POWER METERING [- NOT USED]

A. Provide a power meter for each LV Main application [shown on drawings] as follows:

- 1. LV Mains: The metering device used to monitor the low voltage mains for network management, energy cost allocation, power quality analysis, asset management, operational efficiency, and compliance reporting, shall be a [Power Quality Meter as specified in Section 26 27 13.16 Power Quality Meters.][PowerLogic PM8244 Meter by Schneider Electric, [2nd manufacturer and model], [3rd manufacturer and model]].
- 2. High-visibility color graphical display.
- 3. Direct connect to circuits up to 600 VAC, eliminating the need for voltage (potential) transformers; Four metered 5 A nominal current inputs for 3 phase measurements plus neutral.
- 4. Supported monitoring parameters—full range of 3-phase voltage, current, power, and energy measurements, total harmonic distortion (THD), individual current and voltage harmonics readings, waveform capture, voltage and current disturbances (dip/swell) detection, ability to determine the location of a disturbance (upstream or downstream).
- 5. COMTRADE—up to 255 COMTRADE disturbance capture files available directly from meter via FTP and providing client notification of new captures through IEC 61850 (RDRE logical node).
- 6. Power Quality compliance—without using separate software, determine statistical indicators of power quality that include but are not limited to voltage dips and swells, harmonics, and frequency in accordance with EN 50160 power quality standard and provide an indication of pass/fail in a web interface; Third party laboratory tested to the power quality standard IEC 61000-4-30 Class 'S'.
- 7. User customization capable of deriving values for any combination of measured or calculated parameters using arithmetic, trigonometric, and logic functions through graphical, flexible object oriented, programmable modules. Modules shall be able to be linked together in an arbitrary

manner to create functionality such as totalization, efficiency measurements, control functions, load shedding, demand response, power factor correction, and compliance monitoring.

8. Communications capability: multi-port Ethernet and serial communications with at least two Ethernet ports and one RS485 serial port. Functionality through Ethernet connectivity includes e-mail on alarm, e-mail interval energy data, on-board web server, SNMP network management, NTP time synchronization, Ethernet-to-serial RS-485 gateway, Modbus, DNP3, and IEC 61850.
9. On-board logging: non-volatile time stamped on-board logging of input/output (I/O) conditions, minimum and maximum values, energy and demand, maintenance data, alarms, and any measured parameters; trending and short-term forecasting of energy and demand; custom alarming with time stamping in which the meter has the capability of learning set-point limits based on the system behavior; trigger alarms on at least 50 definable power or I/O conditions; use of Boolean logic to combine alarms.
10. Input/outputs: provide at least three 3 digital inputs and 1 digital output for equipment status/position monitoring and equipment control or interfacing with millisecond timestamp. The meter shall accept up to four field installable I/O modules. Provide additional modules as required for application. Each digital I/O module shall provide 6 digital status/counter inputs and 2 Form C relay outputs rated at 250 V, 8 A. Each analog I/O module shall provide 4 inputs configurable to 4-20 mA or 0-30V ranges and 2 outputs configurable to 4-20 mA or 0-10V ranges..
11. Disturbance direction: provide an indication of the location of each power system event as “up stream” or “down Stream” along with the level of confidence of the location.

B. Provide a power meter for each LV Feeder application [shown on drawings] as follows:

1. **LV Feeders:** The metering device used to monitor the low voltage mains for network management, energy cost allocation, asset management, operational efficiency, and compliance reporting, shall be [a Power Meter as specified in Section 26 27 13.13 Power and Energy Meters][a PowerLogic [Circuit Monitor 4000T][PowerLogic PM5563 Meter] by Schneider Electric, [2nd manufacturer and model], [3rd manufacturer and model]].
2. Connections and form factor: direct connect to circuits up to 600 VAC, eliminating the need for voltage (potential) transformers; 5 A nominal current inputs. Removable connectors for voltage inputs, control power, communications, inputs and outputs; easily mountable in the pre-made cutout without tools; form factor will be ¼ DIN with 92 X 92 cut-out and 96 x 96 panel mount integrated display.
3. Supported monitoring parameters: full range of 3-phase voltage, measure each phase and neutral current using 4 current inputs, power and energy measurements, power factor, frequency, total harmonic distortion (THD), individual power harmonics (up to 63rd order).
4. Accuracy standards: use four-quadrant metering and sample current/voltage simultaneously without gaps with 64 samples per cycle (zero blind); comply with ANSI C12.20 class 0.2 and IEC 61557-12 class 0.2 for revenue meters.
5. Display: Backlit dot-matrix LCD display, anti-glare and scratch resistant with a minimum of 128 x128 pixels, capable of displaying four values in one screen simultaneously; a summary screen to allow the user to view a snapshot of the system; support either integrated or remote display.
6. Support 4 digital inputs for Demand Synch Pulse, Time Synch Input, and Conditional Energy Control; have 2 digital outputs that operate either by user command sent over communication link, or in response to a user defined alarm or event.
7. Communications: serial RS-485 Modbus, Ethernet Modbus TCP, Ethernet BACnet IP (BTL listed), and EtherNet IP; provide 2 Ethernet ports to allow wiring from meter to meter as a daisy-chain; be capable of serving data over the Ethernet network accessible through a standard web browser; the monitor shall contain default pages from the factory.
8. Onboard data logging capabilities: to log data, alarms and events; logged information shall include data logs, minimum/maximum log files of selected parameter values, and alarm logs for each user defined alarm or event log; support the following on-board nonvolatile memory—14 parameters every 15 minutes for 90 days.

9. Alarming capabilities: support 29 set-point driven alarms, 4 digital alarms, 4 unary alarms, 10 Boolean alarms and 5 custom alarms; user definable alarm events; set-point driven alarms shall be available for voltage/current parameters, input status, and end of interval status; shall send emails and/or text messages containing alarm condition indication via Simple Mail Transfer Protocol [SMTP]; Shall have the capability to manage and monitor devices on the IP network via Simple Network Management Protocol [SNMP]; Indication of an alarm condition shall be delivered by SNMP Traps.
10. Firmware shall be upgradeable to enhance functionality through the Ethernet or serial communication connection and shall allow upgrades of individual meters or groups.
11. Integrated gateway functionality, enabling the capability to connect via Ethernet to downstream, serially connected devices.
12. Designed accordingly to eco-design complying with ISO 14062, especially MCCB materials shall be halogen free type; designed for easy disassembly and recycling at end of life, and comply with environmental directives ROHS and WEEE.
13. The meter shall provide 4 digital inputs configurable for input metering with on-board pulse weight calculation and conversion to standard units for external water, air, gas, electrical or steam (WAGES) meters.

2.13 ETHERNET COMMUNICATIONS [- NOT USED]

A. General Requirements

1. [Where specified or shown on Drawings]MCCs shall be provided with industrial quality managed Ethernet switch(s) as required to communicate and perform the functions necessary for connection to an industrial communications network. In conjunction with the Ethernet switches a communications network shall be provided within the MCC to connect all Ethernet communications capable equipment within the MCC. In addition, the following MCC components shall be provided with Ethernet connections for communications over the network:
 - a. Incoming Mains Power Meter(s)
 - b. Main Circuit Breaker(s)
 - c. Feeder Circuit Breakers as designated on the Drawings
 - d. Motor Starters or associated Intelligent Motor Protection Relays
 - e. Variable Frequency Drives
 - f. Solid State Reduced Voltage Soft Starters
2. The MCC Ethernet network communications architecture shall form a star topology to optimize network availability and reliability. The star topology shall be created by way of home run patch cables individually run from each communicating motor starter or circuit breaker unit back to a centrally located Ethernet Switch unit.
3. A minimum of 2 managed Ethernet switches shall be provided per MCC. Ethernet switch connections to MCC equipment for multiple loads of a single process train shall be evenly split between switches so that a switch failure will not disable all communication to all equipment within that process train.[For example, Switch A would be connected to Pumps 1, 3, and 5 while Switch B would be connected to Pumps 2, 4, and 6.]
4. MCCs with a main-tie-main configuration shall be provided with an Ethernet switch and associated power section on either side of the tie. Each section shall be fully operable independent of state of the switch on the other side of the tie.
5. Additional network communication requirements are depicted on the Process Instrumentation and Control System drawings

B. Managed Ethernet Switches OPTIONAL

1. Subject to compliance with requirements, provide Connexium Ethernet TCP/IP Managed Switch by Schneider Electric or equal as manufactured by [2nd manufacturer], or [3rd manufacturer].

2. Managed switches shall provide capability for prioritization of network traffic, Rapid Spanning Tree Protocol (RSTP), network redundancy, and Simple Network Management Protocol (SNMP).
3. Each MCC shall contain two or more Ethernet switch devices with a sufficient quantity of RJ-45 ports for all communicating units, management ports, uplink ports, and approximately 10% spares.
4. All Ethernet switches shall be centrally mounted in (a) compartmentalized unit(s) for easy and ready access for troubleshooting without the presence of control power voltages greater than 24Vdc.
 - a. Ethernet Switches shall be unit mounted and centrally located near the bottom of the MCC to optimize cable runs across shipping splits. Individually mounting Ethernet switches in horizontal or vertical wireways or behind wireway barriers that require maintenance personnel to work around or near exposed power cables is strictly prohibited. Ethernet Switch units shall be provided with cable supports which help to prevent stress and damage to Ethernet switch ports.
5. Switch compartments shall have no voltage over 24V DC

C. Communications Equipment Power Supply: [A separately mounted, 24Vdc power supply unit shall provide power to Ethernet switch unit(s) in order to prevent personnel exposure unsafe voltages.] [All communicating devices, such as Ethernet switches, overloads, meters, etc., shall be supplied with 24Vdc power externally from the MCC.] Select one of the two options

D. Communication Cabling

1. The full-depth vertical wireway shall contain a communications barrier that will serve to separate communications from power cabling to prevent noise interference and mechanical damage on the network cables. Intermediate Ethernet connectors used to extend CAT5e cables through metal barriers may create additional points of failure, and are strictly prohibited.
2. The MCC shall employ industrial grade, shielded 600V rated Category 5e communication patch cables to interconnect communicating units with Ethernet switch units.
3. Subject to compliance with requirements, provide DataTuff Cat 5e Ethernet cables assemblies by Belden or equal as manufactured by [2nd manufacturer], or [3rd manufacturer].

E. Configuration protocol

1. The MCC shall communicate [Modbus TCP] [Ethernet/IP].

F. A startup/commissioning Network Validation Service shall be provided with each Intelligent MCC line item to reduce installation, commissioning and setup time on site. Training shall be provided as part of the service. This service shall be performed by a qualified Intelligent MCC services engineer.

2.14 POWER SYSTEM PLATFORM (MAINTENANCE MONITORING SYSTEM) [- NOT USED]

Square D Power System Platform™ for Model 6 MCCs provides a maintenance monitoring system using a local HMI interface with remote SCADA connectivity.

- A. The monitoring system shall be built on an MS Windows based Operator Interface Terminal (OIT) running Wonderware HMI software.
- B. The monitoring system shall be remotely accessible from electronic tablets and Windows-based computers
- C. The monitoring system shall communicate with all of the power meters, VFDs, IMPRs and communicating circuit breakers manufactured by the MCC manufacturer in the Motor Control Center
- D. The monitoring system shall display the following information:
 1. Real-time data for each communicating device in the Motor Control Center
 2. Trended data over the past five minutes

3. Historian with trended data for a minimum of three years
 4. Wiring diagrams for each unit in the Motor Control Center
 5. Device manuals for each communicating device
- E. The monitoring system shall have an alarm system with the following features:
1. On screen alarm display with Shelve and Silence capability
 2. Device Fault alarms
 3. Impending maintenance alerts for conditions including the following:
 4. Motor Drift
 5. Breaker Contact Wear
 6. Starter Contactor Wear
 7. Email and Text notifications for alarms and maintenance alerts
 8. Four alert groups to allow grouping of devices for notifications
- F. The monitoring system shall be able to upload and store device configuration files for any of the MCC manufacturer's manufactured VFDs or IMPRs in the Motor Control Center
- G. The monitoring system shall provide access to all device webpages available within the Motor Control Center

2.15 ELECTRICAL POWER MANAGEMENT SYSTEM [- NOT USED]

EPMS systems, such as Schneider Electric EcoStruxure™ Power, provide many benefits throughout the lifecycle of an electrical distribution system through the connection, monitoring and analysis of the system and its connected equipment. Equipment connectivity and application support are critical to achieving the benefits of a safe, reliable, efficient and compliant system architecture.

- A. The equipment specified herein shall provide the necessary communications connectivity and functionality of an Electrical Power Management System (EPMS). This shall include, but not be limited, to the following:
1. Communications connectivity using the specified Ethernet network and protocols of the EPMS and related EPMS connected devices and equipment necessary to provide functionality. Devices may be connected through a communications gateway as shown or specified; otherwise Ethernet and protocol connectivity shall be provided within the equipment. Equipment sections with multiple connected devices and assemblies of bolted adjacent bays shall include an internal inter-wired communications network for a singular connection to the EPMS network for power monitoring, equipment status and alarms.
 2. Compliance with Cyber security requirements.
 3. Remote EPMS application functionality for equipment configuration [and operational control]; electrical power monitoring; power quality monitoring, compliance and correction; and alarm monitoring with event log.
 4. Refer to the Electrical Power Management System specification section for additional requirements.
- B. Native software compatibility shall be fully factory-tested and shall include the following characteristics:
1. Capability for pre-engineered, interactive graphical display screens to view and analyze real-time device data. Data displayed shall include the following:
 2. Pre-mapping of registers to standard measurement names without the need for additional configuration or internal device registers.
 3. Automatic collection and logging of device data by EPMS software without additional configuration. Historical data logged shall include the following.

2.16 MARKINGS AND LABELING

- A. All identification and warning labels and nameplates exterior to the MCC shall be resistant to weather, UV, and their intended installation environment.
- B. Each MCC shall be provided with an engraved nameplate identifying the project specific equipment tag and service description.
- C. Warning labels and nameplates shall be present at access locations to advise personnel of possible hazards. The MCC shall be marked in accordance with UL, NFPA 70 NEC, NFPA 70E, and other applicable standards.
- D. In addition to the requirements specified herein, MCCs and their components shall be identified in accordance with the general Work requirements of [Division 26][Process Instrumentation and Control System] Specification Sections and Drawings.
- E. Each MCC and unit compartment shall be identified with an engraved nameplate using 1/2-inch high lettering. Each enclosure mounted control and pilot device shall be identified with an engraved nameplate using 3/8-inch high lettering. Nameplate lettering shall be [all capitals,][all capitals except for math or empirical formulas,] black on a white background. [Equipment designated as safety or emergency related shall have white on red background nameplates.]

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of specifications Section [26 00 10][16010], [40 60 00][13400] Process Instrumentation and Control System, Section [26 08 00][16080] and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
 - 1. MCCs shall not be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust, and dirt. The temperature of the area shall be no less than 32° F (0° C) and no greater than 104° F (40° C). For indoor locations, protection shall be provided to prevent moisture entering the enclosure.
 - 2. MCCs shall be located in an area with a minimum of 3 feet (914 mm) of free space in front of front-of-board construction. An additional 3 feet (914 mm) shall be allowed in the rear of back-to-back construction. This free space shall give adequate room to remove and install units. A minimum of 0.5 inch (13 mm) space shall be provided between the back of front-of-board MCCs and a wall, 6 in (152 mm) required for damp locations).
 - 3. Check that concrete pads are level and free of irregularities. The MCCs shall be assembled on a smooth level surface so that sections are properly aligned. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.
 - 4. For Arc Resistant MCCs, install in a room with an overhead clearance of 28.5 inches (724mm) and 14.25 inches (362mm) from the rear to the front of the MCC clear of obstruction. Installation of Arc Resistant MCCs must follow the manufacturer installation requirements.

- D. **Pre-Installation Conference:** Prior to commencing the installation, an onsite pre-installation conference shall review the material selections, installation procedures, and coordination with other trades. Attendees shall include, but shall not be limited to, the Contractor, the Installer, manufacturer's representatives, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Engineer
- E. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- F. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- G. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory trained manufacturer's representative field service engineer. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment. Report to the Engineer any discrepancies or issues with the installation.

iMCC manufacture startup services specific to the communications and configuration of an iMCC are recommended especially when the iMCC is the first make and type of its kind being installed onsite.

- H. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.2 **FACTORY ACCEPTANCE TESTING (FAT) [- NOT USED]**

MCC are usually provided with an unwitnessed FAT. Consider requiring a witnessed FAT if the iMCC or communications ready MCC is to be incorporated into a SCADA system and coordination is needed to ensure a smooth interface between systems.

- A. The entire MCC shall go through [an unwitnessed][a witnessed] factory acceptance test prior to shipment. This FAT shall include, but shall not be limited to, the following:
 - 1. Physical Inspection of the following:
 - a. Structure.
 - b. Electrical conductors, including, but not limited to, the following:
 - c. Bussing.
 - d. General wiring.
 - e. Units.
 - 2. Electrical Tests:
 - a. General electrical tests shall include, but shall not be limited to, the following:
 - 1) Power circuit phasing.
 - 2) Control circuit wiring.
 - 3) Instrument transformers.
 - 4) Meters.
 - 5) Ground fault system.
 - 6) Device electrical operation.
 - b. AC dielectric tests shall be performed on the power circuit.
 - 3. Markings/labels include, but shall not be limited to, the following:
 - a. Instructional type.
 - b. UL/CSA.
 - c. Inspector's stamps.
 - 4. Each device shall be configured and addressed to correspond with software settings.
 - 5. A read/write test shall be performed prior to shipment on network devices, including, but not limited to, overloads, drives, and soft starters.
 - 6. Testing shall be designed to verify system operation and shall include, but shall not be limited to, these verifications as a minimum:
 - a. Drawings and bill of materials.

- b. I/O addressing.
 - c. Correct device operation by I/O address.
 - d. Host communications.
 - e. Control network interface.
7. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

3.3 FIELD QUALITY CONTROL [- NOT USED]

Schneider Electric extends the warranty of most equipment by 12 months at no additional cost when their service technicians perform functional testing, commissioning and first parameter adjusting of the installed equipment.

- A. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory-trained manufacturer's field service representative. This manufacturer's field service technician shall provide all material, equipment, labor and technical supervision to perform inspection, testing and adjustments to ensure equipment is installed, adjusted, and tested in accordance with the manufacturer's recommendations and is ready for operation. The manufacturer's field service technician shall replace damaged or malfunctioning equipment and report to the Engineer any discrepancies or issues with the installation.
- B. The manufacturer's representative shall, upon satisfactory completion of inspection and testing, attach a label to all serviced devices indicating the date serviced and testing company responsible.

3.4 FIELD TESTING AND COMMISSIONING [- NOT USED]

- A. MCCs and related equipment shall be commissioned in accordance with Specification [Section 26 08 00—Commissioning of Electrical Systems][Section 16080—Commissioning of Electrical Systems].
- B. iMCCs and related equipment shall be commissioned in accordance with Specification [Section 40 61 21— Process Control System Testing][Section 13400—Process Instrumentation and Control System].
- C. Operational Readiness Testing
 - 1. The Contractor shall inspect and test furnished equipment and associated systems for conformance to the contract documents, including equipment manufacture's recommendations, and readiness for operation. The test shall include the following as a minimum:
 - a. Visually inspect for physical damage and proper installation
 - b. Perform tests in accordance with manufacturer's instructions
 - c. Perform tests to ensure compliance with Contract Documents
 - d. Perform tests that equipment is ready for operation
 - e. Touch-up paint all chips and scratches with manufacturer-supplied paint and transfer remaining paint to Owner
 - 2. Contractor shall submit an operational readiness test report documenting all test results, including all assumptions, conditions, allowances and corrections made during the test. **The report shall provide a listing of all modifications and adjustments made onsite to include any settings / parameters not identified as factory defaults within the equipment's O&M documentation.** The test report shall include a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.

D. Functional Demonstration Testing

1. Prior to scheduling functional demonstration testing the Contractor shall submit a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.
2. The Contractor shall completely demonstrate the functionality and performance of the equipment and associated systems in the presence of Owner and Engineer, observing and documenting complete compliance with the Contract Documents.
3. The Contractor shall submit a written report documenting successful completion of functional demonstrating testing including all assumptions, conditions, allowances and corrections made during the test.

3.5 TRAINING [- NOT USED]

- A. O&M Training: The services of a factory-trained instructor shall be provided for training the Owner's staff in the proper operation and maintenance of the MCC and components. Training shall consist of not less than [1][2 repeated] session(s) with [6][4][2] hours of onsite classroom and hands-on instruction for a minimum of [4] attendees per session. The instructor shall provide sufficient time and detail in each session to cover the following as a minimum:
1. Theory of operation
 2. Operation of MCC and components furnished
 3. Maintenance and configuration
 4. Configurations of MCCs and components furnished
 5. Troubleshooting and repair
 6. Replacement of component level parts
- B. [The submitted O&M manuals shall be used for training.][Manuals and documentation shall be provided to each participant for training.]

END OF SECTION [26 24 19][16443] [40 69 11][13436]

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