

Part 1 General

1.1 GENERAL

- .1 All 'reference specifications' indicated in Division 26 are to be distributed as part of the specification.
- .2 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 01.
- .3 If this specification or the referenced drawings conflict in any way with the requirements of the applicable codes and/or standards, the more rigorous requirement shall prevail. Contractor shall be responsible for the compliance with applicable codes and/or standards.
- .4 The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of all equipment and apparatus required to be installed by the Contractor. All equipment shall be removed by the Contractor upon completion of the project.
- .5 The drawings depicting electric work are diagrammatic and show, in their approximate location, symbols representing electrical equipment and devices. The exact location of such equipment and devices shall be established in the field.
- .6 Contractor shall furnish and install all such work, piping, structural supports, electrical wiring and conduit and any other additional equipment for a complete operational system.
- .7 Unless specifically stated to the contrary, no measurement of an electrical drawing by scale shall be used as a dimension. Dimensions noted on the electrical drawings are subject, in each case, to measurements of adjacent or previously completed work and all such measurements necessary shall be taken before undertaking any work dependent upon them.
- .8 In the event of a conflict of quantities between the drawings and specifications Contractor shall base his bid on the greater quantity, cost or quality of the item in question, unless such conflict is resolved by an addendum.
- .9 Contractor must follow all requirements set by Corrections Canada and Public Works Canada.
- .10 All equipment in an inmate accessible area shall be tamper resistant.

1.2 CODES AND STANDARDS

- .1 Do complete installation in accordance with CSA C22.1 except where specified more stringently as identified on drawings specifications or by the authority having jurisdiction.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 where specified more stringently as identified on drawings specifications or by the authority having jurisdiction.

1.3 REGULATORY REQUIREMENTS

- .1 Furnish products listed and classified by CSA and/or a nationally accepted testing laboratory (NRTL) such as UL, ETL, etc. Products must be acceptable to authority having jurisdiction.

1.4 DEFINITIONS

- .1 Provide: Furnish, install and wire complete and ready for service.
- .2 Furnish: Responsible for purchasing item and also delivery to the jobsite.
- .3 Install: Responsible for moving and mounting equipment to the final location.
- .4 Wire: Responsible for final connections, ready for service.
- .5 Exposed: Exposed to view in any room, corridor or stairway.

1.5 CARE, OPERATION AND START-UP

- .1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.
- .4 During the progress of the work the Contractor shall remove from the building site rubbish, dirt and other debris caused by performance of the work.

1.6 VOLTAGE RATINGS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by CAN3-C235. Equipment to operate in extreme operating conditions established in CAN3-C235 without damage to equipment.

1.7 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees and taxes as required to complete the work.
- .3 Departmental Representative will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.
- .4 Notify Departmental Representative of changes required by Electrical Inspection Department prior to making changes.

- .5 Furnish Certificates of Acceptance from Electrical Inspection Department and Authorities Having Jurisdiction as required on completion of work to Departmental Representative.

1.8 MATERIALS AND EQUIPMENT

- .1 Provide materials and equipment in accordance with Division 01.
- .2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.
- .3 Contractor to provide factory assembled control panels and component assemblies as necessary.
- .4 All items specified shall be the latest type or model produced by the manufacturer specified. If descriptive specification or model number is obsolete, substitute with current product with approval of Departmental Representative.

1.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 The Contractor shall clean all exposed ironwork, the interior and exterior of cabinets and pull boxes, etc., and remove all rubbish and debris resulting from the work.
- .4 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.10 LABELLING

- .1 Labelling - Equipment
 - .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates:
 - .1 Lamicoid 3 mm thick plastic engraving sheet, white face, black core, mechanically attached with self-tapping screws.

Nameplate Sizes			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels:

- .1 Embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for average of twenty-five (25) letters per nameplate and label.
- .5 Identification to be English.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Identify equipment with Size 3 labels engraved "ASSET INVENTORY No. ". Number as and if directed by Departmental Representative.
- .8 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .9 Terminal cabinets and pull boxes: indicate system and voltage.
- .10 Transformers: indicate capacity, primary and secondary voltages.
- .2 Labelling – Wiring
 - .1 All power, instrumentation and control wires:
 - .1 Shall be provided with indelible permanent wire tags at each end of the wire.
 - .2 Shall use polyester or polyolefin heat-shrinkable sleeves.
 - .3 Marking shall be abrasion, ozone, ultraviolet, and solvent resistant.
 - .4 Numbering shall match control wiring diagrams
 - .5 Numbering shall match on both ends of phase conductors of feeders and branch circuit wiring.
 - .2 Maintain phase sequence and colour coding throughout.
 - .3 Colour code: to CSA C22.1.
 - .4 Use colour coded wires in communication cables, matched throughout system.
- .3 Labelling – Conduit and Cable
 - .1 Conductors to be labelled at each end by slip-on plastic tags Wieland type Z5 or Weidmuller type Z or by machine-printed heat-shrink labels. Use the conductor designations shown on the wiring drawings. Seal all conductor labels with clear heat-shrink covers.
 - .2 WRITE-ON LABELS ARE NOT ACCEPTABLE.
 - .3 Colour code conduits, boxes and metallic sheathed cables.
 - .4 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
 - .5 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Wire Colours		
	Prime	Auxiliary Stripe
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
Telephone	Green	

Other Communication Systems	Green	Blue
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1.11 LABELS - MANUFACTURER AND CSA

- .1 Visible and legible, after equipment is installed.
- .2 All electrical equipment shall be approved by a nationally recognized testing laboratory such as the Canadian Standards Association.
- .3 New electrical equipment shall have potential electric shock and arc flash hazard labels as per CSA.

1.12 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

1.13 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Departmental Representative.
- .2 Decal signs, minimum size: 175 x 250 mm.

1.14 LOCATION OF OUTLETS

- .1 Locate outlets as shown on drawings and to CSA C22.1.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

1.15 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300 mm.

- .5 Wall mounted telephone and interphone outlets: 1500 mm.

1.16 LOAD BALANCE

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.17 CONDUIT AND CABLE INSTALLATION

- .1 In-slab conduit is not to be used under any circumstances unless existing in-slab conduit is reused.
- .2 Arrange for holes through exterior walls and roof to be flashed and made weatherproof.
- .3 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel, sized for free passage of conduit, and protruding 50 mm.
- .4 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .5 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

1.18 FIELD QUALITY CONTROL

- .1 All electrical work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices' program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.
- .2 The work of this division to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province that the work is being constructed.
- .3 Conduct and pay for following tests:
 - .1 Power system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system, communications.
- .4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .5 Insulation resistance testing.
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

- .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- .3 Megger 4160 V circuits, feeders and equipment with a 5000 V instrument.
- .4 Check resistance to ground before energizing.
- .6 Carry out tests in presence of Departmental Representative unless directed otherwise.
- .7 Provide instruments, meters, equipment, and personnel required to conduct tests during and at conclusion of project.
- .8 Submit test results for Departmental Representative's review.
- .9 Should it be found by the Departmental Representative that any equipment or any portion of the electrical system installed under this Contract fails to comply with the Contract Documents with respect to quality of workmanship or materials, such shall be replaced by the Contractor and all other work disturbed by correction of defects or imperfections shall also be corrected at the Contractor's expense.
- .10 The operation of the equipment and electrical systems does not constitute an acceptance of the work. The final review is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.
- .11 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction. Demonstrate that all work is complete and in ideal operating condition, with raceway and conduit system properly grounded, all wiring free from grounds, shorts, and that the entire installation is free from any physical defects. In the presence of the Departmental Representative and the Municipality, the Contractor shall demonstrate the proper operation of all miscellaneous systems.

1.19 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

1.20 RECORD DRAWINGS

- .1 The Contractor shall keep a detailed up to date record of the following items:
 - .1 Feeder conduit routing.
 - .2 Dimensions drawings indicating all conduits in the slab.
 - .3 Approximate junction box and branch conduit locations.
 - .4 Actual circuit numbers, the equipment, and devices are connected to.
- .2 Record drawings shall be maintained throughout the duration of the project. At the time of project completion, a complete set drawings reflecting pertinent information shall be completed and turned over to the Departmental Representative.

Part 2 Products

- .1 Not applicable.

Part 3 Execution

- .1 Not applicable.

END OF SECTION

Edmonton Maximum Security Institiution - Radial Breaker Replacement MCC Shutdown Strategy

Date: 8/10/2017
Description: Issued For Tender
Rev: 0

Item	Initial Operating Mode	Tag #	Event	Expected Action	Test Methods	Comments
MCC'S LOCATED THROUGHOUT BUILDING						
SHUTDOWN/NEW WORK						
1	ON		lockout tag out radial #1 breaker in generator building switchgear	one bus duct is de-energized		contractor to test busduct breakers beforehand to determine which radial to turn off first.
2	OFF		lock out and tag out MCC busduct breaker #1 connected to radial #1.	breaker #1 locked out	Multimeter	Contractor to first replace busduct breaker that do not pass initial tests
3	ON		lock out and tag out MCC busduct breaker #2 connected to radial #2.	MCC is denergized.	Multimeter	coordinate with Owner before denergizing any MCC.
4	OFF		disconnect and protect cable feeding busduct breaker #1	MCC will only be fed from busduct breaker #2		Exposed cables need to be protected
5	OFF		energize busduct breaker #2	MCC will have power from radial #2	Multimeter	
6	OFF		Replace de-energized busduct breaker #1			
7	ON		lock out and tag out MCC busduct breaker #2 connected to radial #2.	MCC is denergized.	Multimeter	coordinate with Owner before denergizing any MCC.
8	OFF		connect existing cable to new busduct breaker #1	MCC fed from two sources		MCC will now have the option to be fed from busduct breaker #1 or busduct breaker #2
9	OFF		energize busduct breaker #2	MCC will have power	Multimeter	
10	ON		Verify busduct key interlock breakers work as designed	only one breaker can be turned on at a time		
11	ON		Verify downstream loads have power	equipment is fully functional	Multimeter	
12	-		Follow similar procedure to replace busduct breaker #2.			

NOTES:
1.The following is a proposed shutdown plan to mitigate the need for a generator rental. It is the contractors responsibility to coordinate with the Owner and modify the proposed shutdown plan to suit the project as required.
2.generic breaker tags are being used for clarity

Part 1 General

1.1 GENERAL

- .1 Description:
 - .1 This specification covers the field inspection, testing, checking out and adjustments, if necessary, of all electrical equipment and materials in the completed facility.
 - .2 All Start-up and Commissioning to conform to the requirements of Division 01.
- .2 General:
 - .1 Workmanship, methods, inspections, and materials used in erection and installation of the subject equipment to conform with accepted engineering practices, IEEE Standards, the Canadian Electrical Code and the Specifications for electrical work.
 - .2 Perform all wire checks, including factory wiring, setting up all test equipment and any other preliminary work in preparation for the electrical acceptance tests. Inspect all equipment to make sure it has been installed in accordance with the Manufacturer's recommendations.
 - .3 Each acceptance test shall be witnessed by the authorized Departmental Representative unless otherwise advised.
 - .4 Schedule all testing with Departmental Representative's approval and no testing shall be performed without Departmental Representative's approval.
 - .5 The testing shall be performed by and under the immediate supervision of the Contractor:
 - .1 Notify the Departmental Representative in writing at least seventy-two (72) hours prior to test establishing the time the test is to be performed.
 - .6 Field test (as outlined in the following paragraphs) all wire, cable and electrical equipment to assure proper installation, settling, connections, and functioning in accordance with this project's contract drawings, Specifications, and manufacturer's recommendations and perform any additional tests deemed necessary by Departmental Representative to determine that equipment, materials and systems meet the requirements of the project.
 - .7 Final acceptance will not only depend on equipment dependability, as determined by the subject tests; but will depend on complete operational tests on all equipment to show that the equipment will perform the functions for which it was designed and meet the requirements of the project and specifications.
 - .8 Manufacturers shall be notified and shall be permitted to witness high voltage or other tests performed on their equipment, if they so request.
 - .9 No equipment is to be energized without the approval of a designated Departmental Representative.
 - .10 The following precautions shall be observed prior to energizing any equipment:
 - .1 Make certain that all construction dirt and debris, conducting material, wire trimmings, and unused or dropped hardware have been removed. All electrical equipment shall be vacuum cleaned to dust free

- condensation (equipment shall be dried out, if necessary). The enclosures, door(s), etc., shall then be visually inspected for protective integrity.
- .2 Inspect and check all bolted bus connection and bus bracing for proper assembly.
 - .3 Operate the equipment manually and visually inspect the same for proper clearances of all moving items also making certain that proper lubrication is in evidence.
 - .11 Furnish all required testing equipment and safety devices including, but not limited to the following items:
 - .1 500 V, 1000 V, 5000V DC meggers, 0-10+ giga ohm scale.
 - .2 Portable telephone sets and 2-way radios, if required.
 - .3 Battery powered ringing sets.
 - .4 150-1000 V AC voltmeters, 0-500 A AC ammeters 1.5% accuracy.
 - .5 Volt-OHM-Milli-ammeters, Simpson or as approved.
 - .6 Micro-ohm meter 10A output.
 - .7 Phase rotation meters, 60 hertz.
 - .8 D.C. voltmeter 0-1000 V DC. DC ammeter to 10 Amps.
 - .9 Rubber gloves, rubber mats, goggles, insulated tools, and any other equipment necessary to ensure safe working condition.
 - .10 Signals and danger signs.
 - .11 Miscellaneous cable, switches, receptacles, plugs, etc., as required.

1.2 SAFETY

- .1 The purpose of electrical equipment testing and checking is to determine whether the device will work properly as intended for the specific job to which it is applied. The field testing of apparatus shall, as much as possible, duplicate actual operating conditions, e.g. control circuits energized. In many instances, this requires that the apparatus be in actual use. For safety, however, the testing of live equipment at power voltage shall be avoided whenever possible.
- .2 If temporary circuits must be maintained, accidental contact with other circuits and live parts on adjacent apparatus must be prevented. If at all possible, power to adjacent apparatus shall be disconnected prior to testing.
- .3 Equipment under test shall be isolated from remote control or feedback circuits to prevent accidental energization by others. If power must be maintained as part of the test, personnel shall be protected against electrical shock by rubber floor mats, rubber gloves, goggles, approved non-conducting safety hats, and insulated tools.
- .4 Bus runs that have been disconnected for test purposes shall be grounded to prevent feedback of test voltages. If these conductors cannot be grounded, the test area shall be roped off or otherwise protected from the accidental approach of unauthorized and unnecessary personnel while test is in progress.
- .5 Capacitive circuits and any device capable of storing electrical energy received from test voltages are a significant hazard. They shall be grounded during the test, or if they are

necessary and included in the circuitry, they shall be grounded after each application of test voltages.

1.3 PHASING AND SYNCHRONIZING

- .1 All power cable and bus duct circuits shall be checked to verify that connections, in regard to phasing, are in accordance with the contract drawings.
- .2 All power cable circuits shall be checked to verify that all circuits that can be energized from two (2) or more sources are in phase.

1.4 WIRE AND CABLE

- .1 All cable connections must pass visual inspection for workmanship and conformance with standard practice.
- .2 All wire and cable shall be tested for continuity.
- .3 All cables for 600 V AC circuits shall be megger tested with a 1000 V DC megger for one (1) minute. The insulation resistance level shall not be less than one hundred (100) megaohms, with the exception of circuit directly connected to existing equipment shall not be less than five (5) megaohms.
 - .1 During insulation tests all switchboards, panelboards, fuse holders, switches, and overcurrent devices to be in place (except devices with sensitive electronic components recommended by manufacturer not to be megger tested).
 - .2 Motors and transformers shall not be connected during megger tests.
- .4 Each phase shall be tested between conductor and ground and between phases.
- .5 For 600 V cables, the cable megger test shall be held until three (3) equal readings, each one (1) minute apart, are obtained.
- .6 Lighting circuits and all 120 V power services shall be tested only during construction for continuity and identification and shall pass operational tests to see that the circuits perform all functions for which they are designed.
- .7 120 VAC to 4160 VAC and control cable shall be checked by megger tests similar to those described for 600 V wire and cable (1.4.5). Control wiring shall be checked for proper connection in accordance with interconnection diagrams or tables and for tightness of terminal contacts and continuity through each "run" of control circuiting.
- .8 Complete and accurate records of all cable tests and inspection shall be made

1.5 MOTORS

- .1 All motors large and small shall pass a minimum 100 megaohms reading at room temperature. Any machine not passing this test shall be dried and retested until it either passes or is found unsatisfactory.
- .2 Prior to testing, all rotating equipment shall be inspected for cleanliness, damage, moisture, proper lubrication, oil leaks and phase identification. Proper rotation shall be checked.
- .3 The test shall include the connected motor cables. Where magnetic contactors are used, contactor shall be blocked in closed position so that the section of conductor between

circuit breaker and magnetic contactor is included in test. Control circuit conductors shall be isolated.

- .4 Megger tests shall be applied between all phases tied together and ground. Megger tests shall be taken with motor winding temperatures at room temperature.
- .5 Megger test shall be held for one minute once the megger reading stabilises. Repeat tests to be performed at Departmental Representative's discretion.
- .6 Final acceptance of motors cannot be made until the equipment is energized during operational tests. Operational tests shall prove proper rotation and lubrication. The motor shall not have excessive vibration or unusual heating.
- .7 Motors above 100 hp to be fitted with insulated bearings (drive and non-drive ends).
- .8 Motors below 100 hp to be fitted with ground ring/brushes on the shaft.

1.6 BEARING CURRENT MEASUREMENT

- .1 Shaft Voltage – measure the discharges per minute using a SKF discharge wand.
 - .1 Measure the shaft discharges at start up, commissioning and after the 30 day run in.
 - .2 Provide a report to the Departmental Representative after the 30 day run in period.
 - .3 Immediately report greater than five discharges per minute to the Departmental Representative.

1.7 CONTROLS

- .1 Electrical controls, circuits and systems shall be tested by trial operation of control equipment after all wiring is completed to see that each interlock and control function operates in accordance with the contract drawings, specifications and the description of operation for the equipment. Where field conditions prevent actual equipment functioning during testing, the Contractor shall simulate the intended operating condition in the associated control circuits.
- .2 Locate the cause of any malfunction, within the contractor's scope of responsibility, and make the necessary wiring and/or equipment changes or corrections to obtain the particular systems intended operation as defined by the contract drawings. Costs of these necessary changes are included in the base bid. Such changes shall be included in the test report.
- .3 Control panels shall be operated through all design functions. This shall include remote operation of all equipment and actuation of alarms and indicating devices according to design requirements.
- .4 Complete operational tests shall be given to all relays and control devices to show that the equipment performs all design functions and meets design and procurement specifications.

1.8 TRANSFORMERS

- .1 Locate, install and ground transformers in accordance with manufacturer's instructions.

- .2 Check transformers for dryness before putting it into service if it has been stored on site for any length of time.
- .3 Energize transformers and check secondary no-load voltage.
- .4 Adjust primary taps as necessary to produce rated secondary voltage at no-load.
- .5 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.

1.9 GROUNDING

- .1 Loop Impedance – test to demonstrate compliance to CEC 22.1 – Appendix B, 10-500.
 - .1 Use a Fluke 1653B Installation Tester W/Autotest.
 - .2 Use 2403368 NEMA 5-15 Plug 3 ea 4mm Banana.
- .2 Perform ground continuity and resistance tests meeting the approval of Departmental Representative and local authority having jurisdiction over installation.
 - .1 Use a Fluke 1653B Installation Tester W/Autotest.
- .3 Earth Impedance use Geo-Earth-Stake A604510350 Ground/Earth Earth Stake.
- .4 Perform ground impedance tests before energizing electrical system.
- .5 Perform loop impedance tests with electrical system energized.
- .6 Disconnect ground fault indicator during tests.

1.10 METERING

- .1 Verify correct PT and CT ratio and that the connection conforms to manufacturer's recommendation.
- .2 Voltage, current, kW, pf, harmonics, etc., displayed on meter must be verified to Departmental Representative, to be representing actual system characteristics.

1.11 MISCELLANEOUS

- .1 All other breakers, switches, and contactors shall be given complete operational tests to determine that all design functions are satisfactorily performed.
- .2 All switches (control, instrument, disconnect, safety, etc.) shall be inspected and tested as to cleanliness and operation. Contacts so requiring, shall be cleaned before operation.
- .3 Switches shall be checked for correct sequence of operation.
- .4 Fuses shall be inspected for correct rating.
- .5 Coordinate all testing of instruments for those devices.

1.12 PANELBOARDS

- .1 Complete all field tests for panelboards as herein outlined.
- .2 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads. Maintain proper phasing for multi-wire branch circuits.

- .3 Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- .4 Megger check of phase-to-phase and phase-to-ground insulation levels prior to connection of any load circuits.

1.13 CIRCUIT BREAKERS – LOW VOLTAGE

- .1 Complete all field tests for low voltage circuit breakers as herein outlined.
- .2 Visual Inspection
 - .1 Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
 - .2 Operate circuit breaker to ensure smooth operation.
 - .3 Inspect case for cracks or other defects.
 - .4 Check tightness of connection with torque wrench in accordance with manufacturer's recommendations.
- .3 Electrical Test
 - .1 Measure contact resistance.
 - .2 Insulation resistance shall be determined phase to phase and phase to ground. Test voltage shall be 1000 VDC.
- .4 Test Results
 - .1 Contact resistance shall be compared to adjacent poles and similar breaker. Deviations of more than 50% shall be investigated and corrected.
 - .2 Insulation resistance shall not be less than 50 meg-ohms.

1.14 SURGE PROTECTION DEVICES

- .1 Visual and Mechanical Inspection
 - .1 Inspect lightning surge arresters for physical damage, such as chipped or fractured porcelain.
 - .2 Verify proper mounting and clearances.
 - .3 Check external bolted joints shall be checked for tightness by calibrated torque wrench method.
 - .4 Check ground leads on each device for attachment to a ground bus or ground electrode.
 - .5 Check exhaust ports on expulsion type arresters for any obstructions.
- .2 Electrical Tests
 - .1 A ground continuity test shall be performed to the ground grid system.
 - .2 Varistor surge arresters: Perform tests as recommended by the manufacturer.

1.15 RECEPTACLES

- .1 All field tests for receptacles as herein outlined shall be completed by the Electrical Contractor.

- .2 Verify that each receptacle device is energized.
- .3 Test each receptacle device for proper polarity.
- .4 Test each GFCI receptacle device for proper operation.

1.16 MEDIUM VOLTAGE CABLE

- .1 All field tests for medium voltage cable as herein outlined shall be completed by the Independent Testing Contractor.
- .2 Each conductor shall be individually hypot tested with other conductors grounded. Shields shall be grounded.
- .3 Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable methods.
- .4 DC hypotential shall be applied in at least eight equal increments until maximum test voltage is reached. DC leakage current shall be recorded at each step after a constant stabilization time consistent with system charging current decay.
- .5 Graphic plot shall be made of leakage current versus voltage at each increment.
- .6 Test conductor shall be raised to a maximum test voltage and held for a total of 10 min. Readings of leakage current (Y axis) versus time (X axis) shall be recorded and plotted on 30 sec intervals for the first 2 min and every minute thereafter.
- .7 Conductor test potential shall be reduced to zero and grounds applied for at least 10 min.
- .8 Maximum test voltage shall not exceed the maximum test voltage recommended by the cable manufacturer.
- .9 Conductors shall be tested both before and after installation in raceway system.
- .10 Perform a shield continuity test by Ohm meter method. Ohmic value shall be recorded.

1.17 DC HYPOTENTIAL TEST RESULTS

- .1 Step voltage slope shall be reasonably linear.
- .2 Absorption slope shall be flat or negative. In no case shall slope exhibit positive characteristics.
- .3 Shield continuity test shall exhibit circuit continuity of shield and conductor.

1.18 SWITCHGEAR, MCCS AND SWITCHBOARD ASSEMBLIES

- .1 Complete all field tests for metal enclosed switchgear as herein outlined.
- .2 Visual and Mechanical Inspection
 - .1 Inspect for physical damage.
 - .2 Verify equipment is supplied and connected in accordance with design specifications.
 - .3 Inspect for proper alignment, anchorage, and grounding.
 - .4 Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions for proper foot pound levels.
 - .5 Doors, panels, and sections shall be inspected for paint, scratches and fit.

- .6 Physically test all key interlocking systems.
- .3 Electrical Tests
 - .1 Insulation Resistance Test: Measure insulation resistance of each bus section phase to phase and phase to ground.
 - .2 All electronic equipment shall be disconnected prior to testing.
 - .3 Testing shall proceed final connection and energization of feeders (i.e., prior to placing in service).
- .4 Test Results
 - .1 Values of insulation resistance less than rated kv + 1-in megohms shall be investigated and corrected.

1.19 PAD MOUNTED DISTRIBUTION TRANSFORMERS

- .1 Complete all field tests for pad mounted distribution transformers as herein outlined.
- .2 Visual and Mechanical Inspection
 - .1 Inspect for physical damage, cracked insulators, tightness of connections, and general mechanical and electrical conditions.
 - .2 Compare equipment nameplate data with design drawings report any discrepancies.
 - .3 Verify proper auxiliary device operation such as fans, sudden pressure device, indicators and tap changer.
 - .4 Check tightness of accessible bolted electrical connections by calibrated torque wrench method. Refer to manufacturer's instructions for proper foot pound levels.
 - .5 Check liquid level in tank for proper level.
 - .6 Perform specific inspections and mechanical tests as recommended by the manufacturer.
- .3 Electrical Tests
 - .1 Perform inspections and tests listed in NEMA ATS, Section 7.2. Include the following optional tests:
 - .1 Winding resistance tests for each winding at nominal and final tap setting.
 - .2 Individual excitation current tests on each phase.
 - .3 Insulating liquid specific gravity, water content, and total combustible gas.
 - .4 Operational test and adjustments on fan and pump controls and alarm functions.
 - .5 Percent oxygen test on nitrogen gas blanket.

1.20 GROUND FAULT SYSTEMS

- .1 Complete all field tests for ground fault systems as herein outlined.
- .2 Visual and Mechanical Inspection
 - .1 Inspect for physical damage and compliance with drawings and specifications.

- .3 Inspect Neutral main bonding connection to ensure:
 - .1 Zero sequence system is grounded upstream of sensor.
 - .2 Ground strap systems are grounded through sensing device.
 - .3 Ground connection is made ahead of neutral disconnect link.
 - .4 Inspect control power transformer to ensure adequate capacity for system.
 - .5 Proper operation and test sequence shall be recorded.
 - .6 Zero sequence system shall be inspected for symmetrical alignment of core balance transformers about current carrying conductors.
 - .7 Ground fault device circuit nameplate identification shall be verified by actuation observation.
 - .8 Pickup and time delay settings shall be set in accordance with settings developed through verification with Departmental Representative.
- .4 Electrical Tests
 - .1 System neutral insulation resistance shall be measured to ensure no shunt ground paths exist, neutral ground disconnect link shall be removed, neutral insulation resistance measured, and link replaced.
- .5 Test Parameters
 - .1 System neutral insulation shall be minimum of 100 ohms preferably 1 meg-ohm or larger.

Part 2 Products

- .1 Not applicable.

Part 3 Execution

3.1 GENERAL FIELD TESTING REQUIREMENTS

- .1 Complete the following testing requirements:
 - .1 Test work and equipment installed to ensure its proper and safe operation in accordance with intent of drawings and specifications.
 - .2 Check interlocking and automatic control sequences and test operation of safety and protective devices.
 - .3 Correct defects.
 - .4 Cooperate with electrical utility, suppliers', and manufacturer's representatives in order to achieve proper and intended operation of equipment.
 - .5 Test, adjust, and record operating voltages at each system level before energizing branch circuits.
- .2 Transformer taps must be adjusted to obtain as near as possible nominal system voltage.
- .3 Where transformer is under utility jurisdiction, obtain services of utility to correct voltage.
- .4 Replace devices and equipment damaged due to failure to comply with this requirement.
- .5 Balance load among feeders conductors at each panelboard, switchboard, or substation, and reconnect loads as may be necessary to obtain a reasonable balance of load on each

phase. Electrical unbalance shall not exceed 7½% between phases. If the Contractor feels that because of the nature of the load, a 7½% or less unbalance cannot be achieved, the Contractor shall submit written request to the Departmental Representative for approval.

3.2 TEST REPORTS

- .1 During each of the aforementioned tests, maintain a comprehensive set (quantity of duplicates to be determined by Departmental Representative) of test reports defining the specific condition in which the apparatus is left, after it has been given approval for use in its intended service. The completed reports shall become the property of the Departmental Representative.
- .2 A checklist type report for each individual item of major electrical equipment should be headed with, but not limited to, the following identification data defining:
 - .1 Equipment Name.
 - .2 Item Tag Number.
 - .3 Manufacturer.
 - .4 Type of Class.
 - .5 Application.
 - .6 Plant Location.
 - .7 Voltage Rating.
 - .8 Date of Test.
 - .9 Ambient Conditions.
 - .10 Testers Signature.
- .3 Among the specific requirements of testing to determine the equipment's operational condition relative to that particular apparatus, all items shall be visually inspected and evaluated on the report as to its general condition both exterior and interior.
- .4 Unless otherwise directed by Departmental Representative, the forms used for testing shall be those that are available by the particular equipment's manufacturer and as per Division 1.

3.3 EQUIPMENT TO BE TESTED

- .1 Building wire and cable.
- .2 Wiring devices.
- .3 Grounding.
- .4 Motors.
- .5 Feeders.
- .6 Motor controllers and control centers.
- .7 Dry type transformers.
- .8 Circuit breakers
- .9 Panelboards.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.
- .2 Additional section references:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 21 - Waste Management and Disposal.
 - .3 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Only applicable when Section 01 74 21 – Construction/Demolition Waste Management and Disposal, is part of contract.
- .2 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type TWU or TWH, rated at 600 V.

2.2 CONTROL CABLES

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket, and armour of closely wound aluminum wire.
- .2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TW, TW -40°C or TWH polyethylene insulation with shielding of metallized tape with wire braid over all conductors and overall covering of PVC jackets.

- .3 600 V type: stranded conductors, sizes as indicated with PVC insulation type RW90 and overall covering of thermoplastic jacket with sheath of aluminum interlocked armour and jacket over sheath of PVC thermosetting compound.

2.3 FITTINGS

- .1 In wet, damp location indoors or outdoors StarTeck compression fittings or equivalent shall be used.
- .2 For hazardous locations, a Class I hazardous location sealing fitting shall be added.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34.

3.2 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837- IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA International
 - .1 CSA C22.2 Rule 10-500 including Appendix B.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as indicated and as required to electrically conductive underground water pipe.
- .2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.
- .3 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .4 Insulated grounding conductors: green, copper conductors, size as indicated.
- .5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.

- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .8 Connect building structural steel and metal siding to ground by welding copper to steel.
- .9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .10 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .11 Ground secondary service pedestals.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.4 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.
- .2 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 1/0AWG.

3.5 COMMUNICATION SYSTEMS

- .1 Install grounding connections for fire alarm as required by code.

3.6 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Perform loop impedance tests with electrical system energized.
- .5 Disconnect ground fault indicator during tests.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General**1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data to the Departmental Representative for approval.

1.2 DEFINITIONS

- .1 Junction Box: A box where conductors are spliced with or without terminal blocks, generally not scheduled on drawings or tagged in field. Junction Box can be used as a Pull Box for some cables.
- .2 Terminal Box: A box containing terminal blocks to connect conductors, generally scheduled on drawings and tagged in field as AJB, CJB, DJB and EJB for instrumentation and electrical circuits respectively.
- .3 Pull Box: A box used to ease the pulling of conductors. May be a through-pull or a T or X conduit connection, but no splicing of conductors is being done. Generally, not scheduled on drawings or tagged in field.
- .4 Panel: An enclosure containing electrical control components such as relays, controllers and the like or an enclosure with a large number of terminal blocks for the purpose of serving as a marshalling point for a number of branch circuits. Scheduled on drawings and tagged in field.
- .5 Splitter: An enclosure containing a splitter block or bus bars for the connection of a main circuit and several branch circuits.

Part 2 Products**2.1 ACCEPTABLE MANUFACTURERS**

- .1 Catalogue numbers specified are for the purpose of illustrating features and to establish the grade of quality of the products specified in this section and are taken from one manufacturer's product line. Unless otherwise noted, products from other listed manufacturers that have identical features and characteristics are acceptable.
- .2 Acceptable manufacturers:
 - .1 Appleton.
 - .2 BEL.
 - .3 Hammond.
 - .4 Hoffman.
 - .5 Pursley.
 - .6 Or approved equal.
- .3 All equipment shall be CSA certified.

2.2 SPLITTERS

- .1 Compliance: CSA C22.2 - No. 76.
- .2 Sheet metal enclosure, welded corners and formed hinged gasketed cover suitable for locking in closed position.
- .3 Main and branch lugs or connection bars to match required size and number of connecting conductors as indicated.
- .4 At least three (3) spare terminals on each set of lugs in splitters.

2.3 JUNCTION AND PULL BOXES

- .1 For outlet and conduit boxes refer to Division 26.
- .2 Metal enclosure, NEMA Type 4 for process areas and NEMA Type 12 for electrical rooms.
- .3 Exterior pull boxes to be non-metallic and suitable for vehicle traffic. Open bottom, four sided with raceway openings and lid. Depth to be approximately 1000mm or by specific vendor.

2.4 TERMINAL AND PULL BOXES

- .1 Intended for surface mounting, except as otherwise shown or specified.
- .2 Weatherproof Style
 - .1 Metal enclosure, NEMA Type 4.
 - .2 Hinged door if any one (1) dimension exceeds 300 mm.
 - .3 Manufactured breather, designed to maintain weatherproof classification of enclosure.
 - .4 When used as terminal box, equipped with mounting pan and terminal strip.
- .3 Weather- and Corrosion-Proof
 - .1 Same features as for weather proof style, non-metallic, NEMA Type 4X enclosure.
 - .2 Quick-release latches.
- .4 Indoor Dry Location
 - .1 Welded steel or aluminum NEMA Type 12 enclosure.
 - .2 Hinged cover with quick-release latch or automotive handle, for enclosures which exceed 300 mm in width or height.

2.5 PANELS

- .1 Intended for surface mounting, except as otherwise shown or specified.
- .2 Single or double door construction with stainless steel full-length hinge.
- .3 Minimum standard: Formed and welded NEMA Type 12 construction, of minimum 1.8 mm thick sheet steel, with automotive door handle.
- .4 For process and outdoor areas: Formed and welded NEMA Type 4 construction of minimum 2 mm thick sheet aluminum, with stainless steel door clamps.

- .5 Full size equipment mounting pan of formed sheet metal.

2.6 EQUIPMENT MOUNTING HARDWARE

- .1 Mounting straps, brackets and fastening hardware designed for the installation of terminal blocks.
- .2 Welded studs in sheet metal enclosures to avoid penetration of enclosure walls.
- .3 Raised cast bosses in cast metal enclosures, drilled and tapped, for hardware installation.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Division 26.

Part 3 Execution

3.1 SPLITTER INSTALLATION

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND PANELS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount panels with top not higher than 2 m above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items.
- .3 Install terminal blocks as indicated using mounting straps and hardware designed for this purpose.
- .4 Only main pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit runs between pull boxes as specified in Division 26.
- .5 Minimum standard in Process Areas and below grade locations is NEMA Type 4.
- .6 Install a breather in locations of high humidity and changing temperature conditions; the downgrading to weatherproof of the enclosure will be acceptable.
- .7 Where boxes terminate conduits at interior walls below grade elevation, provide a drain hole in the bottom of the box suitable for accumulated moisture drainage

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA 22.1, Canadian Electrical Code, Part 1.

1.2 GENERAL

- .1 Establish installation method based on area use; provide concealed installation in finished areas; embed or surface mount boxes on unfinished poured concrete walls as indicated.
- .2 Installation methods to be consistently followed in each area.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 Provide corrosion resistant boxes in corrosive areas.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. Use 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Use 102 mm square or octagonal outlet boxes for lighting fixture outlets.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single gang boxes for devices flush mounted in exposed block walls.

2.4 CONDUIT BOXES

- .1 Cast FS Feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.5 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet-metal boxes.

Part 3 Execution**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Identify systems for outlet boxes as required.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International):
 - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56 Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets:
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils:
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.

2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.
- .6 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.
- .7 For hazardous location use, unless specified otherwise rigid metal conduit will be used. Galvanized rigid steel threaded conduit or threaded aluminum conduit.
- .8 For corrosive areas, unless specified otherwise use:
 - .1 Epoxy coated rigid metal conduit
 - .2 Rigid PVC conduit.
 - .3 Fibreglass reinforced plastic (FRP) upon Departmental Representative approval.
- .9 Use electrical metallic tubing (EMT) above 2.4 m or where not subject to mechanical damage. Aluminum above grade in non-corrosive environments and steel above or below grade with protective coating for corrosion.
- .10 Use rigid metal conduit and tamper proof screws for supports in locations that are inmate accessible.
- .11 Motor / Vibrating equipment connections:
 - .1 Use flexible metal conduit for connection in dry areas.
 - .2 Use liquid tight flexible metal conduit for connection in damp, wet or corrosive locations.
 - .3 Use explosion proof flexible connection for connections in zone classified areas.
 - .4 Flexible runs shall not exceed the maximum distance allowed by CEC Part 1.

2.3 CONDUIT FASTENINGS

- .1 One-hole steel straps to secure surface conduits 50 mm and smaller:
 - .1 Two-hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for NPS 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable. Grounding must be maintained throughout the raceway.

2.5 FISH CORD

- .1 Polypropylene.
- .2 For spare conduit, prior to closing conduit with end cap, fish cord:
 - .1 To be taped to inside of end cap.
 - .2 Or, taped near end of conduit such that it is accessible in the future.

2.6 MANUFACTURERS

- .1 Schedule 40 PVC type
 - .1 IPEX, Scepter Series.
 - .2 Allied Tube and Conduit, Schedule 40 PVC.
 - .3 Carlon Plus 40® Series.
 - .4 Cantex, Forte-Duct® Conduit - UL Schedule 40.
- .2 Galvanized Rigid Metal Conduit
 - .1 Allied Electrical Group.
 - .2 Or approved equivalent.
- .3 Schedule 80 PVC type:
 - .1 IPEX, Super Duct Series.
 - .2 Carlon Plus 80® Series.
 - .3 Allied Tube and Conduit, Schedule 80 PVC.
 - .4 Cantex, Schedule 80.
- .4 EMT
 - .1 Allied Electrical Group.
 - .2 Republic Conduit.
 - .3 Tomas & Betts.
 - .4 Or approved equivalent.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Install conduit sealing fittings in hazardous areas. Fill with compound.

- .4 Minimum conduit size for lighting and power circuits: 19 mm.
- .5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 19 mm dia.
- .7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .8 Provide grounding clamps on the unions where the length of non-threaded conduit exceeds the allowed distance in the CEC Part 1.
- .9 Install fish cord in empty conduits.
- .10 Run 2-NPS 25 mm spare conduits up to ceiling space and 2-NPS 25 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete surface type box.
- .11 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .12 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .4 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the supply and installation of Dry Type Power Transformers.
- .2 Not to be applied to instrumentation / control transformers.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA Standard C22.2, No. 47, Air Cooled Transformers (Dry Type).
 - .2 CSA C9, Dry-Type Transformers.
 - .3 CSA C802.2 Minimum Efficiency Values for Dry-Type Transformers.
- .2 Additional section references: Division 26.

1.3 SUBMITTALS FOR REVIEW

- .1 Submit the following to the Departmental Representative for approval.
- .2 Shop drawings and product data which includes the following information:
 - .1 Dimensioned drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.
 - .2 Weight, dry / wet as applicable.
 - .3 Technical data:
 - .1 Type to be indicated as: dry, wet, laminated core, toroidal, autotransformer, polyphase, resonant, constant voltage, ferrite core, planar, isolation, etc.
 - .2 kVA rating.
 - .3 Primary and secondary voltages.
 - .4 Frequency.
 - .5 Single or three phase.
 - .6 Full load efficiency.
 - .7 Regulation at unity pf.
 - .8 BIL¹
 - .9 Insulation class/type.
 - .10 Sound rating.
 - .11 Impedance.
 - .12 X/R Ratio.

¹ Basic-Impulse Insulation Level

1.4 SUBMITTALS FOR INFORMATION ONLY

- .1 Submit the following to the Departmental Representative for approval:
 - .1 Operation and maintenance information for incorporation into manual.
 - .1 Mounting details of transformer.
 - .2 Operation and maintenance instructions to include:
 - .1 Tap changing.
 - .2 Recommended environmental conditions.
 - .3 Recommended periodic inspection and maintenance.
 - .4 Bushing replacement.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 Unless otherwise approved by the Departmental Representative, transformers to be of one manufacture throughout.
- .2 Acceptable Manufacturers (in alphabetical order):
 - .1 Eaton
 - .2 Federal Pioneer.
 - .3 Hammond.
 - .4 Synergy Energy.
 - .5 Rex Manufacturers.
 - .6 Engineering approved alternates.

2.2 DESIGN

- .1 Dry-type, ANN², ventilated NEMA 12 enclosure for transformers located indoors.
- .2 Minimum efficiency to be:
 - .1 97.6% for general purpose transformers.
- .3 Primary voltage: As indicated.
- .4 Secondary voltage: As indicated.
- .5 Lighting Transformers: As indicated.
- .6 Frequency: 60 Hz.
- .7 Windings: Copper only.
- .8 Primary taps above normal: 2-2½% full capacity.
- .9 Primary taps below normal: 2-2½% full capacity.
- .10 kVA size: As indicated.

² Air cooled, natural circulation.

- .11 Impedance:
 - .1 3-4% max. up to 112.5 kVA.
- .12 Sound level:
 - .1 45 dB max. up to 45 kVA.
 - .2 Impulse level: 10 kV B.I.L.
- .13 Mounting fixture / frame to be complete with anti-vibration pads.

2.3 INSULATION

- .1 Class H (220°C) insulation with maximum 130°C rise with continuous full load.

2.4 ENCLOSURE

- .1 Fabricated from sheet steel.
- .2 Bolted removable panels for access to tap connections, enclosed terminals, fan brackets, fans, and other accessories.
- .3 Conductor entry:
 - .1 Knockouts.
 - .2 Potheads.
 - .3 Junction boxes.
 - .4 Bushings.
 - .5 Clamping rings.
 - .6 Entry for cable.
- .4 Designed for MCC, floor, or wall mounting as indicated.
- .5 Indoor, ventilated, self-cooled type. Temperature of exposed metal parts not to exceed 65°C rise.
- .6 Pad mounted type:
 - .1 Conductor entry through bottom for underground distribution, with separate high and low voltage compartments divided by full length metal barrier.
 - .2 Each compartment to have access door with concealed hinges.
 - .3 Secondary door to have 3-point latch, external operating handle, provision for padlocking and arranged so that secondary door must be open before access gained to primary compartment.
- .7 Open type: no enclosure, for installation in switchgear enclosure.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Division 26.

Part 3 Execution

3.1 INSTALLATION

- .1 Unless indicated otherwise in drawings mount transformers within buildings as:
 - .1 75kVA or less on wall.
- .2 Ensure adequate clearance around transformers for ventilation.
 - .1 Orient vents away from wall, perpendicular to wall, to ensure good air cross flow.
- .3 Install transformers in level upright position.
- .4 Remove shipping supports only after transformer is installed.
- .5 Loosen isolation pad bolts until no compression is visible.
- .6 Make primary and secondary connections in accordance with wiring diagram.
- .7 Energize transformers after installation is complete.

3.2 FIELD TESTING AND INSPECTION

- .1 Conduct tests in accordance with Division 26 and in accordance with manufacturer's recommendation

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.
- .2 Operations and Maintenance Manuals: Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboard Manufactures:
 - .1 Eaton Pow-R-Line Series.
 - .2 Schneider Electric NF, NQ, NQOD.
 - .3 Siemens equivalents.
- .2 The 208/120 V lighting panel boards bus and breakers rated:
 - .1 For minimum 10,000 A (symmetrical) interrupting capacity.
 - .2 To match panel interrupting capacity or as shown on drawings.
- .3 The 347/600 V and 600 V panel boards bus and breakers rated:
 - .1 For minimum 22,000 A (symmetrical) interrupting capacity.
 - .2 To match panel interrupting capacity or as shown on drawings.
- .4 Panel boards: mains, number of circuits, and number and size of branch circuit breakers as indicated on schedules.

2.2 CONSTRUCTION

- .1 Interior
 - .1 Continuous main current ratings, as indicated on associated schedules and drawings, not to exceed 600 amperes maximum.
 - .2 Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Bussing shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar.
 - .3 All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

- .4 A solidly bonded copper equipment ground bar shall be provided.
 - .5 Split solid neutral shall be plated and located in the mains compartment up to 225 amperes so all incoming neutral cable may be of the same length. CSA Listed panelboards with 200% rated solid neutral shall be plated copper for non-linear load applications (200% Neutral only required when specified). Panelboards shall be marked for non-linear load applications.
 - .6 Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting spaces.
 - .7 Nameplates shall contain system information and catalogue number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
 - .8 Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 100A interiors shall be horizontally mounted. Main circuit breakers over 100A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior levelling provisions shall be provided for flush mounted applications.
 - .9 Interior phase bus shall be pre-drilled to accommodate field installable options (NQ only), i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs.
- .2 Main Circuit Breaker
- .1 Main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40°C ambient environment. Thermal elements shall be ambient compensating above 40°C.
 - .2 Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
 - .3 Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be rated for reverse connection without restrictive line or load markings.
 - .4 Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
 - .5 Lugs shall be CSA Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75°C temperature rating. Lug body shall be bolted in place; snap-in designs are not acceptable.
 - .6 The circuit breakers shall be CSA Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

.3 Branch Circuit Breakers

- .1 Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the associated schedules and drawings.
- .2 Moulded case branch circuit breakers shall have bolt-on type bus connectors.
- .3 Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
- .4 There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.
- .5 The exposed faceplates of all branch circuit breakers shall be flush with one another.
- .6 Lugs shall accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire. Branch circuit breakers rated 20 amperes and below shall be CSA Listed to accept 60°C rated wire.
- .7 Breakers shall be CSA Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.
- .8 Breakers feeding fire alarm panels shall be permanently painted red.

.4 Enclosures

- .1 Type 1 Boxes for dry areas, Type 4 in wet areas.
- .2 Boxes shall be galvanized steel constructed. Galvannealed steel will not be acceptable.
- .3 Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
- .4 Box width shall be 26" wide maximum.
- .5 Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel where panel is loose equipment. Front shall be sand color when connected to MCC or switchgear. Front shall be orange for UPS panels.
- .6 Fronts shall be 1-piece with door. Mounting shall be as indicated on associated schedules or drawings.
- .7 Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.
- .8 Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Division 26.
- .2 Complete circuit directory with typewritten legend showing equipment tag for each circuit. Handwritten directory is not acceptable.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panel boards as indicated and mount securely, plumb, and true and square, to adjoining surfaces.
- .2 Install surface mounted panel boards on plywood backboards. Where practical, group panel boards on common backboard. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards
- .3 Mount panel boards to height specified in Division 26.
- .4 Connect loads to circuits and balance loads.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .7 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- .8 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials for moulded-case circuit breakers.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.
- .3 Include arc flash characteristics and indicate on all panels and disconnect switches as to arch hazard and category levels.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 22 kA symmetrical RMS interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 MAGNETIC BREAKERS DESIGN B

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 BUSDUCT BREAKERS

- .1 Existing bus duct is Square D, I-Line, 800A, 600V, 3 Phase, 4 W, 100% neutral aluminum feeder type.
- .2 New key interlock busduct breakers must be compatible with existing busduct. New busduct breakers replacing new must

2.5 OPTIONAL FEATURES

- .1 Include:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 Motor-operated mechanism c/w time delay unit.
 - .4 Under-voltage release.
 - .5 On-off locking device.
 - .6 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General**1.1 REFERENCES**

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 21 – Waste Management and Disposal.
- .3 Section 26 05 00 – Common Work Results for Electrical.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products**2.1 DISCONNECT SWITCHES**

- .1 Non-fusible, disconnect switch in CSA Enclosure, size as indicated on drawings.
- .2 Provision for padlocking in on-off off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution**3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Division 1.

1.2 REFERENCES

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for equipment for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 CONTACTORS

- .1 Electrically held controlled by pilot devices as indicated and rated for type of load controlled.
- .2 Breaker combination contactor as indicated.
- .3 Complete with 2 normally OPEN and 2 normally CLOSED auxiliary contacts unless indicated otherwise.
- .4 Control transformer in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Size 4 nameplate indicating name of load controlled if installed outside an MCC.

Part 3 Execution

3.1 INSTALLATION

- .1 Install contactors and connect auxiliary control devices.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This section specifies starting equipment for single and three phase motors up to 600 V.
- .2 Where indicated on the drawings, supply and install starters and all necessary apparatus. Starters to be mounted in MCCs or in separate enclosures as shown. Wiring and accessories to be as per schematic diagrams.
- .3 Where starters have been provided by others, supply and install disconnects and wire to the terminals of the equipment.

1.2 REFERENCES

- .1 Conform to the following reference standards in accordance with Division 1.
 - .1 NEMA
- .2 Additional References:
 - .1 Section 26 05 00 - Common Work Results for Electrical.
 - .2 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Division 01.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type and size of starter.
 - .6 Interconnection diagrams.

1.4 OPERATION & MAINTENANCE DATA

- .1 Provide data for incorporation into maintenance manual specified in Section 26 05 00.
- .2 Include operation and maintenance data for each type and size of starter.

Part 2 Products

2.1 MATERIALS

- .1 Starters: NEMA E14-1:
 - .1 Half size starters not acceptable.
 - .2 Interrupting Capacity: to match MCC rating or panel feeding starter.
 - .3 Provide NEMA Type 12 enclosures in electrical rooms and control rooms.

- .4 All enclosures for mounting outside of electrical rooms and control rooms to be NEMA Type 4. In a corrosive environment, use non-metallic or stainless steel NEMA Type 4X enclosures.

2.2 MANUAL MOTOR STARTERS

- .1 Single and three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make, and break.
 - .2 One (1) or three (3) overload heater(s), manual reset, trip indicating handle.
 - .3 Single-phase motors equipped with inherent temperature protection only require suitable H.P. rated disconnects.
- .2 Accessories:
 - .1 Key switch, pushbutton: Heavy duty, oil tight. Labeled as per Section 26 05 00.
 - .2 Indicating light: Heavy duty, oil tight, Labeled as per Section 26 05 00.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

- .1 Full voltage magnetic starters of size, type, rating, and enclosure type as indicated with components as follows:
 - .1 Contactor three-pole, solenoid operated, and rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Adjustable solid-state overload devices ambient compensated type.
 - .4 Power and control interface terminals strips.
 - .5 Wiring and schematic diagram inside starter enclosure in visible location.
 - .6 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Accessories:
 - .1 Pushbuttons, selector switches: Heavy duty, oil tight, labeled as per Section 26 05 00.
 - .2 Indicating lights: Heavy duty, oil tight, labeled as per Section 26 05 00.
 - .3 Auxiliary contacts.
 - .4 Control Power Transformers.

2.4 COMBINATION TYPE STARTERS

- .1 Combination type starters to include motor circuit protector with operating lever on outside of enclosure to control motor circuit protector, and provision for:
 - .1 Locking in "OFF" position with up to three (3) padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open and provision for preventing opening door when switched in "ON" position. Provide a defeat mechanism for starters in MCC.

- .4 Starters shall be minimum size NEMA 1. Control devices, terminals blocks, auxiliary contacts, etc., to be included as required to comply with control schematics.

2.5 CONTROL TRANSFORMERS

- .1 Each control transformer to be rated 600-120 V, single phase, 2-wire, 60 Hz. Size the transformer for the load it feeds but not less than the minimum ratings as follows:
- .2 Provide each control transformer with time-delay, slow-blow secondary fuse rated to interrupt 10kA short circuit at 250 V AC. Provide two (2) primary fuses rated to interrupt 50kA at 600 V on all starters.
- .3 Fuse holder for secondary fuse shall be properly rated for control voltage. Fuse holders for primary fuses shall be dead front fuse clips with full barriers between fuses.

Starter Size	Minimum Transformer Volt-Ampere Rating
1	100
2	150
3	200
4	300

2.6 AUXILIARY CONTACTS

- .1 Contactors to be equipped with auxiliary contacts, rated 10 A at 120 V AC. Unless otherwise specified on the drawings, each contactor to be equipped with one (1) spare normally open and one normally closed, field convertible, electrically isolated auxiliary contacts. Wire auxiliary contacts out to terminal blocks. Refer to drawings for actual quantities required.

2.7 TERMINAL BLOCKS

- .1 Provide quick disconnect on terminal blocks to allow terminal block to be pulled without wiring disconnection.
- .2 Provide terminal blocks of screw type rated 600 V; 20 A for control wiring and 30 A for power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). Supply the number of terminal blocks shown on the drawings.
- .3 On starters Size 4 and larger, provide terminals for connection of the conductors for power factor correction capacitors between the contactor and overload relay as indicated on the drawings.
- .4 Provide terminal blocks with integral marking strips permanently marked with the conductor number as specified on the drawings.
- .5 Internal wiring to be connected on one (1) side of the terminal block; outgoing conductors to be connected to the other side.

2.8 AC CONTROL RELAYS

- .1 Control relays for control and instrument panels shall be plug-in types with clear polycarbonate covers, 120 V AC, 60 Hz, unless otherwise indicated on the drawings.

- .2 Plug-in relays shall have a minimum contact rating of 10 A, mechanical life expectancy 10 million operations, operating temperatures -45°C to +50°C, dielectric strength 1500 VAC for one (1) minute.
- .3 The exact type of relay shall be determined from the number of contacts used as shown on each control diagram as indicated on the drawings. The minimum number of contacts to be DPDT. If more than three (3) contacts are shown, parallel relays shall be used.
- .4 All relays to provide indication of whether the relay is energized or not.
- .5 Acceptable products:
 - .1 Potter & Brumfield.
 - .2 Omron.
 - .3 Departmental Representative approved alternate.

2.9 ELAPSED TIME METERS

- .1 Elapsed time meters shall be calibrated in hours, suitable for door mounting, non-resettable, 120 VAC.
- .2 Acceptable Manufacturers:
 - .1 Veeder-Root 7795 Series.
 - .2 Departmental Representative approved alternate.

2.10 OPERATOR CONTROL STATIONS

- .1 Enclosure: NEMA Type 4 door mounted.

2.11 PUSHBUTTONS

- .1 Operator flush type, as indicated. Black with 1-NO and 1-NC contacts rated at 10 A, AC, labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position.
- .2 Acceptable Manufacturers:
 - .1 Allen-Bradley, Bulletin 800T series.
 - .2 Departmental Representative approved alternate.

2.12 PUSHBUTTONS E-Stop

- .1 Red coloured, two position latching (non-momentary), with twist to release to reset. Tamper resistant, front-of-panel mounting and non-removable operator head.
- .2 Compliant with global E-stop standards.
- .3 Acceptable Manufacturers:
 - .1 Allen-Bradley, Bulletin 800T series.
 - .2 Departmental Representative approved alternate.

2.13 SELECTOR SWITCHES

- .1 Maintained two (2) position labeled as indicated, operators standard knob, contact arrangement as indicated, rated 120 V AC, 10 A.

- .2 Acceptable Manufacturers:
 - .1 Allen-Bradley, Bulletin 800T series.
 - .2 Departmental Representative approved alternate.

2.14 INDICATING LIGHTS

- .1 LED type, push-to-test, and lens colour as indicated, supply voltage: 120 V AC, labels as indicated.
- .2 Acceptable Manufacturers:
 - .1 Allen-Bradley, Bulletin 800L series.
 - .2 Departmental Representative approved alternate.

2.15 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00.

2.16 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.

2.17 SPARE PARTS AND MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Division 1.
- .2 Provide listed spare parts:
 - .1 One (1) control transformer.
 - .2 Ten (10) of each size of fuse.
 - .3 Five (5) indicating lamp bulbs.
- .3 Provide a list of recommended spare parts, not specifically listed above, for each size and type of starter.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters, connect power, and control as indicated.
- .2 Ensure motor circuit protectors, breakers, and correct fuses and overload device elements are provided for equipment through confirmation of motor nameplate data.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment and control devices operate as indicated.

END OF SECTION