Part 1 General

1.1 GENERAL

.1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.

1.2 CODES AND STANDARDS

.1 Complete installation in accordance with CSA C22.1-2012 except where specified otherwise.

.2 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.

1.3 DRAWINGS AND SPECIFICATIONS

.1 The intent of the Drawings and Specifications is to include all labour, products, and services necessary for complete Work, tested and ready for operation.

.2 These Specifications and the Drawings and Specifications of all other divisions shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.

.3 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.

.4 If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting Bid, in accordance with B4.

1.4 CARE, OPERATION AND START-UP

.1 Instruct City maintenance and operating personnel in the operation, care and maintenance of systems, system equipment and components.

.2 Where services of a manufacturer's factory service engineer is required, arrange and pay for services 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.

1.5 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.

.3 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.

.4 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

1.6 MATERIALS AND EQUIPMENT

.1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.

.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 Factory assemble control panels and component assemblies.

.4 Minimum enclosure type to be NEMA 12 unless otherwise specified.

1.7 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 indoor switchgear and distribution enclosures light grey to ANSI 61 grey enamel, unless otherwise specified.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.8 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamicoid 3 mm thick plastic lamicoid nameplates, 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	5 mm high letters
Size 8	35 x 100 mm	3 lines	5 mm high letters

.3 Wording on nameplates to be approved by Contract Administrator prior to manufacture.

.4 Allow for average of twenty-five (25) letters per nameplate.

.5 Identification to be English.

1.9 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, 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.

1.10 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.

.3 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colours.

System	Prime Band	Aux. Band
Medium Voltage (>750 V)	Orange	
347/600 V	Yellow	
120/208/240 V Power	Black	
UPS 120/208/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring (<50 V)	Blue	Orange
Intrinsically Safe	Blue	White

.4 Cable Identification: Supply and install lamacoid type cable identification tags for all cables. Install identification tag at both ends.

1.11 MANUFACTURERS AND CSA LABELS

.1 Visible and legible after equipment is installed.

1.12 WARNING SIGNS

.1 As specified and to meet requirements of Electrical Inspection Department and the Contract Administrator.

.2 Lamicoid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping screws, 20mm text.

1.13 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 Unless otherwise noted, mount equipment replacing existing equipment at the same height.

.3 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.4 Install electrical equipment at following heights unless indicated otherwise.

.1 Panelboards: as required by Code or as indicated.

1.14 CONDUIT AND CABLE INSTALLATION

.1 Sleeves through concrete: schedule 40 galvanized steel pipe, sized for free passage of conduit.

.2 For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 25 mm above finished floor level.

.3 Fire stop opening with ULC approved assembly for the installation conditions.

.4 Provide a detailed proposed conduit routing plan to the Contract Administrator prior to proceeding with the installation of conduit.

.5 If possible, avoid routing conduits through hazardous area.

.6 Separate cables of different voltage levels when cables are installed parallel to each other.

1.15 CUTTING AND PATCHING

.1 Provide all cutting and patching as required.

.2 Return exposed surfaces to an as-found condition.

.3 Exercise care where cutting holes in existing concrete elements so as not to damage existing reinforcing.

.1 Locate existing reinforcing utilizing a reinforcing bar locator and mark out on the surface of the concrete.

.2 For all holes larger than 50mm passing through reinforced concrete, mark the location of the desired hole and all adjacent rebar. Obtain approval from the Contract Administrator prior to cutting.

.3 Firestop and seal all penetrations, regardless of whether the penetration requires a fire rating.

1.16 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 of Manitoba.

.3 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

1.17 ANCHOR INSTALLATION

.1 The Contractor shall exercise care where installing anchors into existing concrete elements so as not to damage existing reinforcing. All anchors shall be installed utilizing carbide tip drill bits. The existing reinforcing shall be located utilizing a reinforcing bar locator and marked out on the surface of the concrete. The drill holes shall be advanced to the required depth for installation of the anchors. Should reinforcement be encountered while drilling the hole shall be terminated and repositioned to clear the reinforcement. Do not use core bits that can easily intercept and damage/cut the reinforcing during drilling.

1.18 TESTING

.1 All test instruments utilized are to have been calibrated within one year of the date utilized.

.2 Carry out tests in presence of the Contract Administrator or delegated representative.

.3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.4 Submit test results for Contract Administrator's review.

1.19 SUBMITTALS

.1 Within 15 days of award of Contract, the Contractor shall submit a completed equipment procurement schedule, which lists the Manufacturer and model of equipment, indicating the projected ordering, Shop Drawing submittal date and delivery dates of all Products to meet the required construction schedule.

.2 Prior to delivery of any Products to job Site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings for review as specified in Division 01.

.3 Submit Shop Drawings (including Product Data) for all equipment as required in each Section of this Specification.

.4 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.

.5 The term “Shop Drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work. Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross-references to Design Drawings and Specifications. Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

.6 Manufacture of Products shall conform to revised Shop Drawings.

.7 Keep one (1) complete set of Shop Drawings at job Site during construction.

.8 Prior to shipping pre-fabricated panels, photos of completed panels shall be sent to the Contract Administrator of final review. The resolution of the photos should be such that individual wire tags can be read.

1.20 AS-BUILT DRAWINGS

.1 The Contractor shall keep one (1) complete set of white prints at the Site during work, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of As-Built Drawings. As the Work on-site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions, which deviate from the original Contract Documents. As-Built Drawings to include circuiting of all devices, conduit and

feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.2 On completion of the Work, two (2) weeks prior to final inspection, submit As-Built Drawings to Contract Administrator for review. The Contractor shall certify, in writing, that the As-Built Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 38, Thermoset-Insulated Wires and Cables.

.3 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.

.4 CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

1.2 SUBMITTALS

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

Part 2 Products

2.1 BUILDING WIRES

.1 Wire: to CAN/CSA-C22.2 No. 38

.2 Conductors:

.1 Size as indicated. Minimum size: 12 AWG.

.2 Stranded for 10 AWG and larger.

.3 Copper conductors.

.3 Insulation: chemically cross-linked thermosetting polyethylene rated type RW90.

.1 Insulation Voltage Rating:

.1	Circuits 480 V and less:	600 V
.2	Circuits > 480 V:	1000 V

.4 Colour coding to Section 26 05 01, wires sized 2 AWG and smaller to be factory-coded, taping will not be accepted.

2.2 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation: chemically cross-linked thermosetting polyethylene rated type RW90.

.1 Insulation Voltage Rating:

.1	Circuits 480 V and less:	600 V
.2	Circuits > 480 V:	1000 V

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: polyvinyl chloride material.

.7 Fastenings:

.1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.

.2 Channel type supports for two (2) or more cables at 1000 mm centers.

.3 Threaded rods: 6 mm dia. to support suspended channels.

.8 Cable Fittings:

.1 Minimum requirement: Watertight, approved for TECK cable.

.2 Hazardous Locations:

.1 CSA approved.

.2 Watertight type with:

.1 an elastomeric bevelled bushing.

.2 a funnel entry, splined gland nut.

.3 a non-magnetic, stainless steel grounding device with dual grounding action.

.4 a taper threaded hub.

.5 a hexagonal body and gland nut

.3 Integral seal type with metal-to-metal contact construction.

.4 Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.

.5 The fitting must:

.1 Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.

.2 Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosionproof seal.

.6 All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.

.7 Approved products:

.1 T&B Startech XP series.

2.3 VFD CABLE

.1 Cable to:

.1 CAN/CSA-C22.2 No. 38.

.2 CAN/CSA-C22.2 No. 174.

.3 CAN/CSA-C22.2 No. 230.

.2 Conductors:

.1 Grounding conductors: Three copper, symmetrically located in continuous contact with the copper tape shield or continuous aluminum armour.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation: chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.

.4 Shield: Continuous copper tape shield with 50% overlap or continuous (non-interlocked) aluminum armour.

.5 Armour: aluminum, interlocking or continuous.

.6 Overall covering: polyvinyl chloride material.

.7 Approved for six-pulse VFD use.

.8 Fastenings:

.1 One hole malleable iron / steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables.

.3 Threaded rods: 6 mm dia. to support suspended channels.

.9 Connectors:

.1 Watertight, approved for the cable.

2.4 ACIC/CIC CONTROL CABLE

.1 Cable: to CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

.2 Conductors: copper, size as indicated.

.3 Insulation: chemically cross-linked thermosetting polyethylene rated type RW90.

.4 Voltage: as shown on the drawings and cable schedule

.5 Shielding as indicated on the drawings.

.6 A higher level of shielded cable may be substituted for unshielded, or overall shielded cable, unless otherwise specified, provided that all appropriate shield grounding, as required by the Contract Administrator, is performed. All subsequent related changes, such as required conduit size, fittings, etc are the responsibility of the Contractor.

2.5 ETHERNET CABLE

.1 Requirements for wiring between panels in cable tray:

.1 Industrial Grade Cat 5e Ethernet cable.

.2 Shielding: none.

.3 Conductors: 24 AWG, copper, solid.

.4 Armoured.

.5 Use Belden 121700A or approved equal in accordance with B6.

.2 Requirements for inner panel patch cables:

.1 Commercial Grade Cat 5e Ethernet cable.

.2 Shielding: none.

.3 Conductors: 24 AWG, copper, solid.

.4 Use Belden DataTwist 1200 Series or approved equal in accordance with B6.

Part 3 Execution

3.1 GENERAL

.1 Do not splice cables. A continuous length is required for all feeds.

.2 Install in accordance with manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.

.3 Exercise care in stripping insulation from wire. Do not nick conductors.

3.2 INSTALLATION OF BUILDING WIRES

.1 Install in conduit as per Section 26 05 34.

.2 Ensure conduit is dry and clean prior to pulling wire. If moisture is present, thoroughly dry conduits. Vacuum as required.

.3 Utilize wire-pulling lubricant.

3.3 INSTALLATION OF TECK CABLE 0 -1000 V

.1 Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

.2 Perform an insulation-resistance test on each conductor, prior to termination, utilizing a megohmmeter with a voltage output of 1000 volts DC. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 50 megaohms, or deviations between parallel conductors. Conductors with insulation resistance values, at one minute, less than 25 megaohms, or that deviate from other similar conductors by more than 50% will be rejected.

3.4 INSTALLATION OF VFD CABLE

.1 Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

.2 Perform an insulation-resistance test on each conductor, prior to termination, utilizing a megohmmeter with a voltage output of 1000 volts DC. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 50 megaohms, or deviations between parallel conductors. Conductors with insulation resistance values, at one minute, less than 25 megaohms, or that deviate from other similar conductors by more than 50% will be rejected.

.3 Space VFD cable as per the following minimum distances:

.1	From 120/208V wiring:	300 mm
.2	From 24 VDC instrumentation and control wiring:	300 mm

3.5 INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit or cable tray as indicated.

.2 Ground shields at one end only. Where possible, ground shields at the end where power is supplied to the cable. Utilize shield grounding bar in panels, where present, to ground overall shields. Individual pair shields to be grounded on appropriate terminals.

.3 Shield drain wires, at the ungrounded end, are to be taped back to the cable. Do not cut the shield drain wire off.

.4 CIC cable may not be installed in cable tray. Protection in conduit is required over the entire length.

.5 ACIC cable may be installed in cable tray, provided that:

.1 There is a barrier separating power and control cables within the tray, or

.2 The cable tray does not contain power cables, unless specifically authorized by the Contract Administrator in writing, and

.3 The ACIC cable voltage rating is equal or greater than the highest voltage contained in the cable tray.

3.6 INSTALLATION OF ETHERNET CABLES

.1 Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

.2 Ethernet cables may be installed in cable tray, provided that:

.1 There is a barrier separating power and control cables within the tray, or

.2 The cable tray does not contain power cables, unless specifically authorized by the Contract Administrator in writing, and

.3 The ACIC cable voltage rating is equal or greater than the highest voltage contained in the cable tray.

3.7 TERMINATIONS AND SPLICES

.1 Wire nuts are permitted only in the following circuits:

.1 Lighting circuits.

.2 Receptacle circuits.

.2 Exercise care in stripping insulation from wire. Do not nick conductors.

.3 Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

.4 Where screw-type terminals are provided on equipment and instrumentation, terminate field wiring with insulated fork tongue terminals.

.1 Manufacturer: Thomas and Betts, Sta-Kon, or approved equal in accordance with B6.

3.8 RE-USE OF EXISTING WIRING

.1 Except where specifically identified or approved, reuse of existing wiring is not permitted.

.2 Ensure all existing wiring is tagged prior to disconnection of equipment.

.3 Tag spare wires as “Spare” and indicate the location of the other end of the wire.

3.9 INSTALLATION IN CONDUIT

.1 Utilize cable grips, appropriately selected to accommodate the type and geometry of the cable.

.2 Utilize cable pulling lubricant, compatible with the cable and conduit.

3.10 CABLE INDENTIFICATION

.1 Install cable tags.

3.11 TESTING

.1 Perform an insulation resistance test on all new and existing power conductors that are being terminated as part of the work.

END OF SECTION

Part 1 General

Part 2 Products

2.1 FRAMING AND SUPPORT SYSTEM

.1 Materials:

.1 Conduit support structures shall employ an aluminum strut framing system together with the manufacturer's connecting components and fasteners for a complete system.

.2 Finishes:

.1 Wet locations: Aluminum.

.2 Indoors, dry locations: Aluminum.

.3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut

.1 As required for load and span, with mounting screws.

.2 Acceptable products:

.1 Unistrut P1000 or approved equal in accordance with B6.

2.2 CONCRETE AND MASONRY ANCHORS

.1 Materials: hardened steel inserts, zinc plated for corrosion resistance.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

.3 Manufacturer: Hilti (Canada) Limited.

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with galvanized anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts, unless otherwise indicated.

.4 Do not drill through steel reinforcement encased in concrete.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Maximum spacing between conduit supports:

.1 As per 26 05 34.

.7 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole aluminum straps to secure surface conduits and cables 50 mm and smaller.

.2 Two-hole aluminum straps for conduits and cables larger than 50 mm.

.8 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.9 For surface mounting of two or more conduits use channels, with maximum centre spacing as indicated above.

.10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.11 Ensure adequate support for raceways and cables dropped vertically where there is no wall support.

.12 Do not use wire lashing or perforated strap to support or secure cables.

.13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

.14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

.15 Touch up abraded surfaces and cut ends of galvanized members with an approved galvanizing repair compound.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and components for splitters, junction, pull boxes, and cabinets.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No.76, Splitters

Part 2 Products

2.1 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Refer to 40 95 74 for custom automation junction boxes.

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

3.2 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 3 identification labels indicating system voltage, phase, and source of feed.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.1-2009, Canadian Electrical Code, Part 1.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square 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.

2.2 SURFACE MOUNTED OUTLET BOXES FOR METAL CONDUIT

.1 General Requirements:

- .1 Acceptable materials:
  - .1 Cast Aluminum
  - .2 Cast ferrous alloy with corrosion resistant epoxy coating.
- .2 Finish
  - .1 Epoxy Enamel
- .3 Suitable for threaded rigid conduit
- .4 Mounting lugs as required.
- .5 Wet location covers for all locations unless otherwise approved by the Contract Administrator.
- .6 To CSA 22.2

.2 Round Boxes:

- .1 100mm (4”) round.
- .2 Tapped conduit openings and plugs.
- .3 Manufacturer / Model:
  - .1 Crouse Hinds VXF series

.3 Device Boxes

- .1 FS or FD cast aluminum boxes with factory threaded hubs and mounting feet for surface wiring of receptacles.
- .2 Single gang unless specified otherwise.
- .3 Manufacturer / Model:
  - .1 Crouse Hinds FS/FD series

2.3 CONDUIT BOXES

.1 FS or FD cast aluminum boxes with factory-threaded hubs and mounting feet for surface wiring.

2.4 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 35 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

.1 Provide boxes sized as required by the Canadian Electrical Code.

.2 Support boxes independently of connecting conduits.

.3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.

.4 Vacuum clean interior of outlet boxes before installation of wiring devices.

.5 Provide permanent label or lamacoid for all device boxes indicating the circuit(s) contained within.

.1 Example: G10-2 (Panel G10, circuit 2)

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

.2 CSA C22.2 No. 45, Rigid Metal Conduit.

.3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

1.2 CONDUIT REQUIREMENTS

.1 The drawings do not show every specific conduit run. Supply and install conduit as required to provide a complete system.

.2 All conduits shall be surface mounted unless otherwise indicated in the specifications and/or shown on the drawings.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures for the following:

.1 Metal Conduit Fittings

.2 Fittings for hazardous locations

Part 2 Products

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, aluminum threaded.

.2 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

.3 Minimum conduit size: 19 mm, unless specifically indicated on the drawings or approved by the Contract Administrator.

2.2 CONDUIT FASTENINGS

.1 One hole aluminum straps to secure surface conduits 50 mm and smaller. Two hole aluminum straps for conduits larger than 50 mm.

.2 Strap material to match conduit material.

.3 Beam clamps to secure conduits to exposed steel work.

.4 Channel type supports for two or more conduits.

.5 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT SPACERS

.1 PVC coated malleable iron spacers, CSA approved for the purpose.

.2 Aluminum channel may be utilized where conduits are grouped, however a non-metallic spacer must be provided between the aluminum channel and concrete.

2.4 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 All fittings to be liquid and dust tight.

.3 Utilize insulated grounding bushings at all enclosure entries.

.4 Enclosure Connections

.1 Connections in dry locations (bottom or side)

.1 Locknuts inside and outside enclosures.

.2 Insulated bushings Thomas & Betts Series 222.

.2 Connections in wet locations and tops of enclosures in dry locations

.1 Liquid-tight threaded hubs

.2 Insulated bushings Thomas & Betts Series 222.

.3 Utilize insulated grounding bushings at all non-metallic enclosure entries for metallic conduit, or as required for bonding in accordance with Code and good practice.

.5 Elbows:

.1 Utilize factory elbows for 27mm and larger conduits.

.6 Threaded Hubs for Metal Conduit

.1 liquid and dust tight with insulated throat

.2 Approved products

.1 Thomas & Betts "Bullet Hub" 370AL Series.

.7 Fittings for Metal Conduit

.1 Cast metal

.2 Gasketted covers.

.3 Approved products

.1 Crouse-Hinds Canada Ltd. "Condulet" series.

.8 Explosion proof conduit sealing fittings:

.1 CSA Certified suitable for Hazardous Locations – Class I, Zone 1, Group IIA.

.2 Material: Cast aluminum.

.3 Sealing Compound: As recommended by manufacturer.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 All conduits entering outlet boxes and devices that are located in walls subject to movement shall be terminated by means of liquid-tight flexible conduit, approximately 450 mm in length between the conduit and the outlet box or device which is being supplied. All conduits, bus duct, wireways, etc., passing through or across expansion joints of the building shall be installed with the use of approved expansion fittings.

2.6 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 ROUTING

.1 Locate conduits containing communication and low voltage conductors away from conduits containing power wiring.

.2 Route conduits on existing or new pipe rack or suspended channels where possible.

.3 Avoid routes that would interfere with any potential maintenance activities.

.4 Where not specifically shown in detail on the drawings, review proposed conduit routing with Contract Administrator prior to installation. Comply with all routing changes requested by the Contract Administrator.

3.2 INSTALLATION - GENERAL

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.3 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.4 Do not include more than the equivalent of four (4) quarter bends. Provide pull boxes as required.

.5 Ensure electrical continuity in all conduit systems.

.6 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.7 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant. Seal all conduits entering or leaving hazardous classified areas with approved seals.

.8 Where conduits pass through walls, group and install through openings. After all conduits shown on the Drawings are installed, close wall openings with material compatible with the wall construction.

.9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.10 Mechanically bend conduits over 19 mm in diameter.

.11 Dry conduits out before installing wire.

.12 Surface Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Group conduits wherever possible on suspended or surface channels.
- .3 Provide a minimum space of 12mm between conduits.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .6 Install spacers as required to provide a space between the conduits and the supporting surface, with a minimum space as follows:
  - .1 Above grade spaces not classified as CEC Category 1 or 2:
    - .1 Drywall / Wood surfaces: no space required

.2 Masonry / concrete surfaces: 6 mm
.3 Below grade spaces: 12 mm
.2 CEC Category 1 or 2: 12 mm

.13 Underground Conduits
.1 Slope conduits to provide drainage.

.14 Floor Penetrations
.1 Mark out intended location for openings and confirm acceptability with Contract Administrator prior to drilling.
.2 Provide galvanized steel pipe sleeve
.3 Provide 102 mm curb to floor penetrations in areas that are subject to regular clean up and wash down.

.15 Colour Coding
.1 As per 26 05 01 Common Work Results – Electrical.

3.3 METAL CONDUIT

.1 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.2 Mechanically bend conduits over 19 mm in diameter.

.3 Concrete Penetrations:
.1 Sleeves for Aluminum Conduit
.1 Install schedule 40 galvanized steel pipe, sized for free passage of conduit.
.2 Seal and firestop penetration around conduit with ULC approved assembly for the installation conditions.
.3 For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 50 mm above finished floor level or housekeeping pad level.

.4 Maximum spacing between supports for rigid metallic conduit:

.1	16mm conduit:	1.0 m
.2	21mm conduit:	1.5 m
.3	27mm conduit	1.5 m
.4	35mm conduit	2.0 m
.5	41mm conduit and larger	2.5 m

3.4 INSTALLATIONS IN CATEGORY 1 LOCATIONS

.1 Arrange to provide drainage at frequent intervals to suitable locations.

.2 Equip with approved fittings to permit the moisture to drain out of the system.

.3 Install the conduit with a minimum of 12 mm space from the supporting surface.

.4 Install every joint to be water-tight.

.5 Where conduit leaves a warm room and enters a cooler atmosphere, seal the conduit and arrange the conduit in a manner to avoid condensation accumulation at the seal.

3.5 INSTALLATIONS IN CATEGORY 2 LOCATIONS

.1 Comply with all requirements of Category 1 locations.

3.6 INSTALLATIONS IN CATEGORY 2 WET LOCATIONS

.1 Comply with all requirements of Category 1 locations.

3.7 INSTALLATIONS IN HAZARDOUS CLASS I, ZONE 1 LOCATIONS

.1 Explosion proof conduit sealing fittings:

.1 Install sealing fittings as indicated and on all new conduit installations to meet CEC requirements.

.2 Percent fill through fitting not to exceed 25%.

.3 Add sealing compound following manufacturer's instructions.

3.8 INSTALLATIONS IN HAZARDOUS CLASS I, ZONE 2 LOCATIONS

.1 Explosion proof conduit sealing fittings:

.1 Install sealing fittings as indicated and on all new conduit installations to meet CEC requirements

.2 Percent fill through fitting not to exceed 25%.

.3 Add sealing compound following manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2 No.126, Cable Tray Systems.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

Part 2 Products

2.1 CABLE TRAY

.1 Cable trays shall be aluminum ladder type, CSA Class D1 loading with loading depth of 125mm (5 inches) minimum, 150mm (6 inch) rung spacing and in widths as shown on the drawings. Horizontal supports shall be installed at maximum intervals of 4000mm in strict accordance with the manufacturer recommendations for the loading class.

.2 Cable Channel shall be aluminum ventilated type with aluminum cover, where required for mechanical protection.

2.2 CABLE TRAY ACCESSORIES

.1 Cable tray accessories shall be supplied by the same manufacturer and shall be of the same model.

.2 Cable tray accessories shall include all supports, fittings, covers and bonding / grounding connectors.

2.3 FLOOR/WALL SEAL SYSTEMS

.1 Floor/wall sealing systems shall be one-hour fire rated.

.2 Systems to be listed assemblies

.3 Provide system to allow for easy re-entry as part of future work.

Part 3 Execution

3.1 INSTALLATION

.1 Do not allow or cause any work performed or installed to be covered up or enclosed by work of this Section prior to the required inspections, tests and approvals.

.2 Inspect cable tray routing to determine any conflict with other trades. Inform the Contract Administrator of any conflicts and make adjustments as determined by the Contract Administrator.

.3 Provide a cover for cable trays that are run vertically along walls.

.4 Install cable and channel tray in accordance with the drawings and the manufacturer’s recommendations.

.5 Install cable and channel tray of the size, type, and routing specified on the drawings. The installation shall be parallel to structure walls, straight and plumb.

.6 Install cable and channel tray and its support system suitable for the maximum allowable load based on the CSA Class of the tray.

.7 The drawings may not show all details required for mounting or installation. Supply and install any additional items required to complete the installation.

.8 Ensure that the cable and channel tray and supports are properly aligned with a minimum of distortion.

.9 All direction changes in main runs of cable tray shall be made using standard factory made fittings.

.10 Minimum cable and channel tray fitting radius shall meet or exceed the minimum bending radius of the cables installed.

.11 Cable tray sections shall be saw cut as required. Cut sections shall be square, deburred, and drilled for standard factory splice plates. Cutting by welding or burning is not permitted. Cut ends or defaced surfaces shall be painted or as directed by the Contract Administrator.

.12 Channels for cable and channel tray supports shall be saw cut as required. Cut sections shall be square and deburred. Cutting by welding or burning is not permitted. Cut ends or defaced surfaces shall be painted or as directed by the Contract Administrator.

.13 Cable tray supports shall be installed at every 4000mm interval or less as required.

.14 Cable tray fittings, expansion joints and the like shall be supported within 600mm of both sides of such connection.

.15 Locate splice plates within 600mm of a support.

.16 Where a cable tray support is installed at a location greater than 1200mm from a structural column, the horizontal strut of the cable tray support shall be supported by two structural steel members.

.17 Vertical cable trays shall have cable tray supports spaced at intervals not exceeding 1200mm and shall be open on one side to facilitate cable pulling.

.18 Expansion Joints.

- .1 Install expansion joints complete with ground bond as indicated on the drawings.
- .2 Install expansion joints at intervals not exceeding 30M.

.19 Install a bare copper grounding conductor in each interior tray. Bond the conductor to the cable tray at intervals not exceeding 6000mm and at all separate joints, fittings, tray sections.

.20 Bonding cables shall be 2/0 AWG copper, unless otherwise indicated on the drawings.

.21 Repair or restore to original condition, any equipment or structure damaged during installation or before final acceptance at no additional cost.

.22 Restore to original condition any painted surfaces damaged during installation at no additional cost.

.23 Cables shall be installed uniformly across the width of the tray to minimize the number of layers.

.24 Install a barrier between 600V power cables and lower voltage instrumentation cables.

.25 Secure cables to cable tray/channel tray with cable clamps at intervals not exceeding 4500mm for horizontal runs and at intervals not exceeding 1200mm for vertical runs.

.26 Provide metal cable clamps (approved for use by the tray manufacturer) bolted to the side of the tray for all cables entering or exiting the cable tray.

.27 Remove all debris and foreign material from the complete cable tray system prior to installation of cables.

.28 Construct and use approved platforms, scaffolding and rigging systems for installation and access. The use of cable trays as walkways, "ladders", or structural rigging supports is not permitted.

.29 Following completion of cable and system tests install fire proofing-sealing system in cable tray wall/ceiling/floor entry into electrical rooms in accordance with manufacturer’s recommendations.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 NETA Acceptance Testing Specifications, 2003 (ATS-2003)

1.2 TESTING EQUIPMENT

.1 All test equipment shall be in good mechanical and electrical condition.

.2 Accuracy of metering in test equipment shall be appropriate for the test being performed.

.3 Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

.4 The test equipment shall be calibrated as specified below:

.1 The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

.2 The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

.3 Instruments shall be calibrated in accordance with the following frequency schedule:

.1 Field instruments: Analog, 6 months maximum. Digital, 12 months maximum.

.2 Laboratory instruments: 12 months maximum.

.3 Leased specialty equipment: 12 months maximum.

.4 Dated calibration labels shall be visible on all test equipment.

.5 Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

.6 Calibrating standard shall be of higher accuracy than that of the instrument tested.

.5 Specific requirements of insulation resistance meters.

.1 Must be digital units. Crank-type analog insulation resistance meters will not be acceptable.

.6 Specific requirements of low-resistance meters:

.1 Measure resistance range from 1 μΩ to 1000 Ω.

.2 Standard electrician multimeters will not be accepted.

1.3 TESTING REPORT

.1 Prepare an overall inspection and test report that details all investigations and tests.

.2 The Contractor shall furnish five paper copies and two electronic copies on CD of each final report.

.1 The electronic copies of the report, including the test forms, shall be provided in PDF format.

.2 The Microsoft Word version of the all completed test forms provided to the Contractor shall also be included on the CDs.

.3 The report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the report in the appropriate section, and completely resubmitted.

.4 A draft of each report shall be completed and sent to the Contract Administrator for review a maximum of one month after the completion of the inspections at the Site.

.5 The final report shall be submitted a maximum of two weeks after the Contractor receives the mark-up of the draft report from the Contract Administrator.

.6 The report shall include the following:

.1 Summary of project.

.2 Testing Equipment.

.3 Detail the type, manufacturer, model, and last calibration date of all testing equipment.

.4 Description of equipment tested.

.5 Description of all tests.

.6 Typed inspection forms including:

.1 Identification of the testing organization.

.2 Equipment identification.

.3 Humidity, temperature, and other conditions that may affect the results of the tests/calibrations.

.4 Date of inspections, tests, maintenance, and/or calibrations.

.5 Identification of the testing technician.

.6 Indication of inspections, tests, maintenance, and/or calibrations performed and recorded, along with charts, and graphs as applicable. All measurements and readings taken shall be noted for inclusion in the report. Where repairs are made, measurements and readings before and after the repair shall be included.

.7 Indication of expected results, when calibrations are to be performed.

.8 Indication of “as-found” and “as-left” results, as applicable.

.7 Itemized list of all repaired deficiencies which shall include:

.1 Detailed description of the deficiency.

.2 The cost associated with the deficiency repair.

.8 Itemized list of all un-repaired deficiencies encountered which shall include:

.1 Detailed description of the deficiency.

Part 2 Products

2.1 NOT USED

.1 Not Used

Part 3 Execution

3.1 SCOPE OF TESTING

.1 VFD-G601

.2 VFD-G602

.3 VFD-G687

.4 MS-G686

.5 MS-G682

.6 MS-G692

.7 MS-G603

.8 MS-G605

.9 MS-B580

.10 Motor for G601-SF

.11 Motor for G602-SF

.12 Motor for G687-EF

.13 Motor for G686-EF

.14 Motor for G682-AHU

.15 Motor for G692-EF

.16 Motor for G603-GP

.17 Motor for G605-GP

.18 Motor for B580-SMP

.19 Circuit breaker for VFD-G601

.20 Circuit breaker for VFD-G602

.21 Circuit breaker for VFD-G687

.22 Cables:

.1 All 600 V cables.

3.2 INSPECTION, TESTING AND MAINTENANCE PROCEDURES

.1 General

.1 All tests are based on NETA (InterNational Electrical Testing Association) standard ATS-2003. Where manufacturer's specifications, tolerances, and/or published data are not available, refer to the appropriate tables in ATS-2003.

.2 Torque all accessible bolted electrical connections. Additional requirements apply as specified.

.3 Utilize the existing drawings for reference while performing the specified electrical inspection work. Where the existing installation deviates from that shown on the drawings, mark-up the drawings with red pen as required to reflect the installation. Include the marked-up drawings in the report.

.4 The scope of required drawing checks is limited to the equipment and components that are part of the electrical inspection work.

.5 Any repairs made that affect the accuracy of the drawings shall be marked up on the drawings.

.6 Drafting of drawings is not required.

.7 All inspection values, readings, corrections, and assessments shall be clearly recorded for inclusion within the report.

.8 Where corrections or repairs are made, record both as found/as left test readings on the inspection sheet. If space is not provided on the inspection form, record the readings in the Note fields or on a separate sheet.

.2 Inspection Forms

.1 The inspection forms to be completed by the Contractor are provided for reference in PDF format.

.2 Microsoft Word form templates will be provided prior to the work being initiated.

.3 Make appropriate print-outs of the inspection forms and utilize for entry of data and test results on site.

.4 Utilizing the Microsoft Word form templates, enter the data recorded manually into the forms electronically.

.5 Complete the inspection forms in the entirety and include them in the report.

.6 Submit electronic PDF copies of the inspection forms.

.7 The scope of work required in the specifications is in no way limited by the inspection forms, or spaces provided. Provide additional pages, documents, and forms as required to provide a complete report.

.8 The inspection forms may be updated during the Work by the City or Contract Administrator. Utilize the latest forms provided.

.9 Perform insulation resistance temperature correction calculations utilizing the following:

.1 To correct to 20°C, utilize Table 260805-1.

.2 To correct to 40°C, utilize Table 260805-2.

Table 260805-1

Insulation Resistance Correction Factors (20 °C)

Measured Temperature (°C)	Oil Immersed Insulation	Solid Insulation
-10	0.125	0.25
-5	0.18	0.32
0	0.25	0.40
5	0.36	0.50
10	0.50	0.63
15	0.75	0.81
16	0.80	0.85
17	0.85	0.89
18	0.90	0.92
19	0.95	0.96
20	1.00	1.00
21	1.08	1.05
22	1.16	1.10
23	1.24	1.15
24	1.32	1.20
25	1.40	1.25
30	1.98	1.58
35	2.80	2.00
40	3.95	2.50
45	5.60	3.15
50	7.85	3.98
55	11.20	5.00
60	15.85	6.30

Table 260805-2 Insulation Resistance Correction Factors (40 °C)		
Measured Temperature (°C)	**Oil Immersed Insulation**	**Solid Insulation**
-10	0.03	0.10
-5	0.04	0.13
0	0.06	0.16
5	0.09	0.20
10	0.13	0.25
15	0.18	0.31
16	0.19	0.33
17	0.21	0.34
18	0.22	0.36
19	0.24	0.38
20	0.25	0.40
21	0.27	0.42
22	0.29	0.44
23	0.31	0.46
24	0.33	0.48
25	0.35	0.50
30	0.50	0.63
35	0.71	0.79
40	1.00	1.00
45	1.41	1.26
50	2.00	1.59
55	2.83	2.00
60	4.00	2.52

.3 Perform winding resistance temperature correction calculations utilizing the following:

.1 $$R_C = R_M \frac{T_C + T_K}{T_M + T_K}$$

.2 Where, RC = Resistance at corrected temperature.

RM = Resistance at measured temperature.
TC = Temperature to correct to in °C.
TM = Measured temperature in °C.
TK = Temperature Resistance Constant
(234.5 °C for copper, 226.0 °C for aluminum)

3.3 CABLES, < 1000 V (ALSO FEEDERS IN CONDUIT)

.1 Inspection and testing shall be comprised of the following:

.1 For cables/wires 4/0 AWG or larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate and correct values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.2 Torque all accessible bolted electrical connections.

.3 Inspect compression applied connectors for correct cable match and indentation.

.4 Inspect grounding and cable/conduit support.

.5 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.6 Measure length of cable/conduit and record in meters.

.7 If cables/wires are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.8 Perform an insulation-resistance test on each conductor. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1000 megaohms. The voltage applied shall be 500 Vdc for 300 V rated cables, and 1000 Vdc for 600 V or 1000 V rated cables.

3.4 CONTROL POWER TRANSFORMERS, < 1000 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the report.

.2 Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

.3 Verify that primary and secondary fuse ratings or circuit breakers match available drawings. Where drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the drawings, where not shown.

.4 Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be:

.1 windings < 250 V: 500 Vdc

.2 windings > 250 V: 1000 Vdc

3.5 MOTORS, INDUCTION, AC, 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging. Air baffles and filter media should be clean. Cooling fans should operate. Slip ring wear and brushes should be within manufacturer's tolerances for continued use. Brush rigging should be intact.

.5 Clean the unit.

.6 Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.7 Verify the application of appropriate lubrication and lubrication systems.

.8 Verify the absence of unusual mechanical or electrical noise or signs of overheating.

.9 Perform a rotation test to insure correct shaft direction.

.10 Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43. Test voltage shall be in accordance with manufacturer's published data or 500 Vdc.

.1 Where possible, test each winding separately. Ground all windings not under test.

.2 Ensure all cables and accessories are disconnected during the test.

.3 For motors <= 150kW (200 HP), the test duration is to be one (1) minute. Calculate the dielectric absorption ratio.

.4 For motors > 150kW (200 HP), the test duration is to be ten (10) minutes. Calculate the dielectric absorption ratio and polarization index.

.5 Correct test results to 40 °C.

.6 Investigate readings below 100 megaohms. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B insulation and Class F insulation.

.11 Where it is not possible to perform an insulation resistance test separately on each winding, perform a winding resistance test on each winding using a low-resistance ohmmeter.

.12 Measure running voltage and current and evaluate relative to load conditions and nameplate full-load amperes. Utilize a true RMS meter.

.1 Where powered by a VFD with bypass, perform test with the motor powered by the VFD and by the bypass starter.

.13 Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data, if applicable.

.14 Perform resistance tests on resistance temperature detector (RTD) circuits. RTD circuits should conform to design intent and/or machine protection device manufacturer's specifications.

3.6 MOTOR STARTERS, 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Record all adjustable settings, size of overload, etc.

.3 Inspect physical and mechanical condition.

.4 Inspect anchorage, alignment, and grounding.

.5 Verify the unit is clean.

.6 Torque all accessible bolted power connections.

.7 Inspect contactors for evidence of overheating or stress.

.8 Visually inspect and exercise circuit breaker.

.9 If power fuses are present, record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.

3.7 VARIABLE FREQUENCY DRIVE, 600V < 37 kW

.1 Inspection and testing shall be comprised of the following:

.1 Inspect physical and mechanical condition.

.2 Inspect anchorage, alignment, and grounding.

.3 Inspect for evidence of corrosion.

.4 Clean the unit.

.5 Check the air filters.

.6 Ensure vent path openings are free from debris and that heat transfer surfaces are not contaminated by oil, dust, or dirt.

.7 Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.

.8 Visually inspect VFD grounding to ensure continuity.

.9 Inspect condition of line reactors, if present.

.10 Inspect DC bus capacitors for bulging and leakage.

.11 Cooling fans and heat sinks:

.1 Visually inspect and listen for any abnormal noises or vibration.

.2 Verify that fans rotate freely.

.3 Verify correct direction of airflow.

.4 Clean and verify integrity of heat sinks.

.5 Verify the operation of the grounding switch, if present.

.2 Record the following VFD Parameters:

.1 Motor voltage, current, frequency, nominal speed, nominal power.

.2 Control mode / method.

.3 Minimum and maximum control frequency.

.4 Acceleration and deceleration time.

.5 Compare drive overcurrent set points with motor full-load current rating to verify correct settings.

.3 Power fuses:

.1 Record fuse data. Confirm that the fuses are of the correct type and rating. Utilize manufacturer’s published data where available.

.2 Measure fuse resistance.

.4 Bolted connections:

.1 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.2 Torque all bolted connections.

.5 Inverter / Supply Module Power Connections:

.1 Remove each power module and visually inspect the contacts.

.2 Torque all cable connections.

.3 Clean all contact surfaces and apply suitable joint compound as recommended by manufacturer.

.6 Operator Interface:

.1 Check the display and keypad for proper operation and communication.

.2 Retrieve fault history log and note any faults.

.7 Grounding/Bonding measurements:

.1 Measure the resistance of the ground bonding connection between the VFD and the main grounding bus in the corresponding electrical room.

.8 Control Wiring:

.1 Check for tightness of all accessible control wiring and torque any loose connections.

.9 Perform operational tests by initiating control devices.

.1 Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.

.2 Verify operation of drive from local start/stop and speed control signals.

.3 Verify operation of all local pilot lights.

.4 Verify the operation of any emergency stop switches.

.10 Voltage and Current Testing:

.1 With the VFD under load, measure and record the following:

.1 Incoming AC voltage and currents.

.11 With the VFD output in START/RUN mode, and at zero speed:

.1 Measure and record the AC output voltage. Voltages above 40 VAC should be investigated.

3.8 CIRCUIT BREAKERS, INSULATED-CASE/MOLDED CASE, 600 V

.1 Inspection and testing shall include the following:

.1 Note the equipment nameplate data for inclusion in the report.

.2 Record all adjustable settings.

.3 Inspect physical and mechanical condition.

.4 Inspect anchorage and alignment.

.5 Clean the unit.

.6 Torque all accessible bolted power connections.

.7 Operate the circuit breaker to insure smooth operation.

.8 Test all breakers utilizing the “Push-To-Trip” button, if equipped.

.9 Move operating handle to the off and on position.

.10 Restore breaker position to original position.

.2 For cables 4/0 AWG and larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.3 For breakers with a frame size greater or equal to 250A, or as specified elsewhere in the specification:

.1 Perform an insulation resistance test.

.2 Breakers rated < 600V, test voltage is to be 500 VDC.

.3 Breakers rated >= 600V, test voltage is to be 1000 VDC.

.4 Perform a contact/pole-resistance test.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No.55, Special Use Switches.

.2 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

Part 2 Products

2.1 SWITCHES

.1 600V Switch Requirements:

.1	Rating:	600 V, 30 A
.2	Electrical Classification:	Class I, Zone 2
.3	Poles:	As Indicated on drawings
.4	Housing Material:	Copper Free Aluminum
.5	Lockable.	
.6	Approvals:	CSA
.7	Acceptable Products:	

.1 Crouse Hinds DSD-SR Series

.2 Or approved equal in accordance with B6.

2.2 COVER PLATES

.1 Unless otherwise indicated, devices shall come as complete enclosures rated for the hazardous area in which they are installed.

Part 3 Execution

3.1 INSTALLATION - GENERAL

.1 Install a permanent lamacoid with device identifier above switches.

3.2 INSTALLATIONS IN HAZARDOUS CLASS I, ZONE 2 LOCATIONS

.1 Install conduit seals for devices that are not factory sealed.

3.3 INSTALLATIONS IN CATEGORY 1, CATEGORY 2, AND CATEGORY 2 WET LOCATIONS

.1 Install the device with a minimum of 12 mm space from the supporting surface.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers and circuit breakers.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5, 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.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, and Circuit breakers to CSA C22.2 No. 5

.2 Common-trip breakers: with single handle for multi-pole applications.

.3 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.

.4 Circuit breakers to have minimum 10kA symmetrical rms interrupting capacity rating.

.5 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.

.6 Include:

.1 On-off locking device.

2.2 MOUNTED BREAKERS

.1 Enclosures to be suitable for installation into existing MCC, front mounted external operating handle, lockable in the “off” position with a padlock.

.2 Breakers are to be Cutler-Hammer HFD series or approved equal in accordance with B6.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

.2 Identification:

.1 In accordance with Section 26 05 01 – Common Work Results – Electrical

.2 For all individually mounted breakers and breakers in MCCs, CDPs and switchboards:

.1 Provide lamacoid plate on or adjacent to each breaker showing load being fed.

.2 Format:

.1 Line 1: The breaker identifier. Example: “CB-VFD-G601”.

.1 Where the breaker identifier is not specified, utilize “CB-“ followed by the immediate device being fed.

.2 Line 2: The ultimate load being fed, or a description of the breaker functionality. Example: “Load: G601-SF” or “MCC-1G/MCC-2G Transfer Switch”.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 National Electrical Manufacturer's Association (NEMA)

.1 NEMA Standards Publication ICS 2-2000: Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Provide shop drawings for each type of starter to indicate:

.1 Mounting method and dimensions.

.2 Starter size and type.

.3 Layout and components.

.4 Enclosure type.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.

.3 Extra Materials:

.1 Provide listed spare parts for each different size and type of starter.

.1 All control fuses.

.2 1 indicating lamp bulb.

Part 2 Products

2.1 GENERAL

.1 Starters to NEMA ICS 2-2000.

.2 Motor starters are to be completely compatible with existing MCC. Use products from the manufacturer of the existing MCC in order to ensure physical and electrical compatibility.

2.2 FULL VOLTAGE MAGNETIC STARTERS

.1 UL/CSA listed, NEMA size as shown on the drawings.

.1 Smallest size of starter: NEMA size 1, unless otherwise indicated

.2 IEC rated starters are not acceptable.

.2 Magnetic of size, type, rating and enclosure type as indicated with components as follows:

.1 All coils to be epoxy coated.

.2 Contactor solenoid operated, rapid action type.

.3 Motor overload protective device in each phase, manually reset from outside enclosure.

.4 Wiring and schematic diagram inside starter enclosure in visible location.

.5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.3 Accessories:

.1 1-N/O spare auxiliary contact.

2.3 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses, installed in with starter as indicated.

.2 Size control transformer as indicated.

2.4 ACCESSORIES

.1 Pushbutton: heavy duty, oil tight as required.

.2 Selector switches: heavy duty, oil tight as required.

.3 Indicating lights: heavy duty, oil tight, LED type and colour as indicated.

2.5 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results for Electrical.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Magnetic starter designation label, white plate, black letters, as indicated on lamacoid schedule.

2.7 SPARE PARTS

.1 Fuses: two of each type and rating.

.2 Indicating lamps: two (2) indicating lamp bulbs of each type.

Part 3 Execution

3.1 INSTALLATION

.1 Install starters in existing MCC as shown on drawings.

.2 Install starters and control devices in accordance with manufacturer's instructions.

.3 Install and wire starters and controls as indicated.

.4 Ensure correct fuses installed.

.5 Confirm motor nameplate and adjust / replace overload device to suit.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results for Electrical and manufacturer's instructions.

.2 Operate switches and 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, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Technical requirements related to the design and supply of Variable Frequency Drives (VFD), including all equipment, manufacture, assembly, factor, wiring, inspection, testing and delivery.

1.2 REFERENCES

.1 CSA, Canadian Standards Association

.2 NEMA, National Electrical Manufacturer Association

.3 IEEE, The Institute of Electrical and Electronics Engineers

.4 Other, Local Power Utility and Telephone Utility Guidelines for Harmonic Distortion.

1.3 DESIGN REQUIREMENTS

.1 Provide equipment layout drawing detailing

- .1 The dimensions, physical arrangement of major components, and the degree of compartmentalization and physical segregation provided between components
- .2 Front layout of the panel
- .3 When air-cooled systems are provided, the following shall also be shown:
  - .1 air inlet and outlet passages
  - .2 cooling fans
  - .3 filters.

1.4 SUBMITTALS

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

.2 Submit shop drawings including:

- .1 Panel layout.
- .2 Wiring diagrams:
  - .1 AutoCAD versions of the VFD schematic drawings will be provided upon request.
- .3 Enclosure Heat Load calculations

.3 Prior to shipment:

- .1 Submit electronic pictures of enclosure exterior and interior, including door interior.
  - .1 Pictures to be of sufficient resolution to read component labels.
- .2 As-built drawings:
  - .1 Submit as-built drawings. Minor changes may be made via red-line mark-ups.
  - .2 Draft significant changes on AutoCAD drawings.
- .3 Do not ship cabinet until approval from Contract Administrator is received.

1.5 **PARTS AVAILABILITY**

.1 Guarantee that parts for the drive units be available for a minimum of ten years from time of delivery.

1.6 **DESIGN REQUIREMENTS**

.1 Ventilation system designed for ambient temperature range of 10°C to 35°C. Enclosure temperature not to exceed 45°C.

Part 2 Products

2.1 **VARIABLE FREQUENCY DRIVES**

.1 Variable speed controller shall be electronic adjustable frequency and voltage output unit.

.2 Designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting NEMA MG1 Part 31.

.3 Harmonic loading will not exceed a motor service factor of 1.0.

.4 Products shall comply with IEEE standard 519.

.5 CSA certified.

.6 To employ a minimum 6-pulse pulse width modulated (PWM) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors.

.7 Be capable of re-accelerating the driven equipment, following voltage dips greater than 20% of the rated input power supply, of up to 5 seconds duration, without the need to come to a complete stop. Vendor shall indicate the maximum time delay before re-acceleration begins following restoration of the supply voltage.

.8 Be capable to continue operation without coming to a standstill or resulting in a process shutdown, following any momentary voltage dips in the input power supply, auxiliary power supply, or both, of less than 20% rated voltage, which last for less than 0.5 second.

.9 Designed to provide output requirements dictated by the speed/torque characteristics of motor and driven equipment over the entire speed range. The motors may be supplied by others.

.10 VFD shall convert the line input power to adjustable AC voltage and frequency output power. The output power shall be controlled such that permissible volts/Hertz ratio is not exceeded throughout the specified operating speed range, over a voltage range of ±10% and frequency variation of ± 5%.

.11 The VFD output frequency shall not deviate more than ± 1% of any given set point within the operating frequency range.

.12 The VFD shall be provided with radio interference suppression and limit radio interference values to within the limits of local code requirements.

.13 The telephone influence factor shall be in accordance with maximum values specified by local authorities.

.14 Input frequency setting signal will be 0-10 VDC and 4-20 mA. Output speed and current monitoring signals will be 4-20 mA.

.15 Enclosure

.1 VFD shall be installed in individual drip proof, Type 12 free standing enclosure. Filters to be provided for any forced air-cooled enclosures as required by the supplier. VFD(s) shall be suitable for the location installed and shall be able to operate under these conditions with no special cleaning requirements.

.16 Operational features

.1 Integral selector switches and pushbuttons for control on enclosure door.

.1 Standard of acceptance, Allen-Bradley 800T, or approved equal in accordance with B6.

.2 Selector switches and pushbuttons as follows:

.1 Manual/Off/Auto three position maintained selector switch

.17 Diagnostic features

.1 Integral long life LED indicating lights on enclosure door.

.1 Standard of acceptance, Allen-Bradley 800T

.2 Indicating lights as follows:

.1 Running (Red)

.18 Environmental capabilities: Drive to operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Room ambient temperature 0°C to 35°C

.2 Humidity 0 to 90 percent (non condensing)

.3 Vibration up to 0.5 g

.4 Altitude 0 to 1250 m

.19 Protective functions to be incorporated are:

.1 VFD failure

.2 Ground fault in VFD

.3 Ground fault on converter output

.4 VFD overcurrent

.5 Supply system over or under voltage

.6 Supply system phase voltage unbalance

.7 DC link fault

.8 Voltage/frequency ratio incorrect

.9 5% frequency deviation from the set point

.10 Loss of control signal

.11 Control electronics fault

.12 Electronic motor overload protection adjustable up to 150 percent of motor rating for 60 seconds.

.13 Motor stalled

.14 Inverter over temperature.

.20 Acceptable model:

.1 ABB - ACS 800 series.

2.2 INPUT REACTORS

.1 Requirements:

.1	Impedance:	As per drawings
.2	System voltage:	As per drawings
.3	Suitable for ambient operating temperature:	40 °C enclosed
.4	Fundamental frequency:	60 Hz
.5	Short term overload rating:	200% for 3 minutes
.6	Insulation system:	Class H (180 °C)
.7	Maximum temperature rise:	115 °C
.8	Watt Losses:	Less than 1% of rated load

.9 Acceptable Products:

.1 MTE Corporation RL Series

.2 Or appoved equal in accordance with B6.

2.3 **FUSES**

.1 Fuses for branch circuit protection to be fast acting Class J and Class T as specified on drawings.

2.4 **TERMINALS**

.1 Terminals as follows:

.1 Feed-through: Phoenix Contact 3046184 or approved equal in accordance with B6

.2 Potential earth: Phoenix Contact 3046207 or approved equal in accordance with B6

.3 Fused: Phoenix Contact 3046142 with 3036806 or approved equal in accordance with B6

.4 End plate: Phoenix Contact 3047141 or approved equal in accordance with B6

2.5 **RELAYS**

.1 Requirements:

.1	Type:	DPDT or as shown on drawings
.2	Indication:	LED
.3	Coil Voltage:	As per drawings
.4	Contact Rating:	5A (120 VAC), 5A (24 VDC)
.5	Approvals:	CSA
.6	Mounting:	DIN Rail

.2 Manufacturer and Model:

.1 Omron G2R series

.2 Or approved equal in accordance with B6.

2.6 **WIRE COLOUR CODING**

.1 Utilize the following wire colours for the types of voltage/signals indicated:

.1	120VAC Line:	Black
.2	120VAC Control:	Red
.3	120VAC Neutral:	White

.4	24VDC Supply:	Blue
.5	24VDC Control:	Blue
.6	24VDC Common:	Brown
.7	4-20mA Signal:	White (+), Black (-)

2.7 **COOLING SYSTEM**

.1 Perform heat load analysis to determine air-cooling requirements.

2.8 **SPARE PARTS**

.1 Provide, at minimum, the following spare parts:

.1 All control fuses

.2 One N.O. and N.C. contact block for control switches

.3 One form “C” relay

.2 Spare parts to be provided in a sealed plastic bag taped to side of enclosure interior.

Part 3 Execution

3.1 **INSTALLATION**

.1 VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build up of heat. The minimum clearance in front of VFDs is 1 m.

3.2 **CONFIGURATION**

.1 A settings sheet for the ABB ACS800 drives will be provided in PDF format.

.2 Review the settings and modify the settings as required for the drive supplied.

.3 Submit settings sheet for review.

.4 Configure VFD parameters as specified on settings sheet following this section.

.1 Advise the Contract Administrator of any deviations from those specified on settings sheet and update the settings sheet accordingly.

.2 Save VFD parameters.

.5 Include settings sheets in the O&M manuals.

3.3 **TESTS**

.1 VFD units are to be factory tested prior to shipment. Provide confirmation from factory of actual tests completed and results.

.2 Confirm VFD capability to continue operation without coming to a standstill, following any momentary voltage dips in the input power supply, auxiliary power supply or both of less than 20% rated voltage, which last for less than 0.5 seconds.

.3 Confirm VFD capability to automatically re-accelerate following loss of voltage for up to five seconds.

.4 Field testing

.1 Provide on-site startup, fine-tuning, commissioning, operator training, and instruction.

.2 Full-load functional test of the VFD shall be performed. The test shall prove the correct operation of all control functions, auxiliaries, protective systems, alarms and metering.

.3 Ensure shaft to ground voltages do not exceed 1.5 V at any speed or load requirement.

END OF SECTION