
Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-06, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2.
 - .3 CAN/CSA-C22.3 No. 1, Overhead Systems.
 - .4 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.2 CONTRACTOR REQUIREMENTS

- .1 Comply with all Department of Labor, Workplace and Health requirements at all times.
- .2 All Contractors shall have a valid Contractors license to operate in the City of Winnipeg.
- .3 All Electrical Subcontractor employees on Site shall have valid Trade Licenses.
- .4 Electrical Subcontractor shall maintain the appropriate ratio of Journeymen Electricians & Apprentices required by Provincial Codes.
- .5 Obtain all necessary permits & pay all fees and arrange for inspection with City of Winnipeg.
- .6 Obtain a certificate of final inspection and approval from inspection department having jurisdiction on completion of Work.

1.3 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 DESIGN REQUIREMENTS

- .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 above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.5 SUBMITTALS

- .1 Submit for review single line electrical diagrams under plexiglass and locate at main service.
 - .1 Electrical distribution system in main electrical room.
- .2 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .4 Submit and product data to Contract Administrator. Quantities as required.
 - .5 If changes are required, notify Contract Administrator of these changes before they are made.
- .3 Quality Control:
 - .1 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to Site.
 - .2 Submit test results of installed electrical systems and instrumentation.
 - .3 Permits and fees: in accordance with General Conditions of contract.
 - .4 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Contract Administrator.
- .4 Manufacturer's Field Reports: submit to Contract Administrator manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Acts respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

1.7 SYSTEM STARTUP

- .1 Instruct Operating Personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service Contract Administrator 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 will aspects of its care and operation.

1.8 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Post instructions where directed.
- .4 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .5 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to Site and submit such approval as described in PART 1 - SUBMITTALS.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminium conductors.

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels to as follows:
- .1 Nameplates: lamicaid 3 mm matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
- .2 Sizes as follows:
- | 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: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.7 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed 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: 25 mm wide prime colour and 15 mm wide auxiliary colour.

	<u>Prime</u>	<u>Auxiliary</u>
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	

	<u>Prime</u>	<u>Auxiliary</u>
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.8 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.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.

Part 3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 plastic, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .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.

3.5 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. Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 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: 100 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

- .1 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 Provide upon completion of Work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following the tests;
 - .1 Power distribution 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 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 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Contract Administrator.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic Site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule Site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-93(R1999), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper or aluminum conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, aluminum sheathed cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.Execution

2.2 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- .2 Section 01 74 19 - Waste Management and Disposal.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – 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 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.

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:
 - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking galvanized steel or aluminum.
- .6 Overall covering: polyvinyl chloride material.
- .7 Fastenings:
 - .1 One hole 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 at 50 mm centers.
- .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable. Explosion proof connectors shall be used in rated areas.

2.3 ARMoured CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel or aluminum strip.
- .4 Connectors: Teck90 Style.

2.4 ALUMINUM SHEATHED CABLE

- .1 Conductors: copper, size as indicated.
- .2 Insulation: type RA90 rated 1000 V.
- .3 Sheath: aluminum applied to form continuous sheath.
- .4 Fastenings for aluminum sheathed cable:
 - .1 One hole aluminum straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.
 - .2 Channel type supports for two or more cables.
 - .3 Threaded rods: 6 mm dia. to support suspended channels.

2.5 CONTROL CABLES

- .1 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated. All cables shall be FT-6 rated and meet manufacturers requirements for the intended purpose. Cables shall be shielded as required.
- .2 600 V type: as above but with 600V insulation where required.

Part 3 Execution

3.1 INSTALLATION - General

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

3.2 INSTALLATION OF BUILDING WIRES

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

3.3 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire Box Connectors - 0-1000 V.

3.4 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire Box Connectors - 0-1000 V.

3.5 INSTALLATION OF ALUMINUM SHEATHED CABLE

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire Box Connectors - 0-1000 V.

3.6 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield as required for application

3.7 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
 - .1 ANSI/IEEE 837-1989(R1996), Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Rod electrodes: copper clad steel 19 mm dia by 3 m long.
- .3 Plate electrodes: copper, surface area 0.5 m², 1.6 mm thick.
- .4 Grounding conductors: bare stranded copper, soft annealed, size 4/0AWG.
- .5 Insulated grounding conductors: green, type RWU90.
- .6 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .7 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 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.

- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Ground secondary service pedestals.
- .12 Reconnect:
 - .1 Existing grounding system
 - .2 Domestic water piping
 - .3 Existing systems requiring ground i.e. MTS system

3.2 ELECTRODES

- .1 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .2 Install rod and plate electrodes and make grounding connections.
- .3 Bond separate, multiple electrodes together.
- .4 Use size 4/0 AWG copper conductors for connections to electrodes.
- .5 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of 600 V system, secondary 208 V systems.

3.4 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.

3.5 GROUNDING BUS

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

3.6 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.
- .5 Clearly mark exact locations of Ground Rods and Ground routes on As-Built drawings.

END OF SECTION

Part 1 General

1.1 Not Used.

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended set in poured concrete walls and ceilings.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead shields. Use Aluminum shields or as approved by anchoring manufactures recommendations for specific surfaces.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller where above 2700mm.
 - .2 Two-hole steel straps to secure surface conduits and cables 50 mm and smaller where below 2700mm.
 - .3 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .4 Beam clamps to secure conduit to exposed steel Work.
- .6 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.
- .7 For surface mounting of two or more conduits use channels at 2 m on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Contract Administrator.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan in accordance with Section 01 74 19 – Waste Management and Disposal.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SPLITTERS

- .1 Sprinkler proof, sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters 400 A or less.

2.2 JUNCTION AND PULL BOXES

- .1 Sprinkler proof, welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Type E: sprinkler proof, sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sprinkler proof, sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as required.
- .3 All cabinets shall be sprinklerproof.

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 CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.

- .3 Install terminal block as required in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1-2006, Canadian Electrical Code, Part 1.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan in accordance with Section 01 74 19 – Waste Management and Disposal.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square 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 All electrical equipment shall be sprinkler proof.

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. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished tile walls.

2.3 MASONRY BOXES

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

2.4 CONCRETE BOXES

- .1 Electro-glvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

- .1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle. This is only allowed in mechanical spaces.

2.6 WIREMOLD BOXES

- .1 All surface mount devices and receptacles shall be in Wiremold low profile surface boxes with all approved fitting.

2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.8 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 45-M1981(R1992), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-1977(R1999), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R1999), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984(R1999), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-M91(R1999), Flexible Nonmetallic Tubing.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Section 01 74 19 – Waste Management and Disposal.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

- .1 Two hole steel straps for conduits larger than 50 mm. One hole steel straps to secure surface conduits 50 mm and smaller where mounted above 2700mm. Two hole steel straps for conduits smaller than 50 mm in all other areas.
- .2 Beam clamps to secure conduits to exposed steel Work.
- .3 Channel type supports for two or more conduits at 2 m oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90E bends are required for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene.

Part 3 Execution

3.1 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.
- .3 Use RGS conduit in Industrial arts area where conduit is exposed.
- .4 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .5 Use rigid pvc conduit underground.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .7 Use explosion proof flexible connection for connection to explosion proof motors.
- .8 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .9 Minimum conduit size for lighting and power circuits: 19 mm.
- .10 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 19 mm dia.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.

- .14 Run 2-25 mm spare conduits up 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 surface type box.
- .15 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

3.2 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 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.
- .7 Surface conduits shall not be used where exposed.

3.3 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No. 100-04, Motors and Generators.
 - .2 CSA C22.2 No. 145-M1986(R2004), Motors and Generators for Use in Hazardous Locations.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC M1-7-[1992], Standard for Motors and Generators.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: include: product characteristics, performance criteria, physical size, horsepower, watt rating, limitations and finish.
- .3 Shop drawings:
 - .1 Indicate dimensions, recommended installation procedure, wiring diagrams, sizes and location of mounting bolt holes and recommended support method.
- .4 Quality Assurance Submittals:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for fractional horsepower motors for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan in accordance with Section 01 74 19 – Waste Management and Disposal.

Part 2 Products

2.1 FRACTIONAL HORSEPOWER MOTOR

- .1 Non-hazardous locations: to CSA C22.2 No. 100 and EEMAC M1-7.
- .2 Hazardous locations: to CSA C22.2 No. 145.
 - .1 Rating: As indicated.
 - .2 Type: As indicated.

- .3 Bearings: As indicated.
- .4 Frame size: As indicated.
- .5 Enclosure: As indicated.
- .6 Mounting: As indicated.
- .3 Motor with inherent overheating protectors.

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 wiring, flexible connections and grounding.
- .2 Check rotation before coupling to driven equipment.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC M1-7, 1992, Motors and Generators.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data sheets for motors. Include product characteristics, performance criteria, physical size, horsepower, watt rating, limitations and finish.
- .3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Overall dimensions of motor.
 - .2 Shaft centreline to base dimension.
 - .3 Shaft extension diameter and keyway, coupling dimensions and details.
 - .4 Fixing support dimensions.
 - .5 Dimensioned position of ventilation openings. Details of ventilation duct attachments.
 - .6 Terminal box location and size of terminals.
 - .7 Arrangement and dimensions of accessories.
 - .8 Diagram of connections.
 - .9 Starting current and relative data necessary for use in design of motor starting equipment.
 - .10 Speed/torque characteristic.
 - .11 Weight.
 - .12 Installation data.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for motors for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Data necessary for maintenance of motors.
- .3 Manufacturer's recommended list of spare parts.

1.5 DELIVERY , STORAGE AND HANDLING

- .1 Deliver, store, handle and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Handle motors with suitable lifting equipment.
- .3 Store motors in heated, dry, weather-protected enclosure.

1.6 QUALITY ASSURANCE

- .1 Contract Administrator reserves the right to witness standard factory testing of motors 50 hp and above.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan in accordance with Section 01 74 19 – Waste Management and Disposal.
- .4 Fold up metal banding, flatten and place in designated area for recycling.
- .5 Collect, package and store expired motors for either recycling or rebuilding and return to recycler or rebuilder.

1.8 EXTRA MATERIALS

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

Part 2 Products

2.1 MATERIALS

- .1 Motors: to EEMAC M1-7.
- .2 Lead markings: to EEMAC M2-1.

2.2 RATING

- .1 Motor:
 - .1 As indicated.

2.3 MOTOR TYPE

- .1 As Indicated.

□

2.4 DESIGN LETTERS

- .1 Polyphase squirrel cage induction motors design As Indicated.

2.5 ENCLOSURE

- .1 Totally enclosed fan cooled.
- .2 Totally enclosed explosion proof for use in: Class as Indicated.

2.6 SERVICE CONDITIONS

- .1 Service Factor: 1.15.

2.7 INSULATION

- .1 Class: B or As Indicated.
- .2 Ambient temperature: 40 °C or As indicated.

2.8 BEARINGS

- .1 Antifriction type bearings, fitted with readily accessible facilities for lubrication while motor running or stationary.

2.9 STARTING METHOD

- .1 All motors shall be Inverter Duty rated.
- .2 Include anchor devices and setting templates.

Part 3 Execution

3.1 INSTALLATION

- .1 Dry out motor if dampness present in accordance with manufacturer's instructions.
- .2 Install motor.
- .3 Make wiring connections. Use liquid tight pvc jacketed flexible conduit between rigid conduit and motor.
- .4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails.
- .5 Check for correct direction of rotation, with motor uncoupled from driven equipment.
- .6 Align and couple motor to driven machinery to manufacturer's instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements for Commissioning of Electrical Systems equipment and systems.
- .2 Related Sections:
 - .1 Section 01 91 13 General Commissioning Requirements
 - .2 Section 22 08 00 Commissioning of Plumbing
 - .3 Section 23 08 00 Commissioning of HVAC
 - .4 Section 25 08 00 Commissioning of Integrated Automation
- .3 Acronyms:
 - .1 Cx - Commissioning.
 - .2 CxA - Commissioning Agent
 - .3 CSA – Canadian Standards Association
 - .4 EEMAC - Electrical and Electronic Manufacturers' Association of Canada

1.2 INTENT

- .1 Provide commissioning of electrical equipment and systems in accordance with this, Section 01 91 13 and related sections.
- .2 All items noted in this document are the responsibility of the contractor supplying and installing the equipment, unless noted otherwise.

1.3 MANUFACTURER'S SERVICE ON SITE

- .1 Arrange and pay for qualified Manufacturer's representatives to supervise starting and testing of following electrical equipment and systems (if applicable):
 - .1 Lighting Control System
- .2 Use manufacturers factory trained personnel where required to maintain manufacturer's warranty.
- .3 Maintain documentation of all equipment start-up and commissioning and provide to Commissioning Agent.

1.4 REFERENCE DOCUMENTS

- .1 Perform tests in accordance with:
 - .1 These Contract Documents.
 - .2 Requirements of authorities having jurisdiction.
 - .3 Manufacturer's published instructions.
 - .4 Applicable CSA, IEEE, IPCEA, EEMAC, NEMA and ASTM standards.

1.5 CONTRACTOR AND MANUFACTURER REPORTS

- .1 Arrange for Manufacturer to submit copies of all production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment to the Contract Administrator prior to shipping.

Part 2 Products

- .1 Not Used

Part 3 Execution

3.1 GENERAL

- .1 Commission all equipment and systems installed as part of this contract. Typical required information or actions are listed below for each equipment or system.
- .2 Provide check sheets for all equipment not listed in this section.
- .3 Document the commissioning process by completing the Component Verification Forms, System (functional) Tests and Integrated System Tests.

3.2 LIGHTING

- .1 Function test all light switches, luminaries, dimmers and lighting control equipment.
- .2 Record all photocell and time-clock settings.
- .3 Prior to energizing dimming system, ensure Manufacturer has checked all equipment and wiring for proper installation and termination. Manufacturer to check that all pre-set levels are set and operate as specified.
- .4 Check operation of all emergency lighting units, exit lights and connection of exit lights to emergency power as specified.
- .5 Verify that correct lamps and ballasts have been used.
- .6 Confirm operation of battery operated emergency lighting units including battery size and operating time.
- .7 Confirm operation of exit lights and connections of exit lights to emergency lighting panels.
- .8 Check all terminations and label all lighting circuits.

3.3 LIGHTING CONTROL SYSTEM

- .1 Inspect system to ensure that the low voltage lighting system is correctly installed, connected and fully operational in accordance with requirements of the Contract Documents and Manufacturers recommendations.
- .2 Test each lighting sequence and document appropriately.
- .3 Demonstrate the operation of each timed, occupancy control or daylight control function to the Contract Administrator.
- .4 Ensure the program interface provides an easy means for the building operator to make changes to the sequences.

3.4 REPORTING

- .1 Provide CxA and the Design Authority with installation and test documentation consistent with the requirements in this section.

3.5 ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

- .1 Provide operation and maintenance instruction and demonstrations in accordance with Section 01 91 13 – General Commissioning Requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Provide a complete low voltage lighting control system for the building as shown on the plans and specified herein.
- .2 Lighting control system shall utilize networking technology connecting relay panels, switches and sensors based upon a 2 wire data line providing both power and data to all devices. The network shall be free topology; therefore a serial loop is not necessary to achieve maximum network distance. The system shall utilize a web server device complete with a touch screen located in a relay panel so that programming and viewing of status can be accomplished at the panel or by any PC connected to the same LAN or via the internet.
- .3 All relay panels shall be pre-assembled complete with the necessary relays, transformers and interfaces. Relay panel interiors are to contain separate line voltage section and low voltage section to facilitate easy mounting, and conduit installation.

1.2 MANUFACTURERS

- .1 All components are to be supplied by same manufacturer. Manufacturer to be a supplier of this type of equipment for over 10 years.
- .2 Low voltage control system shall be manufactured by WattStopper or approved in accordance with B7..

1.3 INSTRUCTION MANUALS

- .1 Supply manuals on system components to permit ease of installation, system operation and maintenance including, but not limited to the following:
 - .1 Lighting control system step-by-step operating instructions.
 - .2 Relay panel schedules.

Part 2 Products

2.1 RELAYS

- .1 Lighting control relays shall be mechanically latching and shall come complete with a manual ON/OFF switch. The mechanical switch shall continuously display the true state of the relay's internal contacts.
 - .1 Single pole relays shall be rated and UL/CSA listed for 120, 277 and 347 VAC lighting loads at 20 amps. Use Douglas WR-6161.
 - .2 Double pole relays shall be rated and UL listed for 208, 240 or 480 VAC and CSA for up to 347 VAC lighting loads at 20 amps. Use Douglas WR-6172.
- .2 The relays shall have a label indicating the short circuit fault current rating as per the NEC 2005. The single pole relays shall have passed UL 508 short circuit tests at 14,000 amperes.
- .3 Each lighting control relay shall be capable of controlling incandescent, fluorescent, electronic ballast and H.I.D. lighting loads and have an inrush capability of 3000 amperes. Relays shall be complete with a 5 year Manufacturer's Limited Warranty.

- .4 Lighting control relays shall include captive screw terminals for both the line voltage and the low voltage connections. Switching the relay shall be accomplished with ONE signal wire and a common return. The signal wire shall be able to signal ON and OFF and shall carry status current that indicates if the relay is ON or OFF.

2.2 PRE-ASSEMBLED RELAY PANELS: LILM24 SERIES

- .1 Where indicated on the drawings, provide a factory pre-assembled relay panel. The panel shall be for surface or flush installation, with a hinged door assembly as required.
- .2 The panel shall be factory pre-assembled; ETL certified to UL/CSA standards, with capacities for 1 pole or 2 pole relays as required.
- .3 Panel shall include the following pre-assembled and pre-wired:
 - .1 Suitable divider separating class 1 and class 2 compartments
 - .2 Control transformer, UL/CSA approved for class 2 circuits.
 - .3 Low voltage relays as required by switched circuits shown on plans or schedules.
 - .4 External control devices as required.

2.3 DIMMING BALLAST \ DRIVER CONTROL

- .1 The Dialog system shall be able to control the ballasts or any industry standard 0-10VDC Dimming Ballasts by using a Dimming Ballast Module. Each driver shall have 4 outputs, each output can control up to 50 Ballasts.

2.4 DEVICE NETWORK CONTROLS

- .1 The Lighting Control Unit (LCU) shall be able to operate the local lighting control system on a stand alone basis. For large installations that require multiple LCUs, all units must be able to operate on a stand alone basis should they become disconnected from the network.
- .2 The LCU shall provide the following user interfaces for viewing and editing data:
 - .1 Built-in touch screen, for convenient access.
 - .2 Built-in web server, accessed via TCP/IP connection.
- .3 Each LCU shall provide the following standard lighting control functions:
 - .1 Program and control up to 256 relays or dimming points.
 - .2 Link outputs to switches and/or sensors to provide On/Off, Preset, or Dim Up/Down commands. In addition, functions such as flick warn, time out, daylight harvesting, enable/disable, quiet time and cleaning mode can be associated with switches, sensors and relays and have these features scheduled by time of day or date.
 - .3 Be able to group outputs and inputs to facilitate various control schemes.
 - .4 Be able to program peripheral devices (switches, sensors, etc.) to function differently based on specific situations such as time-of-day, demand response status, user intervention, etc.
 - .5 Photo sensor to provide dusk-to-dawn (switching) and/or day light harvesting (dimming) with multiple set points to different groups.
 - .6 Astronomic controls for dusk-to-dawn applications not requiring light sensor.
 - .7 Provide log reports for diagnostic and run time tracking purposes.
 - .8 Time schedule types include: 7day weekly scheduling, 365 day date specific and event scheduling.

- .4 The system shall have pre-defined logical applications for lighting controls.
 - .1 Astronomical Time Clock
 - .2 Daylight Harvesting (CLC) – Open Loop & Close Loop
 - .3 Exterior Threshold Photo Control
 - .4 Time Out (Unoccupied Mode)
 - .5 Quiet Mode
 - .6 Permanent Block
- .5 The system must have the ability to operate multiple items and modes with a single action and sequence them with time offsets.
- .6 Each Lighting Control Unit shall provide the following system functions:
 - .1 Demand response: connection via TCP/IP or contact input.
 - .2 Accept software updates via USB port or Ethernet connection.
 - .3 Backup data via Ethernet, RS485 or USB port.

2.5 WALL SWITCHES & ACCESSORIES

- .1 Switches shall connect to the lighting control network via a common 2-wire, non polarized data line. Switches shall be configured and programmed to control one or more outputs in the lighting control system.
- .2 Switches shall have addresses set with an infra-red setting device that accesses the front of the switch and permits setting of the switch without removing the switch from the wall box.
- .3 Switches are linked to a single output or a group of outputs.
- .4 Switches, occupancy sensors and daylight sensors can be set to a common output address to permit multiple points of control for a single relay or dimming output.
- .5 Switches, occupancy sensors and daylight sensors can be set to a common group address to permit multiple points of control for a group of outputs.
- .6 Each switch can be programmed for ON/OFF control of outputs, UP/DOWN control of 0-10VDC dimming ballasts, and/or preset control to set a specific lighting scene.
- .7 Switch modules shall be available with 1, 2, 3, or 4 single button switches per gang or 8 two button switches per gang. Switch to fit standard 'Decora' opening.
- .8 Switches and switch hardware shall mount to standard wall boxes.
- .9 Switches shall include integral LEDs to indicate both ON and OFF output/group status.
- .10 Each switch shall permit a paper switch label to be inserted for identification purpose. The label shall be held in place under a clear plastic cover and shall be field replaceable should the operation of the switch change. Permanently etched switches are not acceptable.
- .11 Adhere to the factory recommended wiring practices so that physical removal of any single switch shall still permit communication between relay panels in the rest of the lighting control network.
- .12 Keyed Switches: WSK-35xx series

- .1 Keyed switches shall be connected to the lighting control network via a 2-wire, non polarized data line.
 - .2 Keyed ON/OFF switches shall include an integral LED to indicate both ON and OFF states.
 - .3 Keyed switches can be programmed to control individual outputs or groups of output and can also be programmed to enable/disable peripheral devices such as switches or sensors
- .13 Dimmer Switches: WSD-35xx series
- .1 Dimmer switches shall be connected to the lighting control network via a 2-wire, non polarized data line. Each switch shall be capable of raising or lowering light levels of individual or groups of lighting fixtures.
- .14 Switches shall include integral LED indication for light levels as well as a switch for ON/OFF control.

2.6 OCCUPANCY DETECTION

- .1 Where required, provide a PIR occupancy sensor. The occupancy sensor shall be connected via the 2 wire data line and can signal either an individual relay or a group of relays. No additional connections are required for power.
- .2 Occupancy sensor to include the following features:
 - .1 Adjustable time out (30 sec to 30 min) and sensitivity
 - .2 Tilt & swivel lens direction adjustment
 - .3 Coverage of 1600 sq. ft., Indoor ceiling mount, ceiling heights 8' to 16'max
 - .4 Off only configuration
- .3 The occupancy sensor can be adjusted by direct connection or via the Lighting Control Unit. It shall be possible to adjust time-out and other technology options of the sensor via time schedules in the controller.
- .4 The LCU shall log when the sensor senses occupancy so this information is available for HVAC systems via the BacNet gateway in the Controller.
- .5 When occupancy sensors by other manufacturers are required. Each unit shall provide or DC to power each sensor and will accept a contact closure from each sensor which can be assigned to any relay or group. Check with factory to ensure compatibility.
- .6 Sensors connected to input unit to include the following features adjustable via system:
 - .1 Adjustable time out (3 min to 30 min)
 - .2 Function select - on/off switching, off-only switching.
 - .3 Multiple sensors may work together using direct connection to sensors.

2.7 PHOTO SENSOR & DAYLIGHT CONTROLS

- .1 Provide where required a light sensor capable of sensing from 1 to 60,000 lux for direct light measurement or 1 to 6000 lux for indirect light measurement. The sensor shall derive both its power and data information from the Dialog data line. The sensor shall be available in both indoor and outdoor versions.
- .2 The ambient light level shall be continuously monitored in lux by the sensor. The sensor shall broadcast to the network the existing light level when requested or when there is a change in detected light level.

- .3 Set point adjustments can be made via the touch screen or web server interface in the Network Controller.
- .4 Each sensor can be programmed to provide ON/OFF control of relays, raise/lower of 0-10vdc type.
- .5 One sensor shall permit different outputs to switch and/or control light levels as ambient light changes. Light levels shall be controlled by 'sensor only' or in combination with a time schedule.
- .6 It shall be possible to set a maximum light level which cannot be exceeded during daylight harvesting operations or for non daylight controlled areas, a permanent or "tuned" light level to maximize energy savings.

2.8 HANDHELD PROGRAMMER

- .1 Provide a Handheld Programmer to facilitate the following functions:
 - .1 Set switch type and address
 - .2 Create presets
 - .3 Calibrate photo sensors and set addresses and light levels
 - .4 Set addresses of motion sensors

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 datasheet.

3.2 INSTALLATION

- .1 Relay panels and conduit.
 - .1 Ensure that conduit for line voltage wires enters panel in line voltage areas and conduit for low voltage control wires enters panel on low voltage areas. Check manufacturer's drawings for location of line and low voltage areas.
- .2 Daylight Sensors
 - .1 Locate daylight sensors as per manufacturer's recommendations for closed loop and open loop applications. Ensure there is no artificial light shining directly into the sensor head.
 - .2 Adhere to manufacturer's recommendations for wiring and programming.
- .3 Occupancy Sensors
 - .1 Locate sensors so there are no objects blocking the infra red sensor from viewing all of the coverage area. Keep away from HVAC vents and direct light from light fixtures.
 - .2 Adhere to manufacturer's recommendations for location, wiring and programming.
- .4 Low Voltage Wiring
 - .1 For low voltage wiring, provide wire type as recommended by the manufacturer.

- .2 Adhere to recommendations as to maximum wire length and quantity of relays per switch.
- .5 Line Voltage Wiring
 - .1 Use wire gauges #12AWG as appropriately sized for the branch circuit.

END OF SECTION

Part 1 GENERAL

1.1 SCOPE

- .1 This specification describes the electrical, mechanical, environmental, agency and reliability requirements for three phase, adjustable frequency drives as specified herein and as shown on the contract drawings.
- .2 This Specification shall apply to the materials, design, fabrication, inspection, and testing of 208V Variable Frequency Drives (VFD)

1.2 REFERENCES

- .1 VFD's shall be manufactured and certified in accordance with the latest editions of the following regulations, codes, standards and specifications. In all cases where more than one regulation, code, standard or specification applies to the same conditions, the most stringent one shall apply. Conflicts among any of the provisions of these listed codes, standards or specifications shall be referred to the Purchaser for resolution.
- .2 NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements--Rating Specifications for Low Voltage Adjustable Frequency A.C. Power Drive Systems
- .3 IEEE 519-1992: Guide for harmonic content and control.
- .4 Underwriters Laboratories - UL508C: Power Conversion Equipment.

Part 2 PRODUCTS

- .1 The VFD shall convert the input AC power to an adjustable frequency and voltage.
- .2 The VFD shall have no integral disconnect. VFD will be supplied from a Distribution panel circuit breaker or fused disconnect.
- .3 The VFD shall be rated for supplying a commercial HVAC duty load. The load characteristics of the application are:
 - .1 Variable torque (e.g. fans).
 - .2 Operating speed range from 180RPM to Normal Motor RPM.
 - .3 Operating Conditions:
 - .1 Drive to operate within nominal AC voltage of 208 Volts +/- 15%, three-phase, 60 Hertz.
 - .2 Operating ambient a temperature range: 0 to 40C with relative humidity up to 95% (non condensing).
 - .3 Altitude: 0 - 1000 m above sea level.
 - .4 AC Variable Speed Drive Systems:
 - .1 Adjustable frequency AC variable speed drives to convert 208V +/- 15%, 3 phase, 60 Hertz utility input power to an adjustable AC frequency and voltage for controlling variable torque through speed range of AC squirrel cage fan motors as specified herein. Converters to be voltage source design with a pulse width modulated (PM) type inverter section utilizing insulated gate bipolar transistors (IGBT). The use of input/output transformers is not acceptable.

- .2 Drive controllers to be rated for 110% continuous of rated motor current and have capacity to provide speed control of motors throughout speed range specified.
 - .3 Controllers include power conversion components, power control logic devices and regulator circuitry. Regulators to incorporate microprocessor technology for control of power semiconductors.
 - .4 To be capable of running without motor load for set-up and testing.
 - .5 To be capable of accepting the opening of a remote motor disconnect while running without causing damage to the drive.
 - .6 To provide auto restart after power outage (provided run enable is maintained).
 - .7 To provide 3 frequency reject points to prevent the motor from operating at a resonant speed. Both the centre frequency and the band width to be adjustable.
 - .8 To provide automatic restart (with manual override) after an inverter fault trip. The drive to attempt to restart automatically 3 times with lock-out after the third unsuccessful attempt.
 - .9 To be capable of operating a non-continuous load at constant speed (ex. Fan).
-
- .4 To provide a rotating motor restart feature. This feature will allow a motor, which has been shut down or has fault tripped but is still rotating, to be restarted without first stopping the motor. The VSD to restart the motor at the speed at which it is rotating and then accelerate to the speed called for by the speed reference signal. Sellers shall provide as part of their quote, typical harmonic content for 6 – pulse units at 100% load.
 - .5 The VFD shall be a Toshiba AS1 or approved in accordance with B7.
 - .6 The VFD shall have a suitable interrupting rating to meet the minimum short circuit current ratings.
 - .7 The VFD shall be compatible with the current protocol for the City's web-based DDC system.

2.2 ENCLOSURE

- .1 VFD, line reactor, dv/dt filter, and all accessories shall be fully assembled in a single enclosure rated NEMA 12, rubber seal gasket and shall have complete front accessibility with easily removable assemblies.
- .2 Heat sinks for VFDs to be mounted externally to enclosures where required, or increase size of enclosure to suit enclosure fans and filters for temperature control and heat dissipation requirements.
- .3 Lamacoid nameplates, which shall be permanently attached with screws, shall be provided for each enclosure.
- .4 VFD enclosure shall have appropriate labels including shock hazard, arc flash and caution label indicating "Caution multiple control power sources"
- .5 Nameplates shall provide the equipment tag number and the service description.

Part 3 RATINGS

- .1 +/-1% frequency regulation.
- .2 +/-1% voltage regulation.
- .3 0 to 66 Hertz operating frequency range.
- .4 Active current limit function, adjustable 0 to 100% of controller rating.
- .5 Minimum efficiency at maximum load and speed of 98%.
- .6 Minimum efficiency at 50% speed and load of 90%.
- .7 Minimum incoming line displacement power factor of 0.98 at all speeds.
- .8 The VFD shall have a three (3) second overload current rating of 150%. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque drives. Rating of the drive shall permit full rated use of the motor 1.15 service factor.
- .9 The VFD shall be capable of operating any inverter duty, NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
- .10 The VFD shall be provided with a 3% nominal impedance line reactor and dv/dt load filter where indicated. dv/dt Filter on the output of the drive shall limit peak over-voltages at the motor to 15% of nominal.
- .11 To be capable of operating a non-continuous load at constant speed (ex. Fan).

3.2 PROTECTION

- .1 The Power Converter shall be protected against short circuits between output phases and output phases and ground. The VFD shall safely shut down without damaging any power circuit devices. Fault protection shall be based on a short circuit capacity as indicated on the single line diagram.
- .2 For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide up to 10 programmable restart attempts with Lockout after the last attempt. The programmable time delay before restart attempts will range from 1 to 60 seconds. This feature can be defeated if not required.
- .3 The VFD shall be capable of running without a motor connected for setup, configuration and testing.
- .4 The deceleration mode of the VFD shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, emergency stop and DC injection braking.
- .5 Upon a loss of the analog reference signal, the VFD shall operate at a user defined frequency.
- .6 The VFD shall have solid state overload protection providing Class 20. The minimum adjustment range shall be from 25 to 110% of the current output of the VFD.
- .7 The VFD shall have an internal over-temperature protection.

3.3 AJUSTMENTS AND CONFIGURATIONS

- .1 All adjustments to be programmable from the front panel of the VFD. Potentiometer or dip switch adjustments are not acceptable.
- .2 All drive parameter settings shall be entered in the drive prior to shipment.
- .3 The acceleration and deceleration ramp times shall be adjustable from 0.1 to 3000 seconds.
- .4 The memory shall retain and record run status, operating time, fault type of the past 10 faults.
- .5 As a minimum, the following parameters shall be accessible:
 - .1 Start command from keypad, remote or communications port
 - .2 Frequency command from keypad, remote or communications port
 - .3 Motor direction selection
 - .4 Maximum and minimum frequency limits
 - .5 Acceleration and deceleration times, two settable ranges
 - .6 Torque limit
 - .7 Multiple attempt restart function
 - .8 Multiple preset frequency adjustment
 - .9 Programmable analog output
 - .10 Proportional/Integral process controller

3.4 INTERFACE

- .1 The operator interface terminal shall have an alphanumeric display with indicators for frequency controller status (Run, direction, ready stop, alarm, fault) and indicators for control (I/O terminal, keypad, bus/communication). The interface shall be front panel mounted, removable and complete with an access port for computer programming.
- .2 The operator interface terminal shall allow the modification of VFD adjustments via a keypad. All electrical values, configuration parameters, application and activity function access, faults, local control, adjustment storage shall be in plain English.
- .3 The display will be a high resolution, LCD screen capable of displaying a minimum of two lines of alphanumeric characters. The use of coded or abbreviated displays shall not be acceptable.
- .4 The following monitoring values shall be accessible and available when in the operating mode:
 - .1 Frequency (Hz) and/or motor frequency (RPM)
 - .2 Motor current (A), motor voltage (V), motor torque (%), motor power (%)
 - .3 Drive temperature (C)
 - .4 Motor temperature (C) (When applicable)
 - .5 Values or status of analog I/O, digital I/O
- .5 The following control functions shall be available on the keypad:
 - .1 Start

- .2 Stop
- .3 Select
- .4 Reset
- .5 Direction control
- .6 A reset key will allow a parameter to return the existing value if adjustment is not required and the value is displayed.
- .7 The VFD shall have pilot light indicators (LED) with red/green colours indicating run/stop status respectively.
- .8 The VFD shall have an Ethernet interface for remote interrogation by others. Seller shall indicate all drive parameters that are accessible from this interface.
- .9 Control Systems - Analog and Digital I/O
- .10 The VFD shall have a minimum of one (1) analog input and one (1) analog output. The analog I/O shall be compatible with isolated 0-10VDC and isolated 4–20 mA analog signals.
- .11 The VFD shall have a minimum of 2 digital 120 VAC outputs (dry contact) and shall be used to indicate:
 - .1 Fault (O/P)
 - .2 Run (O/P)
- .12 The VFD shall be compatible with the current protocol for the City's web-based DDC system.

Part 4 TESTING

- .1 Factory Testing
- .2 The manufacturer's standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of CSA and NEMA standards. Results from the tests shall be provided

Part 5 HANDLING

- .1 The equipment shall be handled, stored and shipped in accordance with manufacturer's instructions.
- .2 One copy of assembly drawings and operating instructions shall accompany the shipment.

Part 6 EQUIPMENT GUARANTEE AND PERFORMANCE WARRANTY

- .1 Equipment shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheet.

- .2 Equipment shall be free from defects in design, workmanship and material as per the terms and conditions of the request for quotation, purchase order or contract. Unless specified otherwise, the warranty period shall be a minimum of 12 months from energization by Purchaser or 18 months from receipt, whichever comes first.

Part 7 SUBMITTAL REQUIREMENTS

- .1 Documentation submittal shall be in accordance section B7.
- .2 The following information shall be submitted to Contract Administrator for approval:
 - .1 Drive parameter settings
 - .2 Master Drawing Index
 - .3 Front view elevation
 - .4 Floor plan
 - .5 Top view
 - .6 Unit control schematics and wiring diagrams
 - .7 Nameplate schedule
 - .8 Cable entry/exit locations
 - .9 Assembly ratings, including short circuit, voltage, and continuous current ratings
 - .10 Major component ratings
 - .11 Minimum clearances to other equipment.
 - .12 Frequency spectrum for harmonic currents at line side of filter (where provided) at 50% and 100% of rated load.
- .3 The following information shall be submitted to the Contract Administrator for record purposes:
 - .1 Certified production test reports
 - .2 Installation information

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.29-M1989(R2000), panelboards and enclosed panelboards.

1.4 SHOP DRAWINGS

- .1 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 250V panelboards: bus and breakers rated for 42 kA (symmetrical) interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains and 200% neutral where indicated.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.
- .10 Doors to be hinged with captive bolts and lockable.
- .11 Enclosures shall be sprinkler proof.

□

2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

- .1 Double stack panels as indicated.
- .2 Contactors in mains as indicated.
- .3 Feed through lugs as indicated.
- .4 Isolated ground bus.

2.3 BREAKERS

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 to 30A breakers installed as indicated. Turn over unused lock-on devices.

2.4 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard. Plywood backboards to be painted to match existing.
- .3 Mount panelboards to height specified in Section 26 05 01 - Common Work Results - Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 The Munsell System of Colour Notation.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 – Common Work Results – Electrical.

Part 2 Products

2.1 MATERIALS

- .1 Sprinkler proof enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish, Munsell Notation 7.5GY3.5/1.5, size as indicated.
- .2 Entire enclosure capable of withstanding maximum impact force of 86 MN/m² area without rupture of material.
- .3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .4 Enclosure equipped with hot dipped galvanized mounting rails 1 m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.
 - .1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
 - .2 Holes in side panel flanges in 60 mm increments for vertical adjustment.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: minimum 1 m wide, hinged, 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, vermin.
- .8 Door interlocks: as required.
- .9 Enclosure construction such as to allow any configuration of single or ganged enclosures.
- .10 Enclosure capable of being shipped in knocked-down condition.

Part 3 Execution

3.1 INSTALLATION

- .1 Assemble enclosure in accordance with manufacturer's instructions and mount on concrete pad.
- .2 Mount equipment in enclosure.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Equipment and installation for ground fault circuit interrupters (GFCI).

1.2 RELATED SECTIONS

- .1 Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 26 05 01 - Common Work Results - Electrical.

1.3 PAYMENT PROCEDURES

- .1 Payment for field testing of ground fault equipment performed by Contractor in accordance with Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

1.4 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.144-M91(R2001), Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PG 2.2-1999, Application Guide for Ground Fault Protection Devices for Equipment.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and shop drawings.
- .3 Submit test report for field testing of ground fault equipment to Contract Administrator and a certificate that system as installed meets criteria specified herein.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144.
- .2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single and Two pole ground fault circuit interrupter for 15 and 20 A, 120 V, 1 and 2 phase circuit c/w test and reset facilities.

2.3 GROUND FAULT PROTECTOR UNIT

- .1 Self-contained with 15 A, 120 V circuit interrupter and duplex receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.
 - .3 CSA Enclosure 1, flush mounted with stainless steel face plate.

Part 3 Execution

3.1 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Pass phase conductors including neutral through zero sequence transformers.
- .3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and co-ordinate with Section 01 45 00 - Quality Control if required.
- .2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.
- .3 Demonstrate simulated ground fault tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 24 17 – Panelboards.

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 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 25 kA symmetrical (rms) and over at system voltage.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .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 25kA symmetrical rms interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS

- .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 SOLID STATE TRIP BREAKERS [DESIGN D]

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time and instantaneous tripping for phase and ground fault short circuit protection.

2.4 OPTIONAL FEATURES

- .1 Include:
 - .1 Shunt trip.

- .2 Auxiliary switch.
- .3 On-off locking device.
- .4 Handle mechanism.

2.5 ENCLOSURE

- .1 Sprinklerproof.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated on drawings.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
 - .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 26 05 01 – Common Work Results – Electrical.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 sized as per drawings.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Sprinkler-proof indoors, weatherproof outdoors.
- .5 Quick-make, quick-break action.
- .6 ON-OFF switch position indication on switch enclosure cover.
- .7 Where required (For VFDs) provide an auxilliary contact to break prior to main contacts and interlock with the VFD emergency stop.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 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.
- .2 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-1990, Part 4: Contactors and motor-starters.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .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 of starter.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

- .1 Starters: to NEMA ICS 2-2000.

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 Three overload heater's, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 pushbutton: heavy duty oil tight labelled as indicated.
 - .2 Indicating light: heavy duty oil tight type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control disconnect circuit breaker, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Selector switches: heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 VARIABLE FREQUENCY DRIVE STARTERS

- .1 VFD starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Heavy Duty Industrial drives with all required accessories and line and load filters. Drive manufacturers as specified or approved equivalent.
 - .2 Drives shall be ABB, Toshiba, Cutler Hammer, or Allen Bradley.

2.5 CONTROL TRANSFORMER

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

- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 FINISHES

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

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 3 engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and manufacturer's instructions.
- .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, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C82.1-97, Electric Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
 - .2 ANSI C82.4-92, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-1991, Surge Voltages in Low-Voltage AC Power Circuits.
- .3 American Society for Testing and Materials (ASTM)
 - .1 ASTM F1137-88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 United States of America, Federal Communications Commission (FCC)
 - .1 FCC (CFR47) EM and RF Interference Suppression.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by the Contract Administrator.
- .3 Photometric data to include: VCP Table and spacing criterion.

Part 2 Products

2.1 LAMPS

- .1 Fluorescent lamps.
 - .1 As indicated on the luminaire schedule.
 - .2 3 year warranty
 - .3 80+ CRI
- .2 LED Lamps
 - .1 As indicated on the luminaire schedule.
 - .2 3 year warranty
- .3 Spares:
 - .1 One case (24 lamps), of each type of 4' T5 lamps and 4' T5HO lamps. These lamps to be shipped to East Elmwood Community Centre at **end of project** with copy of shipping transmittal.

2.2 BALLASTS

- .1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic and IC electronic dimmable.
 - .1 Rating: 120V, 60 Hz, for use with lamps as indicated.
 - .2 RFI/EMI suppression circuit to: FCC (CFR47) Part 18, sub-part C, Class A and Part 15, sub-part B, Class B.
 - .3 Totally encased and designed for 40 C ambient temperature.
 - .4 Power factor: minimum 95 % with 95% of rated lamp lumens.
 - .5 Crest factor: 1.5 maximum current, 2.0 maximum voltage.
 - .6 Capacitor: thermally protected.
 - .7 Harmonics: 10 % maximum THD, including 49th for electronic discrete and hybrid ballasts.
 - .8 Operating frequency of electronic ballast: 21 khz minimum.
 - .9 Total Circuit Power: 62 Watts (for two 28W T5 Lamps).
 - .10 Ballast Factor: greater than 0.90.
 - .11 Sound rated: Class A.
 - .12 Mounting: integral with luminaire.
 - .13 5 year warranty.
 - .14 Manitoba PowerSmart Approved programmable start electronic ballasts. Apply for rebates. The City is to receive rebates.
- .2 Spares:
 - .1 Two ballasts of each type i.e. single, two & three ballasts and for each system i.e. T5.

2.3 FINISHES

- .1 Baked enamel finish:
 - .1 Conditioning of metal before painting:
 - .1 For corrosion resistance conversion coating to ASTM F1137.
 - .2 For paint base, conversion coating to ASTM F1137.
 - .2 Metal surfaces of luminaire housing and reflectors finished with high gloss alzak aluminum to give smooth, uniform appearance, free from pinholes or defects.
 - .3 Reflector and other inside surfaces finished as follows:
 - .1 White, minimum reflection factor 85%.
 - .2 Colour fastness: yellowness factor not above 0.02 and after 250 hours exposure in Atlas fade-ometer not to exceed 0.05.
 - .3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025 mm.
 - .4 Gloss not less than 80 units as measured with Gardner 60E gloss meter.
 - .5 Flexibility: withstand bending over 12 mm mandrel without showing signs of cracking or flaking under 10 times magnification.
 - .6 Adhesion: 24 mm square lattice made of 3 mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.
- .2 Alzak finish:

- .1 Aluminium sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:
 - .1 Finish for mild commercial service, minimum density of coating 7.8 g/m², minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.

2.4 LIGHT CONTROL DEVICES

- .1 Design.
 - .1 As per design basis material specified.

2.5 LUMINAIRES

- .1 As per design basis material specified.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.

3.2 WIRING

- .1 Connect luminaires to lighting circuits.

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires independently of ceiling.
- .2 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors (Nylon shields not acceptable) or as recommended by Anchor Construction Industrial Building Products Ltd for the specific surface & equipment being installed.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 If there is potential of Asbestos Electrical Subcontractor must use a proper collection boot and HEPA vacuum whenever drilling of holes in facility.

3.4 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for emergency lighting systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 21 - Wires and Cables (0-1000 V).
- .3 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-M1985(R1999), Unit Equipment for Emergency Lighting.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

1.5 WARRANTY

- .1 For batteries, the 12 months warranty period prescribed in subsection GC32.1 of General Conditions "C" is extended to 120 months, with no-charge replacement during the first 5 years and pro-rate charge on the second 5 years.

1.6 LABELLING

- .1 Label battery units and remote heads as per Lord Selkirk School Division Standards (LSSD).
- .2 These tags are to be 1.5" X 3" in size and are to be Black and White. Mount on face of battery unit where it is visible. Tags to contain: Emergency Battery Bank number (Confirm with LSSD for numbering), Model number of battery unit, AC circuits monitored by voltage relays, date of installation, 4 letter school designation, room battery installed in, and unit number in school.
- .3 Label each of the remote lighting fixture with a sticker label, using "Brady" Globemark tape, indicating which battery bank it is fed from & fused DC circuit it is connected to on the unit. Install tape on canopy of fixture.

Part 2 Products

2.1 EQUIPMENT

- .1 Battery Unit
 - .1 Emergency lighting equipment: to CSA C22.2 No.141.
 - .2 Supply voltage: 120 VAC.
 - .3 Output voltage: 12 VDC.

- .4 Operating time: 30 min.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations, reverse polarity protected, modular construction.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Automatic Self Testing Feature that test once a month, every 6 months and 12 months c/w visual and audible alarm and should indicate the following at a minimum:
 - .1 Battery Failure
 - .2 Battery Disconnect
 - .3 Charger Failure
 - .4 Lamp Failure
 - .5 Service Alarm
 - .6 AC on
 - .7 Charger on
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: White.
- .13 Options required:
 - .1 Shelf
 - .2 Ammeter and Voltmeter
 - .3 Line cord & plug
 - .4 A.C. / D.C. Terminal block capable of accepting #10 AWG Cu. Wire
 - .5 Six (10) AC circuit voltage sensing relays internal to battery
 - .6 Six (6) circuit DC fused panel Electronic lockout & brownout circuits
 - .7 Sealed dust-proof transfer relay, test switch and LED indicators
 - .8 RFI suppressors.
- .2 Remote Lamp Heads
 - .1 Impact Resistant
 - .2 Flame retardant
 - .3 Injection molded thermoplastic
 - .4 Adjustable mounting
 - .5 345 degrees horizontal and 180 degrees vertical adjustment
 - .6 Double heads
 - .7 Canopy shall be provided to fit a 4" octagon box
 - .8 White color
 - .9 Provide wire guards in the Gymnasium
 - .10 Polycarbonate lens and tamperproof screws for washrooms

2.2 WIRING OF REMOTE HEADS

- .1 Conduit: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: in accordance with Section 26 05 21 - Wires and Cables 0-1000 V, sized in accordance with manufacturer's recommendations to minimize voltage drop.

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads.
- .3 Connect exit lights to unit equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Code for Preferred Packaging
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No.141- M1985 (R1992), Unit Equipment for Emergency Lighting.
 - .2 CSA C860- 96, Performance of Internally-Lighted Exit Signs.
- .3 National Fire Protection Association (NFPA) requirements

1.2 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittals.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00 - Submittals. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Submit product data sheets for exit lights. Include product characteristics, performance criteria, physical size, limitations and finish.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures.

Part 2 Products

2.1 STANDARD UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.
- .2 Housing: extruded aluminum housing, brush aluminum finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: two - LED- over 500,000 hours.
- .5 Operation: designed for over 100,000 hours of continuous operation without relamping.
- .6 Face plate to remain captive for relamping.
- .7 Exit signs to have green background with white running man symbol.
- .8 Universal Mount.

Part 3 Execution

3.1 INSTALLATION

- .1 Install exit lights.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.

- .4 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION