Part 1 General

1.1 SCOPE OF WORK

.1 All drawings and all sections of the specifications shall apply to and form an integral part of this section.

.2 All electrical systems shall be fully tested and operational in accordance with applicable codes and bylaws.

.3 Provide all labour and materials necessary for complete and operating systems as indicated on the drawings and specified herein. Any work and material, even if not shown or specified, which is obviously necessary or reasonably implied to complete the work shall be provided as if it was both shown and specified.

.4 All materials, tools, appliances, scaffolding, apparatus and labour necessary for the execution, erection and completion of specified systems shall be furnished.

.5 Contractor shall comply with all Department of Labour, Workplace and Health requirements at all times.

.6 All Contractors shall have a valid Contractors license to operate in the City of Winnipeg.

.7 Electrical Subcontractor shall maintain the appropriate ratio of Journeymen Electricians & Apprentices required by Provincial Codes. Only qualified workmen shall be employed on this contract. Supervision shall be by Journeymen Electricians and work carried out by Journeymen and/or registered apprentices only.

1.2 INSTALLATION RESPONSIBILITY

.1 The Contractor shall complete all electrical connections to equipment and accessories pertaining to this Contract and leave all in satisfactory condition.

.2 The Contractor shall ascertain and obtain information from all other sub-trades as to the extent and details of any additional electrical work to complete all systems served with electrical power or controlled electrically and, where necessary, allow in his tender for such work. No extra claim will be accepted for work on such systems whether they are; as specified in architectural, structural, landscape or mechanical plans and specifications; or proposed and accepted as alternate systems.

.3 Control system wiring may be performed by a Controls Subcontractor; all line voltage control wiring is this Electrical Subcontractor's responsibility. Contractor shall work in close cooperation with the Controls Subontractor and shall allow for any part of controls work in base tender. Refer to Mechanical Specification.

.4 Any electrical and communication work carried out on behalf of, or by other contractors shall be in accordance with the Canadian Electrical Code and applicable clauses of this specification.

.5 It shall be the Contractor's responsibility to ensure that all trade contractors and suppliers of electrical equipment observe the applicable clauses of the electrical specifications.

.6 In case of differences between trade contractors regarding extent of work responsibilities, such matters shall be referred to the Contract Administrator through the Contractor. Should any discrepancy between the specification and drawings leave the Contractor in doubt as to the true intent and meaning, a ruling shall be obtained from the Contract Administrator before the tender is submitted. If this is not done it will be the contractor's responsibility to ensure that the more expensive alternate has been included.

.7 Before tendering, the Contractor shall visit the site and report to the Contract Administrator any condition which may prevent him from performing his contract as specified. No extra will be allowed if this procedure is not followed.

.8 Contractor shall make a reasonable allowance in his tender for rerouting or making good any conduit or equipment exposed or rendered useless during the course of demolition or construction.

.9 The drawings show approximate locations of outlets and apparatus. This right is reserved to make changes in location as may be necessary to center lights or meet the exigencies of construction in any way. No extra will be allowed for such changes unless the distance moved exceeds 3000mm.

.10 Should any work or material be needed which is not specified or shown on the drawings and is nevertheless necessary for properly carrying out the obvious intent, such work or materials shall be provided without additional cost.

.11 Contractor shall complete installation in accordance with CSA C22.1 except where specified otherwise.

.12 Contractor shall complete overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

1.3 DEFINITIONS

.1 The following are definitions of terms and expressions used in the specification:

INSPECTION AUTHORITY – means agent of any authority having jurisdiction over construction standards associated with any part of electrical work on site.

SUPPLY AUTHORITY – means electrical power utility company responsible for delivery of electrical power to project (Manitoba Hydro).

ELECTRICAL CODE – means Canadian Electrical Code or Local Code in force at Project location.

INDICATE – means as shown on contract drawings or noted in Contract Documents.

TYPE TESTED – means that each piece of equipment produced by manufacturer is not fully tested. An original piece with similar arrangement has been fully tested and results of that test are available.

PROVIDE – means to supply, install and leave in working order all materials and necessary wiring, supports, access panels, etc., as necessary for equipment indicated.

CONCEALED – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions;

EXPOSED – means work normally visible, including work in equipment rooms, tunnels, and similar spaces;

FINISHED – means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished;

INSTALL (and tenses of "install") – means secure in position, connect complete, test, adjust and verify;

SUPPLY – means to procure, arrange for delivery to site, distribute to floors, inspect, accept delivery and administer supply of manufacturer's products and/or systems, and includes manufacturer's supply of any special cables, standard on site testing, initial start-up, programming, basic commissioning, warranties and assistance to Contractor;

DELETE or **REMOVE** (and tenses of "delete" or "remove") – means to disconnect, make safe, remove including any back box and exposed conduits, patch and repair/finish surfaces to match adjoining similar construction, include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Contract Administrator;

BAS – means building automation system; "BMS" – means building management system, "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same;

ELECTRICAL DIVISIONS – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and /or on drawings is responsibility of Electrical Contractor, unless otherwise noted;

MECHANICAL DIVISIONS – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and /or on drawings is responsibility of Mechanical Contractor, unless otherwise noted;

1.4 DESIGN REQUIREMENTS

.1 All electrical design drawings, details and specifications are diagrammatic, and unless specifically noted by figured dimensions, indicate the general arrangement of receptacles, light fixtures, switches, risers, panels, etc. Any information involving accurate dimensions, shall be obtained from detailed dimensioned drawings or by actual measurements at the building. If doubt exists as to the final location, the Contractor shall contact the Architect or Contract Administrator for clarification prior to installation. The location of switches, receptacles, outlets, etc., shall be coordinated with built-in units, Contract Administrator appliances and equipment, mechanical equipment, etc., as shown on the architectural and mechanical drawings and/or as existing.

.2 Where space is indicated for future equipment, leave such space clear and install feeders and equipment pertaining to this contract in such a way that future equipment can be easily installed.

.3 Contractor shall coordinate locations of lighting fixtures with sprinklers, mechanical ducts, diffusers, beams and other architectural, structural and mechanical items. Any relocation required shall be performed at no cost to the Contract Administrator.

.4 Operating voltages: to CAN3-C235.

.5 Language operating requirements: provide identification nameplates and labels for control items in English.

1.5 PLANS

.1 The Contractor shall familiarize them self with the plans which show the approximate locations of outlets and apparatus. The right is reserved to make such changes in location as may be necessary to meet contingencies of construction. No extras will be allowed for such changes to any piece of electrical equipment, outlets, etc., unless the distance exceeds 3000mm.

.2 Should a discrepancy appear between plans, specifications, or the actual conditions encountered on the site, which leaves the Contractor in doubt as to the true intention and meaning of the plans and specifications, a ruling shall be obtained in writing from the Contract Administrator which will be final.

.3 Do not use Contract Drawing measurements for prefabrication and layout of raceways, conduits, ducts, bus ducts, luminaires, and other such work. Locations and routing are to be generally in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Contract Administrator prior to proceeding with work.

.4 Prepare plan and interference drawings of work for submittal to Contractor, who will then arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with Contractor's plan drawings so that trades may make use of section drawings. Section drawings indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Contract Administrator, engineering drawings for this use. Prints and/or disks of Contractors' interference drawings are to be distributed among other Trade Contractors and Contractor. Submit interference drawings to Contract Administrator for review.

.5 Where drawings indicate that acoustic tile ceiling is being suspended below existing plaster ceiling, coordinate with General Trades Contractor design of framework used to support suspended ceiling, lighting, diffusers, and other Electrical Divisions components that are mounted within or through ceiling. Do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.

1.6 CONFLICT OF TRADES

.1 Contractor shall coordinate with all other sub-trades involved to confirm the locations of the various outlets and equipment and shall cooperate fully to ensure that no conflict arises during the installation. In case of any difference of opinion, the matter shall be referred to the Contract Administrator for final decision.

.2 Unless otherwise directed by Contract Administrator, Mechanical Contractor is to determine final locations of major work within ceiling spaces.

1.7 COORDINATION WITH OTHER TRADES

.1 Contractor is responsible for coordinating with other divisions specifications for possible restrictions on usage and placement of electrical equipment, i.e. conduits in slab, panels in walls, etc.

1.8 PERMITS

.1 Prior to commencement of work, Contractor shall obtain all electrical permits with City of Winnipeg required for this Contract and shall pay all fees required for such permits and arranged for inspections. Contractor shall pay all costs related to changes required by interpretation by all governing authorities.

1.9 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 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.

1.10 SAFETY PRECAUTIONS

.1 The Contractor shall strictly adhere to all safety rules and regulations pertaining to electrical servicing of all sub-trades during construction. All safety precautions as outlined in General Conditions shall be observed.

1.11 WORKMANSHIP

.1 The complete installation shall be carried out in a neat and workmanlike manner to the satisfaction of the Contract Administrator.

.2 Only qualified workmen shall be employed on this contract. Supervision shall be by Journeymen Electricians and work carried out by Journeymen and/or registered apprentices only.

1.12 SUBMITTALS

.1 In addition to the requirement set out below, the Contractor shall review and thoroughly understand the requirements for submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 The Contractor shall take the necessary steps to insure that shop drawings for equipment with long lead-in or delivery time are expedited for review and approval so as to avoid impacting the construction schedule. The Contract Administrator shall take such reasonable steps to insure the review process for these items is performed promptly. The Contract Administrator agrees to make time available to meet with suppliers and the Contractor to expedite the shop drawing process.

.3 Prior to manufacturing any item required for this project, the Contractor shall submit detailed shop drawings of the item.

.4 Contractor shall allow a minimum of ten (10) working days for shop drawing review by the Contract Administrator and time shall be incorporated in construction schedule so no delays occur due to late submission of shop drawings. Facsimile transmission of shop drawings will **NOT BE ACCEPTED**. Late submissions of shop drawings will be sufficient reason for stoppage of construction pending review, or removal and replacement of any unsatisfactory item at the Contractor's expense.

.5 The Contractors shall review the shop drawings before they are submitted to the Contract Administrator. The shop drawings shall be marked to show when this review was done. This review shall determine if the items are as specified or previously approved. Each shop drawing shall clearly indicate which model number or part number is being offered, wiring diagrams, installation details of equipment, and all components, accessories or options. The shop drawings will be returned to the Contract Administrator with this Contract Administrator’s review stamp and/or appropriate comments.

.6 Any shop drawing stamped “revised & resubmit” shall be corrected and resubmitted so as not to delay construction.

.7 Any item rejected must have new shop drawings reviewed and submitted before being manufactured. Any item installed without having shop drawings reviewed may be rejected and may have to be replaced with no cost to Contract Administrator.

.8 Corrections or comments made on the shop drawings by the Contract Administrator during this review do not relieve Contractor from compliance with requirements of the drawings and specifications. This review is only for the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his or her work with that of all other trades and performing all work in a safe and satisfactory manner.

.9 Shop drawings shall be provided for all system components.

.10 Approved shop drawings, subject to meeting specifications, shall be included in the Operation and Maintenance Manuals specified elsewhere. Only shop drawings stamped “Reviewed” or

"Furnish as Corrected" by the Contract Administrator are acceptable for inclusion in these manuals.

.11 The Contractor shall ensure that shop drawings for electrical equipment supplied and installed by any and all trades are reviewed by the Contract Administrator.

.12 Submit for review single line electrical diagrams under plexiglass and locate at the main service, mechanical penthouse and all remote electrical rooms. Minimum of 3 locations; one in the basement electrical room, one in the mechanical mezzanine (room 200) and one in the main floor electrical room (room 127).

.13 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass at the fire alarm control panel and annunciator. Minimum of 2 locations; one in the basement electrical room, and one in the main floor electrical room (room 127).

.14 . Basement electrical room and main floor electrical room.

1.13 SUBSTITUTIONS

.1 Unless otherwise noted on the plans or specifications, substitutions may be allowed by the Contract Administrator, when requested by the Contractor or by equipment suppliers, for items specified by manufacturer and catalogue number.

.2 Request for substitutions must be done in accordance with B7.

.3 Descriptive catalogue sheets accompanying the approval application which may show several items of varying specifications shall be conspicuously marked in such a manner that the offered substitute item may easily be recognized for comparison.

.4 Proposed substitutions must be at least of equal quality to that of the specified item. The manufacturer's specification of the item shall apply for comparison if no other clause of this specification applies. The decision of the Contract Administrator to accept or reject will be final.

.5 Off-the-shelf items which are specified by description only, without any manufacturer, model type or catalogue number, do not require approval prior to the tender date. However, Contractor shall submit to the Contract Administrator a request for review of such items prior to their use, in sufficient time to permit rejection if unsatisfactory.

.6 All additional expenses incurred as a result of substitution will be the direct responsibility of the Contractor.

1.14 EQUIPMENT LOADS

.1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Contract Administrator, via shop drawing submissions, prior to construction.

.2 When choice of specific equipment is made by Contractor, actual weight, location and method of support of equipment may differ from those initially given to Contract

Administrator and thus from those assumed for design. Consequently, it is necessary to back-check equipment loads, location, and supports.

.3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with Contract Administrator prior to construction.

1.15 EQUIPMENT SUPPLIED BY CONTRACT ADMINISTRATOR

.1 On date of delivery, the Contractor shall sign for all items which are being supplied by the Contract Administrator and will be responsible for any loss or damage thereafter until the work is completed and accepted by the Contract Administrator. Sign delivery slips "Subject to Inspection". Keep all delivery slips.

.2 Items supplied and delivered to the site by the Contract Administrator shall be examined by the Contractor, and any damage shall be reported immediately to the Contract Administrator who will enter a claim directly to the supplier and transportation company.

.3 Belated damage claims on any equipment shall not be regarded as transport damage and will become the responsibility of the Contractor for repair or replacement.

.4 All repairs or replacements shall be carried out by a Contractor to the satisfaction of the Contract Administrator.

.5 Contractor is responsible for safe storage of all Contract Administrator supplied equipment

1.16 APPROVAL AND CERTIFICATION

.1 Any electrical material and/or equipment supplied by any Contractor or subcontractor for installation must bear evidence of certification by authorized organization (e.g. CSA) or special certification acceptable to the Authority Having Jurisdiction.

.2 Any material and/or equipment not complying with this requirement and found on the job site will be subject to rejection and replacement with approved equipment at no additional cost.

.3 Contractor, upon receipt of equipment purchased by the Contract Administrator for installation on this project, shall examine it for compliance with the above requirements. Report any non-approved equipment to the Contract Administrator for action. Such equipment shall be returned to its packing crate until instructions are received from the Contract Administrator, unless otherwise directed in writing by the Contract Administrator.

1.17 OPENINGS

.1 Supply opening sizes and locations to Contract Administrator to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.

.2 No openings are permitted through completed structure without written approval of Contract Administrator. Show required openings on a copy of structural drawings. Identify

exact locations, elevations, and size of proposed openings and submit to Contract Administrator for review, well in advance of doing work.

1.18 EXTRA WORK

.1 Any extra work ordered to be done shall be governed by the specification of the Contract unless specific instructions or clauses supersede those of the specification for this particular application only.

1.19 DAMAGE

.1 Where existing structure, grade or pavement has to be removed, altered or otherwise defaced to facilitate electrical installation, Contractor shall arrange for breaking of openings or grooves in any building structure or breaking of pavement and/or digging of trenches.

.2 Any equipment, structure, pavement or grade damaged by the execution of this Contract shall be repaired to its original condition. Any cost incurred for such work shall be allowed for in tender sum.

.3 Irreparably damaged equipment shall be replaced at no cost to the Contract Administrator.

.4 If the finish of new equipment is damaged, the Contractor shall, at the discretion of the Contract Administrator, either replace or restore the equipment to its original condition by re-spraying, refinishing, etc., at no cost to the Contract Administrator.

.5 Openings and cutouts shall not be burned into panels. Oversize openings shall not be patched up with loose plates or oversize washers. Oversized openings will be considered damage to the equipment and are to be treated as specified above.

.6 The Contractor shall use extreme care when working near existing services and any services disturbed shall be replaced by the contractor at no cost to the Contract Administrator to the satisfaction of the Contract Administrator.

.7 Contractor shall determine the location of the existing underground services from the authorities having jurisdiction and/or Contract Administrator and/or Architects before excavation of existing grade and sub-grade, or new construction begins.

1.20 PAYMENT FOR SERVICES BY OTHERS

.1 Where, in the specifications, the Contractor is required to arrange with others to have certain installations carried out, or to have certain services performed, the Contractor shall allow for this work in their tender and pay all costs involved.

1.21 WARRANTY OF CONTRACT

.1 The Contractor will guarantee all work and material covered in this Contract for a period of one year from the date of substantial performance of the contract. This is in addition to any manufacturer’s warranty provided for supply of materials and equipment.

1.22 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 engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.

1.23 LETTERS OF SATISFACTION

.1 Where training is called for in the specification, the Contractor shall obtain a letter of satisfaction signed by the Contract Administrator's representative. This letter shall state that sufficient training for the particular system was provided, and that the Contract Administrator is generally satisfied with the level and content of the session.

1.24 MONITORING

.1 Before substantial performance will be granted, contractor shall arrange for monitoring of the Intrusion and Fire Alarm systems. Provide print-out of all events at monitoring company denoting time and type of signal from each device for Intrusion and FA systems. The print-out shall list time and type of signal received. Contractor shall produce a list of tested devices to show time of time testing. The list shall be produced in the same format as the print-out for fast cross-reference. A letter from monitoring company stating conformance to ULC requirements is required. This letter shall be provided and the connection incorporated in the Fire Alarm system verification as described elsewhere in this specification.

1.25 FINAL ELECTRICAL ACCEPTANCE

.1 As the Contract Administrator are required to give professional assurance that all electrical systems have been installed, tested, commissioned and verified in accordance with the current edition of the Manitoba Building Code and the Canadian Electrical Code, the following items are required from the Contractor prior to substantial performance acceptance and issuance of "Assurance of Field Review and Compliance."

.1 "Certificate of Final Electrical Inspection" certificate signed by the Electrical Inspector for the project (a declaration form signed by the Electrical Contractor is not acceptable);

.2 Certificate of Fire Alarm System Verification; (Certificate shall include checklist for each and every item of the Fire Alarm System), Inspection, Testing and Maintenance Technician sheets; this implies that system is fully operational.

.3 Verification Certificate of Exit and Emergency Light Inspection and Testing Systems; this implies that system is fully operational.

.4 Confirmation of F.A. System monitoring of Alarm, Trouble and Supervisory Signals. Contractor shall obtain this confirmation from the Contract Administrators

monitoring company in the form of a print-out letter. The letters shall show the time each event signal occurred and has been reset during the verification.

.5 Obtain and Complete a Manitoba Hydro Power Smart Lighting Rebate Form and submit to the Project Manager with all required backup.

1.26 RECEIPT SUBMITTAL

.1 At the time of purchase of electrical components, (mainly but not limited to light fixtures), which are components that may require review by regulatory agencies such as Manitoba Hydro Power Smart or LEEDS™ Certification process, the Contractor shall provide the Contract Administrator and Contract Administrator with copies of the corresponding receipts. The submittal of receipts is intended to verify quantities and specification of the components for submittal to the regulatory agencies.

1.27 LOT PRICING

.1 Package lot pricing from manufacturers, suppliers, and/or wholesalers will not be acceptable.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

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

.2 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 below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

.3 All motors and equipment name plate FLA and MOCP shall be verified with the manufacture and shop drawings prior to finalizing and supply or installation of feeders, breakers and safety disconnect switches.

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 Provide Lamacoid nameplates, 3mm (1/8") thick plastic engraving sheet, black or red face, white core, mechanically attached (screwed or riveted) unless specified otherwise to electrical Motor Starters, Motor Control Centers, Disconnect Switches, Panelboards. 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 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture. Submit schedule of nameplates and wording.

.3 Allow for a minimum of twenty-five (25) letters per nameplate and label.

.4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.6 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.

	Prime	Auxiliary
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	
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 NAMEPLATES AND LABELS

.1 Manufacturer’s nameplates and CSA labels shall be visible and legible after equipment is installed.

.2 Provide warning signs on equipment, as required to meet the requirements of the Inspection Authorities, including indication of multiple power sources.

.3 Provide quantity as required of buried cable sign reading “Buried Cable” and “Buried High Voltage Cable”. Signs shall be installed at building structure/equipment and at locations as directed on site and as per Canadian Electrical Code.

3.2 CONDUIT SLEEVES AND HOLES

.1 Install conduit, and sleeves, prior to pouring of concrete. Sleeves through concrete shall be sized for free passage of conduit.

.2 Holes through exterior walls and roof shall be flashed and made weatherproof.

.3 Make necessary arrangements for cutting of chases, drilling of holes and other structural work required to install electrical conduits, cables, pullboxes and outlet boxes.

.4 Install cables, conduits, and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

.5 All conduits and cables shall be entered into the building above grade.

.6 All coring in buildings with electrical in the slab shall be scanned to prevent damage at contractor’s expense.

.7 Contractor is responsible for arranging and coordinating with other divisions for proper drainage of electrical conducts and/or conduits entering from outside, drainage of all exterior

electrical junction and pull boxes, sealing and waterproofing of all electrical penetrations; methods of firestopping, and envelope penetration.

3.3 CUTTING AND PATCHING

.1 Pay the costs of all cutting and patching required for the installation of electrical work. Payment for cutting and patching shall be made through the Contractor.

.2 Cutting and patching required for the installation of electrical work shall be done by the particular trade whose work is involved. No cutting or patching shall be carried out by the tradesman employed on the electrical work.

.3 Obtain the approval of the Architect and/or Contract Administrator before arranging for any cutting. Patching shall restore the affected area to the original condition; materials and methods used for patching shall be in accordance with the requirements of the corresponding Divisions of the specification.

3.4 LOCATION OF OUTLETS

.1 Locate outlets as indicated.

.2 Do not install outlets back-to-back in wall.

.3 Drawings are schematic only and do not indicate all architectural or structural elements.

.4 Change location of outlets at no extra cost or credit, providing distance does not exceed 10'-0" (3 m) and information is provided before installation.

.5 Locate light switches on latch side of doors.

.6 Vertically align outlets of different systems when shown in close proximity to each other and occurring at different mounting heights.

.7 Coordinate mounting heights and location of all equipment with Architectural, Mechanical and Structural Drawings prior to installation of rough-in boxes.

3.5 MOUNTING HEIGHTS

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

.2 If mounting height of equipment is not indicated, verify with Architect before proceeding with installation.

.3 Install electrical equipment at the following heights unless indicated or directed otherwise (to bottom of outlet):

.1 Outlets above counters: 6" (150 mm);

.2 General receptacles: 18" (450 mm).

.3 Receptacles in mechanical and shop areas: 40" (1.0 m).

.4 Switches, dimmers, push buttons, Luxo bracket: 48" (1.2 m).

.5 Fire alarm devices shall be installed as per CAN/ULC-S524-06.

.6 Thermostats: 64” (1.65 m).

.7 Panelboards, annunciators, etc.: 78" (2.0 m) to top.

.8 Clock outlets: 84" (2.15 m).

.9 As per Architectural elevations.

.10 Heights as above or at bottom of nearest block or brick course.

.11 Voice/Data wall outlets: 18" (450 mm) vertical orientation.

.12 Receptacles mounted adjacent voice/data outlet. 18" (450 mm) vertical orientation.

.4 Panelboards and other equipment which are to be surface mounted shall be installed on minimum 3/4" (19 mm) fir plywood mounting backboards. Treat backboards with wood preservative prior to installation and paint with primer and two (2) coats gray enamel before any equipment is mounted. Provide plywood mounted boards unless specified otherwise in other sections.

.5 Panelboards mounted on exterior concrete/block walls shall have minimum 3/4” air gap behind enclosure (to minimize condensation).

.6 All transformers, motor control centers and floor-mounted distribution panels shall be mounted on 4" (100 mm) concrete housekeeping pads. The Electrical Subcontractor shall be responsible for provision of these pads.

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 tests in accordance with Section 01 45 00 - Quality Control.

.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 Systems: fire alarm system, Security System, PA system, communications.

.6 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 Departmental Representative.

.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.

3.8 PROTECTION

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live part “LIVE ( ) VOLTS”, with appropriate voltage.

.3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision.

.4 Provide guards for all electrical equipment in gymnasium or areas subject to damage.

3.9 SHORT CIRCUIT/COORDINATION/ARC FLASH STUDY

.1 Provide a Short Circuit/Coordination/Arc Flash Study for service entrance equipment, main distribution switchboard breakers and first level of sub-distribution (including 120/208V transformers) to ensure proper short circuit capacity and proper selective coordination, and proper Arc Flash requirements. Study shall include Arc Flash approach boundaries, incident energy levels, and personal protective equipment (PPE) requirements. Submit a copy of the Short Circuit/Coordination/Arc Flash Study to the Contract Administrator with distribution shop drawings and include one copy in each Maintenance Manual.

.2 Ensure circuit protective devices such as over current trips, relays, fuses, are installed to values and settings as recommended in the Study. Confirmation of all settings to be forwarded Contract Administrator and signed off by the Electrical Contract Administrator.

.3 Ensure equipment labels are provided indicating Arc Flash information for each piece of studied equipment

3.10 SPARE PARTS

.1 Assemble spare parts as specified.

.2 Include the following:

.3 Part number.

.4 Identification of equipment or system for which parts are applicable.

.5 Installation instructions as applicable.

.6 Provide a written list complete with Contract Administrator's signature assuring that spare parts have been received by the Contract Administrator.

3.11 SPRINKLERPROOF EQUIPMENT

.1 All surface mounted electrical equipment located in sprinklered areas shall be sprinkler proof and shall be provided with suitable hoods and shields.

.2 Entrance of conduits into the top of surface mount electrical panels/cabinets/distributions and motor control centers shall utilize O-rings and watertight connectors.

3.12 EXCAVATION AND BACKFILING

.1 Excavate and backfill as required for underground electrical services as indicated. Provide protective materials around and over services and be present at all times during excavation and backfilling to supervise work. Backfilling shall restore the excavated area to the original condition and shall include sodding where required.

.2 Include all costs for excavation and backfilling, for any underground electrical installation, unless otherwise indicated.

.3 Confirm the locations of all existing underground services, wiring, etc., prior to any trenching or installation of new Pole Bases., etc. The Electrical Subcontractor shall employ a qualified firm to survey and mark out all existing underground services which may be encountered (Electrical, Telephone, Sewer, Gas, Water, etc.).

.4 Provide trenching, cable installations and backfill promptly. Open trenches shall be barricaded in an approved manner.

.5 Cables required to cross under roadways, paved areas, sidewalks, etc. shall be installed in PVC conduits pushed under such areas.

.6 Six (6") of sand shall be provided surrounding the cables and 2" x 4" treated plank installed 6" above the cables. Install cable marker tape in all trenches, minimum 12" above cables. The remainder of the trench shall be backfilled with granular base course. All backfill material shall be thoroughly tamped and compacted to at least 90% of maximum density at optimum moisture. The ground shall be left free from ruts and rough spots. In any asphalt areas, backfill shall be granular material only.

.7 All sodded areas disturbed or damaged during trenching and backfilling shall be repaired with manured soil mix and resodded. Make all repairs to damaged asphalt and/or concrete surfaces to match existing.

.8 Care shall be taken when excavating near existing services. Existing trees and shrubbery in work area shall be protected from damage.

.9 Install buried cable signs as per CEC and Manitoba Electrical addendums.

3.13 FIREPROOFING

.1 Where cables or conduits pass through floors, block or concrete walls and fire rated walls, seal openings with fire stopping material that combines intumescent and endothermic properties.

.2 Fire proofing of electrical cables, conduits, trays, etc, passing through fire barriers shall conform to local codes and inspection authorities.

.3 Fire stop materials shall be asbestos free and have been tested in accordance with ASTM E-84, E8-14, E -136 and UCL 1479.

.4 Fire stop and smoke seals shall be done in accordance with Section 07270.

.5 Approved manufacturers:

.1 Nelson Firestop Products

.2 Specseal

.3 Hilti firestop

3.14 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.

.3 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.

3.15 TRIAL USAGE

.1 The Contract Administrator reserves the right to use any piece of electrical equipment as required to make a complete and thorough check before the completion and acceptance of the work.

3.16 CLEAN-UP

.1 Contractor is responsible for daily clean-up of all debris, packaging, waste, etc., that is created by Contractor and his workers or agents.

3.17 REVIEW

.1 Word "Review" used in this specification or on the drawings means that the Contract Administrator reserves the right to call for revision and resubmission, rejection, furnish as submitted or furnish as corrected.

3.18 EVALUATION OF “PROGRESS CLAIMS”

.1 Contractor shall submit to the Contract Administrator for review and approval a detailed breakdown of material and labor. This detailed breakdown shall be formatted as per the following table.

.2 The Progress Claim form(s) shall be submitted to the Contract Administrator prior to the initiation of the Contractor's first claim for payment for review and acceptance. Failure to submit the Progress Claim form(s), and to subsequently submit all Progress Claims based on the same format, will delay the processing of the Contractor's Progress Claim.

Items		Claim To Date		Current Claim		Previous Claim		To Complete	
		$	%	$	%	$	%	$	%
Start-Up Costs	Labour								
	Material								
Permits/Bonds	Labour								
	Material								
Unit Substation	Labour								
	Material								
Dist. Equip.	Labour								
	Material								
MCC and/or Motor Control	Labour								
	Material								
F.A. System Including Verification & Acceptance	Labour								
	Material								
Fix./Lamps	Labour								
	Material								
Low Voltage Control	Labour								
	Material								
Serv. Raceway	Labour								
	Material								
Lighting Raceways	Labour								
	Material								
Low Tension Raceways	Labour								
	Material								
Distribution Feeders	Labour								
	Material								
Rough-in Branch Circuit Wiring	Labour								
	Material								
Devices - Supply & Installation	Labour								
	Material								
Cable Tray – Supply & Install.	Labour								
	Material								
Door/Access Control Systems	Labour								
	Material								
Telecomm/Data including testing	Labour								
	Material								
Manuals/As-Built Documentation	Labour								
	Material								
Presentations & Training	Labour								
	Material								

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1	Mechanical Specifications	Division 21, 22 and 23
.2	Common Work Results	Section 26 05 00
.3	Wires and Cables (0-1000 V)	Section 26 05 21
.4	Outlet Boxes, Conduit Boxes and Fittings	Section 26 05 32
.5	Conduits, Conduit Fastenings and Conduit Fittings	Section 26 05 34
.6	Disconnect Switches - Fused and Non-Fused	Section 26 28 23
.7	Motor Starters to 600 V	Section 26 29 10

1.2 SYSTEM DESCRIPTION

.1 Provide complete electrical power and control connections for mechanical equipment, except as noted herein, or as noted on the drawings.

Part 2 Products

2.1 MATERIALS

.1 Include motor starters, lockable disconnects, conduit, wire, fittings, interlocks, outlet boxes, junction boxes, and all associated equipment required to provide power wiring for mechanical equipment, unless otherwise indicated.

.2 Include pushbutton stations, motor protective switches, interlocks, conduit, wire, devices, and fittings required to provide control wiring for mechanical equipment, except for temperature/humidity control systems.

.3 Unless otherwise noted, motors and control devices shall be supplied by Division 21, 22 and 23. Motor horsepower ratings shall be as shown in the Division 21, 22 and 23 specifications. Motor voltage and phase ratings shall be as shown on the Division 26, 27 and 28 drawings.

.4 Provide the Mechanical Subcontractor with a copy of the Motor Schedule and ensure conformance with voltage shown. Additional prints of Motor Schedule will be made available by the General Contractor.

2.2 EXTERIOR EQUIPMENT

.1 All equipment, mounted on the exterior of the building, shall be weatherproof.

.2 In compliance with CEC Rule 26-704, Electrical Subcontractor shall provide a weatherproof receptacle next to the installation of any new mechanical equipment located on the rooftop. Receptacles shall be mounted not less than 750mm above the finished roof unless otherwise noted.

Part 3 Execution

3.1 POWER WIRING

.1 Install power feeders, starters, lockable disconnects, and associated equipment and make connections to all mechanical equipment.

.2 Install branch circuit wiring for mechanical system control panels, time clocks, and control transformers.

.3 Install main power feeders to starter/control panels furnished by Division 21,22 and 23. Install branch wiring from starter/control panels to controlled equipment such as motors, electric coils, etc.

.4 Conduit, wire, devices and fittings required to wire and connect low voltage temperage control systems, shall be supplied and installed by the trade supplying the temperature control system. Control wiring shall be installed in conduit.

.5 Wire and connect electrical interlocks for starters supplied by Division 21, 22 and 23.

.6 Flexible connections to motors shall not exceed 6 feet (1.83 m), unless approved by Contract Administrator, and shall be liquid tight flex with watertight connectors.

3.2 CONTROLS

.1 Install all electrical controls, except low voltage temperature controls, unless otherwise noted herein. Controls which have both electrical and mechanical connections shall be installed by the trade supplying the control.

.2 Wire and connect line voltage remote thermostats and P/E switches for furnaces, condensing units, force flows, gas-fired unit heaters, electric heaters and rooftop units.

.3 Wire and connect float switches, pressure switches, alternators, alarms, etc. for sump pumps, domestic hot water re-circulating pumps, and booster pumps.

.4 Conduit, wire, devices and fittings required to wire and connect low voltage controls, which are an integral part of a packaged unit, shall be supplied by the trade supplying the packaged unit, unless otherwise indicated. Control wiring shall be installed in conduit.

.5 Wire and connect electrical interlocks for starters supplied by Division 21, 22 and 23.

.6 Conduit, wire, devices and fittings required to wire and connect low voltage temperature control systems, shall be supplied and installed by the trade supplying the temperature control system. Control wiring shall be installed in conduit.

.7 Wire and connect hi-limit cutouts for remotely mounted electric heating coils provided by Division 21, 22 and 23.

.8 Wire and connect thermistor control devices, built-in to large motors, to motor starters, as per wiring diagrams provided by Division 21,22 and 23.

.9 Wire and Connect air Handling units to Fire Alarm Control Panel for Fan shutdown. Clearly indicate on As-Built Drawings and Fire Alarm Graphical Drawing Unit wired to FACP for Fan shutdown.

3.3 FIRE PROTECTION (SPRINKLER & STANDPIPE)

.1 Wire and connect the flow, pressure and tamper switches, installed on the sprinkler and standpipe systems, to separate zones in the fire alarm control panel. Refer to Fire Protection and Mechanical Drawings for the exact location of these switches. Devices shown on electrical drawings are for convenience. Final device locations shall be as shown in Division 21, 22 and 23, co-ordinate with mechanical.

.2 Provide an E.O.L.R. for each zone and locate adjacent to monitored device.

3.4 CO-ORDINATION

.1 Refer to mechanical drawings for the exact location of motor control devices, and other mechanical equipment requiring an electrical connection.

.2 Obtain full information from Division 21,22 and 23, regarding wiring controls, overload heaters, equipment ratings and over-current protection. Notify the Division 21,22 and 23, at once, if any information provided is incorrect or unsatisfactory.

3. Coordinate control wiring requirements with Division 21, 22 and 23 and provide all control wiring and connections as required to make the control systems operate as specified.

.4 Refer to Division 21, 22 and 23 specifications for any further electrical requirements.

.5 Review both electrical and mechanical drawings and specifications and coordinate all controls with Mechanical Subtrades through the General Contractor. Report all discrepancies to both mechanical and electrical Contract Administrator before close of tender. No additional money will be justified for assumptions made on any duplication of information.

.6 Submit to General Contractor, as part of the tender submission, a list of controls and wiring to be provided in the Electrical Contract.

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

.4 All connections will be performed with approved connectors and in outlet boxes as specified.

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.

.2 Joints in branch circuit wiring shall be made with insulated connectors, twist-on, of approved type and size.

.3 Solderless pressure type connectors shall be used on conductors of size #8 AWG and larger. On underground wiring work they shall be permanent type "Burndy-Insulink".

.4 Ground Fittings

.1 All direct buried grounding connections will be done with Cadweld connections only

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 PRODUCT DATA

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

1.3 SCOPE OF WORK

.1 Provide a complete system of wiring systems, making all required connections as indicated on the drawings, specified herein and as required. Unless noted as larger, install and rate all cables and conductors in accordance with the requirements of the current edition of the Canadian Electrical Code.

.2 Unless otherwise noted, all systems in the building shall be wired in conduit.

Part 2 Products

2.1 WIRES (CONDUCTORS)

.1 All conductors to be copper only, unless otherwise shown or specified. All conductors shall be 98% conductivity copper 600 volt "RW90" X-link insulated, and be of minimum size #12 AWG.

.2 Provide cross-linked thermosetting polyethylene (RW90 X-link) type insulation for all fire alarm system conductors. Where run in cable form with outer jacket, provide Nexans, "Securex II", FAS 105, 300 volts, 105°C (220°F) conductor temperature rated fire alarm system flexible armoured cable with solid copper conductor, shielding, flame retardant PVC insulation and red colour outer overall jacket, ULC listed and labelled and CSA certified to C22.2 No. 208.

.3 Wire for 120 volt lighting and receptacle branch circuits shall be #12 AWG for runs up to 27m (90'-0") and #10 AWG minimum for runs over 27m (90'-0"). Wire for 347 volt lighting branch circuits shall be #12 AWG for runs up to 75m (250'-0") and #10 AWG minimum for runs over 75m (250'-0"). Wire for branch circuits shall be sized for proper current-carrying capacity to limit the voltage drop at the outlet to 3%. Do not use common neutrals for IG circuits or for any electronic loads, e.g. computers, etc. For lighting circuits using electronic ballasts, minimum neutral conductor, one (1) size larger than current carrying conductor. Wire for 120-volt control circuits shall be #14 AWG minimum and for 24-volt control circuits shall be #16 AWG minimum. Wiring drops for luminaires to be copper, #14 AWG flame retardant, heat and moisture resistant, rated at 600 volt, 125 degrees C Insulation.

.4 Conductors up to #10 AWG may be solid. Conductors #8 AWG and above shall be stranded, unless specifically mentioned to be solid.

.5 Equipment bonding conductors shall be insulated.

.6 Provide RWU90 XLPE rated cable for underground wiring. Related to new service entrance feeders and site lighting circuits. RWU90 XLPE not required under interior floor slabs.

.7 The only exception to the above are as follows:

.1 Feeders from main distribution to all panelboards, MCC and sub distribution can be Alcan, NUAL, RW90 XLPE Minus 40% - 600V MIN conductor, however Electrical Subcontractor shall increase sizes of feeders accordingly for equal ampacity and submit a One Line Diagram as shop drawings. One Line Diagram shown on drawings, is meant to use all copper connections.

.8 Cord drops (dropcord receptacles) shall be manufactured to comply with Tables 11 and 12 of C.E.C.

.9 Type ACM conductors permitted for feeders above 60 amps.

2.2 TECK CABLE

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

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper and ACM alloy, size as indicated.

.3 Insulation:

.1 Cross-linked polyethylene XLPE, rating – 600 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum, compliant to applicable Building Code classification for this project.

.6 Overall covering: thermoplastic 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 1500 mm centers.

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

2.3 MINERAL-INSULATED CABLES

.1 Conductors: solid bare soft-annealed copper, size as indicated.

.2 Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.

.3 Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250°C.

.4 Overall jacket: PVC applied over the sheath and compliant to applicable Building Code classification for this project for direct buried and wet locations, as indicated.

.5 Two hour fire rating.

.6 Connectors: watertight, field installed, approved for MI cable.

.7 Termination kits: field installed approved for MI cable.

2.4 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Connectors: standard as required, complete with double split rings.

2.5 CONTROL CABLES

.1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.

.2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TW -40°C polyethylene insulation with shielding of tape coated with paramagnetic material wire braid over each conductor and overall covering of PVC jacket.

2.6 NON-METALLIC SHEATHED CABLE

.1 Non-metallic sheathed copper cable type: NMD90 nylon, size as indicated.

2.7 ACM CONDUCTORS

.1 Annealed, compacted aluminum alloy conductor material (ACM) for circuits 60 amps or more, single or multi-conductor, 600 volt insulation.

.2 Type: AC90, ACWU90 and TECK90.

.3 Armour: interlocked aluminum strip.

.4 Conductivity: 61% IACS to that of copper.

.5 Outer jacket: ACWU90 PVC jacket, FT-4 rated suitable for direct buried and Div. 1 and Div. 2 hazardous locations.

2.8 CONNECTORS AND TERMINALS

.1 Mechanical connectors and terminals are restricted to branch circuit wiring.

.1 Mechanical connectors shall be torqued to manufacturer's recommendations.

.2 Connectors #8 AWG gauge and larger shall be compression type.

.3 Terminals shall be compression type with spade type lugs.

.4 Wire and cables shall be as manufactured by Canada Wire and Cable, Canadian General Electric, Alcan or Phillips Cable.

.5 Use approved compression connectors and terminal (i.e. the type that are formed around the conductor using mechanical or hydraulic tools).

.1 Compression terminal for conductor sizes 350 MCM and larger shall have two holes.

.2 The following compression terminals are approved:

.1 Alcan "Alcons" and Alterms";

.2 Burndy "Hylugs" and "Hylinks", YA-A-TN and YS-A series;

.3 llsco compression tubes, AS series;

.4 llsco compression terminals, ACL and 2AC series;

.5 Thomas and Betts colour key connectors;

.6 Thomas and Betts colour key two-way connectors;

.7 Thomas and Betts "H" taps.

.3 Attach compression type connections only with the manufacturer's approved tools and dies and in accordance with his recommendations.

.4 Watertight and/or type approved for TECK cable, as indicated.

.6 Before applying any connector to an aluminum conductor, abrade the conductor with a wire brush and, in the case of mechanical connectors, it shall be immediately covered with a heavy coat of approved aluminum joint compound already inside the connector.

.1 Approved aluminum jointing compounds are as follows:

.1 Burndy Penatrox "A";

.2 Thomas and Betts aluminum joint compound;

.3 Ideal "Noalox";

.4 Penn Union "Cual-Aid".

.2 Provide a photograph(s) of application.

.7 When aluminum lugs are connected to bus and/or lugs with steel or copper studs or bolts, ensure that bellville and chrome or stainless steel flat washer combinations are used and that unplated aluminum surfaces are cleaned and coated with compound.

.1 Bellville washers are not required where aluminum-to-aluminum contact is made with an aluminum bolt.

.2 If lug is to be bolted to unplated aluminum bus, the bus shall be lightly wire brushed and approved aluminum joint compound shall be applied over the contact area. Do not use a particular compound on a plated aluminum or copper bus.

.8 When connecting aluminum conductors to copper conductors, outdoors or in damp conditions, use CSA approved CU/AL bi-metallic connectors for this purpose and apply them in accordance with the manufacturer's instructions. The completed connection shall be sealed from the ingress of moisture.

Part 3 Execution

3.1 INSTALLATION

.1 Conductor length for parallel feeders to be identical.

.2 Lace or clip groups of feeder conductors at all distribution centres, pull boxes, panel boards and termination points.

.3 All exterior wiring to be RW90 X-link with 600 volt insulation.

.4 Provide permanent plastic name tag indicating load fed on all cable ends.

.5 In applications where multiple conductors in conduit are being run, provide a trapeze configuration of metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall mounted cable/conduit brackets and ring type conduit hangers may also be permitted in applications approved by Contract Administrator. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.

.6 Support flexible armoured cable in ceiling spaces and in stud wall construction with steel two (2) hole cable straps to "Code" requirements. Flexible armoured cables must run in a neat manner parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables as specified. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation.

.7 All wiring shall be done concealed and in conduit except:

.1 Modular Wiring where specified.

.2 Wiring for receptacles and lighting fixtures. From receptacles and lighting fixtures to the local area Junction Box, wiring may be done using AC90 Cable. Home run from local area Junction Box to the Panelboard shall be done in conduit. Typically each room shall be equipped with at least one Junction Box with conduit home run.

.3 Low voltage conductors not installed in conduit or raceways shall be fire insulated rated in accordance with latest governing Code Flame Spread requirements.

.8 Electrical Subcontractor shall ensure that all conduits and boxes are installed concealed in brick work, block work, furred out walls, steel stud and wood stud walls, unless specifically permitted. Any conduit installed on surface shall be removed and reinstalled concealed at Electrical Subcontractor's expense. All costs of making good walls and finishes will be borne by Electrical Subcontractor.

.9 Generally, conductor sizes are indicated on drawings. Such sizes are minimum requirements and must be increased, where required, to suit length of run and voltage drop in accordance current edition of the Canadian Electrical Code.

.10 Provide sizes of conductors as required by Canadian Electrical Code or as indicated on the drawings. Voltage drop from panels to farthest device must not exceed 3% at full load. Voltage drop from the main distribution to the panel board must not exceed 2%.

.11 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraised.

.12 Nylon or similar pulling rope only shall be used to pull conductors into metallic and/or non-metallic conduit.

.13 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.

.14 Exposed wiring, where permitted, shall be installed neatly, parallel or at right angles to the building lines.

.15 An allowance shall be made for re-routing conduits where they go from ceiling to the wall, so they do not appear on side of beams.

.16 No reduction is permitted on neutral conductors.

3.2 IDENTIFICATION OF CONDUCTORS

.1 Line voltage conductors in conduit shall be colour coded to identify service voltage. Conductor colours for 120V circuits shall be:

120 Volt

- Phase A Red
- Phase B Black
- Phase C Blue
- Neutral White
- Ground Green
- Control Orange.

600V conductor colour to be confirmed with Contract Administrator

.2 Loop conductor in a three-way and four-way switching circuit shall be:

- Brown

.3 Switch leg conductors of line voltage switches on lighting and any manually controlled plug receptacle circuits shall be colour coded as follows:

- A Yellow
- B Orange
- C Pink

The sequence of colours shall be repeated if more than three switch legs leave a switch box.

.4 Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.

3.3 WORKMANSHIP

.1 Before installing wire, ensure conduit is clean and dry. If moisture present, thoroughly dry out conduit; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type.

.2 Installation to be free of opens and grounds. Before energization, megger each feeder to ensure that insulation resistance complies with C.E.C. requirements

.3 Do not install any conductor smaller than #12 AWG gauge, except where specifically indicated otherwise.

3.4 Insulation Test

.1 The insulation resistance between wires and between any wire and ground shall not be less than the "Canadian Electrical Code" requirements with all circuits complete and connected. Include tests results in maintenance manual.

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)

1.3 SCOPE OF WORK

.1 Provide all labour and material to constitute a complete system, equipment grounding and bonding.

.2 Ground all components of the electrical system in accordance with the requirements of the Canadian Electrical Code, local authorities and, where more stringent, manufacturers requirements.

.3 Securely and adequately ground all components of the electrical system in accordance with the requirements of the Canadian Electrical Code and additional requirements set up in the contract documents.

.4 The system shall consist of, but not be limited to, ground electrodes (ground rods, underground, etc.) ground buses, cables and supports and all necessary materials to provide a complete system.

1.4 TESTS

.1 Measure the ground grid resistance with an earth test megger and install additional ground rods as required until the resistance to ground is 5 ohms or less. Under no circumstances shall the resistance of the network for under 750V system exceed 5 ohms.

Part 2 Products

2.1 CONDUCTORS

.1 Unless otherwise shown, the ground conductor of a system shall have a minimum size of that shown on Table #16 of the Canadian Electrical Code. Ground and bonding conductors are to be bare stranded copper, soft annealed, size 4/0AWG.

2.2 GROUND ELECTRODES

.1 The water main and any metallic main water waste pipe shall be bonded electrically to the main ground system. The bonding conductor shall be same size as the main grounding conductor.

.2 Provide a minimum of three grounding rods 20mm dia. x 3m copper clad steel driven rods with a #3/0 interconnecting cable.

.3 Provide continuous 30 meters of #3/0 copper ground wire in building footings to constitute ufer ground.

2.3 ELECTRICAL ROOM(S) GROUND BUSES

.1 Ground buses shall be copper, 50mm wide x 6 mm thick, mounted on insulating stand-offs and complete with suitable lugs for grounding conductors. Length of ground bus shall be as required for the number of terminations plus 50% spare, but never smaller than 300mm.

.2 All main distribution centres, motor control centres, switchgear, transformers, distribution centres and all panelboards requiring equipment ground shall contain a ground bus sized adequately for the number of connections required.

2.4 TELECOMMUNICATION(S) GROUND BUSES

.1 Telecommunications Equipment Rack And Cabinet Ground Bars: solid copper ground bars designed for mounting on framework of open or cabinet-enclosed equipment racks with minimum dimensions of 6 mm (1/4") thick by 20 mm (3/4") wide; At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks. Where bolting to painted surfaces, use paint piercing type washers.

.2 LAN Room Ground Bus: 300 mm x 50 mm x 9 mm (12" x 2" x 3/8") copper ground bus with a minimum of eight (8) drilled taped holes; mounted on walls with standoff insulators.

.3 Ground Conductor for Grounding Grid and Associated Connections: Number 3/0 AWG bare, 7-strand medium hard-drawn copper unless indicated otherwise.

.4 Ground Braid: constructed from flat 98% conductivity tinned copper grounding braid.

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 All locknuts, connectors and couplings shall be tight fitting and properly cinched, throughout the entire electrical distribution system for grounding and bonding purposes as required by the CEC.

.3 Ground Connections:

.1 Below Grade: Cadweld as supplied by Erico Products or approved equal in accordance with B7, exothermic-welded type connectors.

.2 Above Grade or in Manholes: Compression type connectors; Exothermic connections permitted above grade if approved by Contract Administrator.

.3 When making ground and bonding connections, apply a corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between metals used.

.4 The Electrical Subcontractor shall bond the waste pipe with the hot and cold pipe using copper jumper of not less than #4 AWG. Bonding as required by Rule 10-406 amended.

.5 Provide separate isolated bond wire to the isolated ground panel. Where indicated, the panel shall contain an isolated ground block with suitable terminals. Size and install bond wire in accordance with Rule 10-906 (9) all in addition to normal bond wire.

.6 Ground conductors shall be installed from copper ground bus located at Main Distribution to switchboards, ground busses, equipment, etc. They shall terminate with Burndy type GAR connectors installed to manufacturer's instruction. From main ground bus provide ground conductors to:

.1 Main distribution switchgear #3/0 in 25mm conduit.

.2 Three Ground rods #3/0 in 25mm conduit.

.3 Water main #3/0 in 25mm conduit.

.4 Sprinkler System water main #3/0 in 25mm conduit.

.5 Ufer Ground in #3/0 in 25mm conduit.

.6 Two widely separated steel columns #3/0 in 25mm conduits

.7 Each and every transformer secondary side

.8 Each and every Telecommunication Room #3/0 in 25mm conduit

.9 Main telephone distribution sound, fire alarm, intercommunication systems #4 RW90 green insulated.

.7 All joints between conductors of #6 AWG and larger shall be made with "Cadweld" process. Special permission from Contract Administrator is required where bolted pressure lugs or screw type "Hydent" connectors are installed.

.8 All bolted ground connections must be accessible.

.9 Install rigid PVC conduit sleeves where ground wires pass through concrete slabs.

.10 Conduits installed buried in earth, installed in or under grade floor slabs shall have a separate ground wire installed in each and every conduit.

.11 From ground bus, connect one #3/0 bare ground conductor in 25mm conduit to ground bus within each section of switchgear, neutral of switchgear and non-current carrying metal parts.

.12 Connect grounding conductors to motors 10 hp and above or circuits 20A or above, with a solderless terminal and a bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to a connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Completely remove paint, dirt, or other surface coverings at grounding conductor connection points so good metal-to-metal contact is made.

.13 From the main electrical room ground bus, connect one #3/0 insulated ground conductor in 25mm conduit to water main with approved ground clamp ahead of water meter. Install one #3/0 ground conductor jumper of flexible copper strapped around water meter and associated unions and valves to ground building side of water system.

.14 Provide service conductors exceeding 400 amperes with minimum No. 3/0 AWG grounding conductors, unless otherwise noted.

.15 Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturers recommendations and in accordance with local governing electrical code requirements.

.16 Ground metal sheathing and any exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond any metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.

.17 Install bonding wire in all flexible conduit connected at each end to a grounding bushing by a solderless lug, clamp, cup washer and screw. Soldered joints not permitted.

.18 All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with the requirements of the current edition of the CEC.

.19 Measure ground resistance and install additional ground rods and conductors as required until resistance to ground complies with CEC, as shown herein and on the drawings.

.20 Each electrical room and telecommunication room shall be equipped with copper ground bus. Provide identification labels for all grounding and/or building conductors.

.21 Install #4 AWG bond wire along the full length of cable trays and between separate sections of trays and bond cable tray as required.

.22 From ground bus, connect one #3/0 bare ground conductor in 25mm conduit to ground bus within each section of switchgear, neutral of switchgear and non-current carrying metal parts.

.23 Ground conductors not sized on drawings are to be sized in accordance with local governing electrical authority requirements. Ground conductor size is to be no smaller than requirements specified herein this article or on drawings.

.24 Each metallic waste water piping system in the building shall be bonded to the interior metallic water supply system by copper bonding jumper, not less than #3 AWG as per current edition of the CEC.

.25 Exterior post mounted lights signs etc., shall be properly bonded to ground.

.26 Install connectors in accordance with manufacturer's instructions.

.27 Protect exposed grounding conductors from mechanical injury.

.28 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.

.29 Install bonding wire for flexible conduit.

.30 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.31 Clearly mark exact locations of Ground Rods and Ground routes on As-Built drawings.

3.2 TELECOMMUNICATION GROUNDING

.1 Provide minimum no. 3/0 AWG insulated copper ground conductors and LAN Room copper ground bus mounted on walls with standoff insulators in each LAN room. Connect ground bus to computer equipment racks and to building ground system.

.2 Comply with TIA/EIA-607 grounding and bonding requirements.

.3 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.

.4 Ground bonding jumpers to be continuous with no splices. Use shortest length of bonding jumper possible.

.5 Provide ground paths which are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to building grounding electrode. Resistance across individual bonding connections to be 10 milliohms or less.

.6 Bonding Jumpers:

.1 Use insulated ground wire of size and type if identified on Drawings if not identified, comply with local governing code, but which is to be a minimum of No. 6-AWG insulated copper wire.

.2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.

.3 Use compression connectors of proper size for conductors specified. Use connector manufacturer’s compression tool.

.7 Bonding Jumper Fasteners:

.1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten plain end of a bonding jumper wire by slipping this plain end under conduit strut clamp pad; tighten clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.

.2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover; e.g., zinc-plated acorn nuts, on any bolts extending into wireway or cable tray to prevent cable damage.

.3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.

.4 Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

.8 Building Ground Busbars:

.1 Provide busbar hardware at each communications room and connect to pigtail extensions of building grounding ring.

.2 Verify that ground ring pigtail is same type and size conductor used for main building grounding ring.

.9 Telecommunications Ground Busbars:

.1 Provide communications room telecommunications ground busbar hardware at cable tray height.

.2 Connect busbar to building ground busbar located in same room using two-hole compression lugs and a grounding jumper of same size as pigtail extension of main building grounding ring (usually 3/0 AWG).

.10 Ground metallic conduits, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated No. 6-AWG ground wire bonding jumpers.

.11 Ground metallic conduit at each end using No. 6-AWG bonding jumpers.

.12 Comply with cable tray manufacturer’s grounding and bonding recommendations. Bond metallic structures of wireway to provide 100% electrical continuity throughout wireway system.

3.3 TESTS

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of the local inspection authority. A report shall be submitted to the Contract Administrator from the testing agency.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator, if provided, during tests.

.5 A ground electrode with an unsatisfactory resistance test result shall be altered as necessary until the required resistance reading is achieved.

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 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

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

.6 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.

.7 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.

.8 For surface mounting of two or more conduits use channels at 2 m on centre spacing.

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

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Luminaires Recessed in T-Bar ceilings shall be supported independent of T-Bar system via aircraft cable or “Gripple” hangers (Toggle or Y-Hook hangers) as manufactured by Cablofil and shall be firmly attached directly to the existing or new roof building structure.

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

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

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

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

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.

.4 No Splitters without approval by Contract Administrator.

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.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 All outlet boxes shall be of sizes suitable for the application and in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Outlet boxes shall be ganged as required. Sectional boxes shall not be used. Gang boxes to be used 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. All combination power/data boxes shall be a minimum 4 gang Hubbell box (or approved equal in accordance with B7). Low voltage telecommunication and multimedia outlets, where separate, shall be a minimum 2 gang Hubbell box. Boxes shall be c/w trims and coverplates to suit installation.

.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.

.2 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.3 102 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-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

.1 Provide Wiremold fire rated poke through boxes. Refer to drawings for product specifications.

2.6 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.

2.7 WIREMOLD BOXES

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

2.8 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.

2.9 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 All outlet boxes to be installed flush except where exposed wiring is permitted. Wiring terminated in an outlet box for future lighting or power shall have 9” of slack and each cable shall be terminated in a connector.

.4 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.5 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.6 In masonry construction, boxes intended for wall receptacles, switches, telephone outlets, etc., located in concrete block or masonry shall be installed at a height nearest the specified elevation.

.7 Coordinate with all subtrades and confirm locations and method of connection to the various outlets and equipment. Coordinate fully to ensure that no conflict arises during the installation. In case of difference of opinion, the Contract Administrator shall be informed without delay.

.8 Metal hangers may be used to secure outlet boxes to the building only with Contract Administrator's permission.

.9 Care shall be taken to locate outlets so they do not conflict with architectural lines or joints in materials, such as acoustic tiles, wood panels, etc.

.10 Position of outlets which do not appear to be properly centered shall be confirmed before installation.

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 Waste Management Plan.

1.3 SCOPE OF WORK

.1 Provide conduit system as indicated herein, on the drawings and as required

.2 All wiring in the building shall be installed in conduits unless otherwise noted.

1.4 RESTRICTION OF PLACEMENT

.1 All conduit locations or placements shall be coordinated with structural drawings, prior to installation.

.2 Unless specifically permitted by Contract Administrator, for slabs on grade, no horizontal conduit shall be run in the slab. The conduits shall be placed below the slab in the gravel or fill layer.

.3 Conduit penetrations of the vapour membrane shall be minimized and treated as per the appropriate specification section.

.4 For suspended floor slabs, conduits shall be installed on the underside of the metal deck or slab. Horizontal conduit runs are not permitted in the slab unless authorized by the Contract Administrator.

.5 Under no circumstances shall Electrical Non-metallic Tubing be used.

.6 DB 2 PVC conduit may be used only where specifically identified as such.

Part 2 Products

2.1 RIGID STEEL CONDUIT

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

.2 Galvanized with threaded joints and connections.

.3 Connections in dry locations: steel or malleable iron lock nuts inside and outside enclosures.

.4 Connectors subject to moisture: Liquid and dust tight with insulated throat.

.5 Fittings: steel

2.2 EMT CONDUIT

.1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.2 Fittings in dry locations: steel or malleable iron set screw type fastener with insulated throats or non-metallic bushings.

.3 Fittings in wet locations: steel or malleable iron in rain tight, compression-type, with insulated throat or non-metallic bushings.

2.3 RIGID PVC CONDUIT

.1 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.2 Conduit: rigid non-metallic conduit of non-plasticized polyvinyl chloride, Sceptre Rigid Conduit made by IPEX.

.3 Fittings: threaded male or female solvent weld connectors and solvent weld couplings.

.4 Solvent: as recommended by conduit manufacturer.

2.4 RIGID PVC DUCT

.1 Duct: rigid, non-metallic conduit of un-plasticized polyvinyl chloride, type EB-1 or DB-2 (as approved by the C.E.C.) requiring concrete encasement, conforming to CSA standards.

.2 Accessories: bell ends, coupling adapters, bends and other fittings of same material as duct. Use solvent recommended by manufacturer. Horizontal, vertical and foundation spacers as recommended by manufacturer.

2.5 FLEXIBLE CONDUIT

.1 Conduit: spiral wound, interlocking flexible.

.2 Connectors: slip-proof insulated throat or non-metallic bushings, steel type.

2.6 LIQUID TYPE FLEXIBLE CONDUIT

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

.2 Conduit: flexible metal conduit with PVC liquid type jacket.

.3 Connectors: captive sealing jacket with ground cone insulated throat, steel. Provide sealing rings at all box entries.

2.7 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.

2.8 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.

2.9 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.

2.10 FISH CORD OR WIRE

.1 Polypropylene.

Part 3 Execution

3.1 GENERAL

.1 Flexible Conduit shall be used for line and low voltage circuit connections to all motors or equipment subject to vibration and shall be metal PVC coated water tight, except for lighting fixture drops. Connectors shall be approved for flexible liquid tight conduits.

.2 Unless otherwise noted, Electrical Metallic Tubing (EMT) - shall be utilized in the building.

.3 Exposed conduit in areas subject to mechanical injury shall be rigid galvanized steel to a height of 4' (1218mm).

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

.5 Conduit for telecommunication systems shall be a minimum 27mm DIA unless noted as larger.

.6 Install all conduit and wiring concealed, except where specifically noted otherwise. Do not recess conduit in columns or concrete slabs unless approved by the Structural Engineer.

.7 Where conduit is run exposed and in accessible ceiling spaces, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on racks.

.8 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150mm from steam or hot water piping, etc.

.9 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.

.10 Use explosion proof flexible connection for connection to explosion proof motors.

.11 Install conduit sealing fittings in hazardous areas. Fill with compound.

.12 Minimum conduit size for lighting and power circuits: 19 mm.

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

.14 Mechanically bend steel conduit over 19 mm dia. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.15 Dry conduits out before installing wire.

.16 Slabs on grade: install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups, through slab and extend 150mm beyond concrete. When rigid steel conduit is installed in contact with earth, it shall be protected with tape or asphaltum paint. Extend taping or paint 300mm above finished grade.

.17 Conduit ends emerging from concrete slab, which are to remain as exposed conduit, shall be rigid galvanized steel. Provide rigid steel oversized sleeve over the exposed PVC portion of conduit.

.18 All conduit exposed to weather shall be approved for the location and be complete with weatherproof fittings.

.19 All rigid PVC conduit installed under slab on grade shall include a bonding wire sized as required by Canadian Electrical Code.

.20 Where used, sleeves shall be c/w proper connectors and plastic bushing (this is particularly important for telecommunications cabling installation.)

.21 An allowance shall be made for rerouting conduits so they do not appear on the side of beams where they go from ceiling to walls.

.22 Install a separate ground wire in conduit installed underground or in concrete or masonry slab in contact with the earth.

.23 Watertight fittings shall be installed in areas exposed to moisture and concrete type fittings in concrete slabs.

.24 At all recessed panels provide 3-25mm conduits c/w pull string and end cap from panel into the accessible ceiling space above for future use. 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.

.25 Where conduit or ducts enter or exit concrete structures below grade, provide 19mm x 1500mm steel reinforced dowels to prevent shearing. Extend dowel 1 meter beyond concrete and bend conduit to this dowel.

.26 Where conduit is required to be bent, do not heat and do not bend in such a way as to reduce the cross-sectional area at any point.

.27 For all runs of conduit, do not include more than the equivalent of four 90 degree bends, including bends located immediately adjacent to an outlet box or fitting. Provide pulling elbows, pull boxes and/or junction boxes where necessary.

.28 Where possible, install conduits so that they are not trapped. Cap turned up conduits to prevent the entrance of any dirt or moisture during construction. If necessary, swab out conduit and thoroughly clean internally before wires and cables are pulled.

.29 Take extreme care in reaming ends of all conduit to ensure a smooth, interior finish that will not damage the insulation of the wires.

.30 Use insulated non-metallic bushings on all conduit terminators. Ensure electrical continuity in all conduit systems. All conduits shown exposed in finished areas are to be free of labels and trademarks. Install a 45kg test line in all empty conduits. Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used. Seal conduits with duct seal where conduits are run between heated and unheated areas or into freezers. Where conduits, cables, or cable trays pierce fire separations, seal openings with approved sealing compound.

.31 Where conduits enter the top or side of exposed equipment; panels, etc. provide seal rings and water resistant connectors (i.e. in Electrical and Mechanical Rooms).

3.2 SLEEVES AND CHASES

.1 Sleeves shall be provided and set for conduit passing through foundations, concrete walls and floors. Sleeves shall have sufficient diameter to allow free conduit movement resulting from thermal expansion and contraction. Sleeves installed through foundation walls, beams and footings shall be installed flush with walls, partitions, floors and ceilings. All sleeves installed below grade shall be caulked with oakum and lead on both sides of the wall. Sleeves in floors where water is present shall be caulked, graphite packing and waterproof sealant used.

.2 Exact locations of conduit stub ups for connection to service equipment, signs etc., shall be checked and verified with the Contract Administrator. Shop drawings shall be issued prior to rough-in and slab being poured.

.3 No extra claim will be accepted by the Contract Administrator for stub up adjustments as a result of the Contractor not following the checking procedure as described under item 0.2.

.4 Adjustments of stub ups shall be carried out to the satisfaction of the Contract Administrator. Damaged surfaces shall be repaired to their original condition. Conduit extension shall comply with Canadian Electrical Code and wires are to be re-pulled.

.5 For each telecommunication outlet (data, voice, video etc.) provide a corresponding sleeve in every wall leading to the local cable tray to facilitate installation of telecommunication cables.

3.3 EMPTY CONDUITS

.1 All empty conduits shall be tested for clear bore using a ball mandrel, brushes and snake. Clear any conduit which rejects the ball mandrel. All costs involved in making good any work, restoring any surface to original condition shall be borne by the Contractor. All empty conduits to be c/w nylon pull cord (181Kg/400Lb test).

.2 All conduits stubbed out shall be provided with rubber grommets and end caps.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.1 No.126.1-02, Metal Cable Tray Systems.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA VE 1-2002, Metal Cable Tray Systems.

.2 NEMA VE 2-2001, Cable Tray Installation Guidelines.

1.2 SUBMITTALS

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

.2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.

.3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.

.4 Identify types of cable trays used.

.5 Show actual cable trays installation details and suspension system.

Part 2 Products

2.1 MANUFACTURERS

.1 Subject to compliance with requirements, provide products by Cablofil, Inc.,

2.2 MATERIALS AND FINISHES:

.1 Cable Tray Materials: shall be Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

.2 Cable Tray Finishes:

.1 Pre-Galvanized

.3 Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers.

.4 Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.

.1 Mesh: 2 x 4 inches (50 x 100 mm).

.2 Straight Section Lengths: 118 inches (3,000 mm).

.3 Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.

.4 Safe-T-Edge: Patented Safe-T-Edge technology on side wire to protect cable insulation and installers' hands.

.5 Fittings: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.

.6 CF Series Cable Tray Size:

.1 Depth: Cable tray depth will be (unless otherwise shown on drawings):

.1 4 inches (105 mm)

.2 Width: Cable tray width will be (unless otherwise shown on drawings):

.1 6 inches (150 mm)

.2 12 inches (300 mm)

.7 Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.

.8 Fill Ratio: Cable tray may be filled to 50% of total fill capacity. Size cable tray to accommodate future cabling changes or additions.

2.3 CABLE TRAY SUPPORTS & ACCESSORIES

.1 Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports will include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting; installation time is reduced; and tray path can adapt to installation obstacles without the need for additional parts. Place supports so that support span does not exceed that shown on the drawings.

.1 Ceiling-mounted supports mount to ceiling structure directly or with ¼", 3/8" or ½" threaded rod.

.2 Wall-mounted supports.

.3 Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer.

.4 Accessories: As required to protect, support, and install a cable tray system.

2.4 EQUIPMENT GROUNDING CONDUCTOR FUNCTION & GROUNDING

.1 Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.

Part 3 Execution

3.1 EXAMINATION:

.1 Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

.1 Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

.1 Cutting: Field-fabricate changes in direction & elevation by cutting & bending cable tray.

.1 Cut cable tray wires in accordance with manufacturer’s instructions.

.2 Cable tray wires must be cut with side-action bolt cutters with offset head to ensure integrity of protective galvanic layer.

.3 Remove burrs and sharp edges from cable trays.

.2 Certified Installers: Cable tray installers must have successfully completed Cablofil’s Certified Installer program.

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)

.2 Insulated Cable Engineers Association, Inc. (ICEA)

Part 2 Products

2.1 CABLE PROTECTION

.1 38 x 140 mm planks pressure treated with coloured, copper napthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 MARKERS

.1 Not Required

Part 3 Execution

3.1 DIRECT BURIAL OF CABLES

.1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.

.1 Make splices and terminations in accordance with manufacturer's instructions using approved splicing kits.

.4 Underground cable splices not acceptable.

.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

.6 Cable separation:

.1 Maintain 75 mm minimum separation between cables of different circuits.

.2 Maintain 300 mm horizontal separation between low and high voltage cables.

.3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.

.4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

.5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.

.6 Install treated planks on lower cables 0.6 m in each direction at crossings.

.7 After sand protective cover is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

3.2 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.1 Do not pull spliced cables inside ducts.

.2 Install multiple cables in duct simultaneously.

.3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.6 After installation of cables, seal duct ends with duct sealing compound.

3.3 MARKERS

.1 Install concrete cable markers within 180 m from each side of runway centreline; 45 m from each side of taxi way centreline; 50 m from edge of taxi ramps or aprons.

.2 Install cedar post type markers.

.3 Lay concrete markers flat and centred over cable with top flush with finish grade.

3.4 FIELD QUALITY CONTROL

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

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests.

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 High Potential (Hipot) Testing.

.1 Conduct hipot testing in accordance with manufacturer's recommendations.

.4 Leakage Current Testing.

.1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.

.2 Hold maximum voltage for specified time period by manufacturer.

.3 Record leakage current at each step.

.7 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1. RELATED DOCUMENTS

.1 NA

1.2. SUMMARY

.2 The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

.3 The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed).

.4 All system devices shall be networked together enabling digital communication and shall be individually addressable.

.5 The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.

.6 The system architecture shall facilitate remote operation via a computer connection.

.7 The system shall not require any centrally hardwired switching equipment.

.8 The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

1.3. DEFINITIONS

.1 NA

1.4. SUBMITTALS

.1 Product Datasheets (general device descriptions, dimensions, wiring details, nomenclature)

.2 Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)

.3 Other Diagrams – as needed for special operation or interaction with other system(s)

.4 Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up

.5 Hardware and Software Operation Manuals

.6 Other operational descriptions as needed

1.5. QUALITY ASSURANCE

.1 All components and the manufacturing facility where product was manufactured must be ROHS compliant.

.2 In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

.3 All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.6. COORDINATION

.1 Coordinate lighting control components to form an integrated interconnection of compatible components.

.2 Coordinate lighting controls with BAS (if necessary) either through IP based intercommunication of system or hardwired auxiliary relay outputs.

.3 The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.7. WARRANTY

.1 All devices in lighting control system shall have a 5 year warranty.

Part 2 Products

2.1. MANUFACTURERS

.1 This specification is based on the nLight® Network Control System from Sensor Switch, an Acuity Brands Company (800-727-7483, www.sensorswitch.com).

2.2. SYSTEM REQUIREMENTS

.2 System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

.3 Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

.4 System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section).

.5 Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.

.6 Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

.7 Devices within a lighting control zone shall be connected with CAT-5 low voltage cabling in any order.

.8 Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

.9 Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

.10 Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

.11 All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

.12 System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

.13 System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

.14 System shall be capable of wirelessly connecting a lighting zone to a Wi-Fi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.

.15 Wi-Fi enabled devices shall be able to detect when Wi-Fi network is down and revert to a user directed default state.

.16 Wi-Fi-enabled devices shall be capable of current monitoring.

.17 Wi-Fi-enabled devices shall utilize WPA2 AES encryption.

.18 Wi-Fi-enabled devices shall be able to connect to 802.11b/g/n Wi-Fi networks.

.19 Wi-Fi-enabled devices shall have at least one local RJ-45 port for communicating with non-Wi-Fi-enabled system devices.

.20 System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

.21 Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

.22 Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or Wi-Fi backbone.

.23 System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

.1 Auto-On / Auto-Off (via occupancy sensors)

- Zones with occupancy sensors automatically turn lights on when occupant is detected.
- Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
- Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.

.2 Manual-On / Auto-Off (also called Semi-Automatic)

- Pushing a switch will turn lights on.
- Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

.3 Manual-On to Auto-On/Auto-Off

- Pushing a switch will turn lights on.
- After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
- Sequence can be reset via scheduled (ex. daily each morning) events.

.4 Auto-to-Override On

- Zones with occupancy sensors automatically turn lights on when occupant is detected.
- Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
- Sequence can be reset via scheduled (ex. daily each morning) events.

.5 Manual-to-Override On

- Pushing a switch will turn lights on.
- Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
- Sequence can be reset via scheduled (ex. daily each morning) events.

.6 Auto On / Predictive Off

- Zones with occupancy sensors automatically turn lights on when occupant is detected.
- Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

- If switch is pressed, lights turn off and a short "exit timer" begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.

.7 Multi-Level Operation (multiple lighting levels per manual button press)

- Operating mode designed specifically for bi-level applications.
- Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
- Eliminates user confusion as to which of two buttons controls which load.
- Three different transition sequences are available in order to comply with energy codes or user preference).
- Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
- Depending on the sequence selected, every button push steps through relays states according to below table.
- In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to "step" in a sequence that achieves bi-level operation is present.

	Alternating Sequence		Full On Sequence		3 Step On Sequence	
Sequence State #	Relay 1	Relay 2	Relay 1	Relay 2	Relay 1	Relay 2
1	On	Off	On	Off	On	Off
2	Off	On	-	-	Off	On
3	-	-	On	On	On	On
4*	Off	Off	Off	Off	Off	Off

(*step only present for devices without separate off button)

.24 A taskbar style desktop application shall be available for personal lighting control.

.25 An application that runs on "smart" handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control Apple iOS is a required platform for lighting control by mobile devices.

.26 Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

.27 Control software shall enable integration with a BMS via BACnet IP.

.28 System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3. INDIVIDUAL DEVICE SPECIFICATIONS

.1 Control Module (Gateway)

.1 Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.

.2 Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

.3 Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.

.4 Device shall automatically detect all devices downstream of it.

.5 Device shall have a standard and astronomical internal time clock.

.6 Device shall have one RJ-45 10/100 BaseT Ethernet connection.

.7 Device shall have a USB port.

.8 Each control gateway device shall be capable of linking 1500 devices to the management software.

.9 Device shall be capable of using a dedicated or DHCP assigned IP address.

.10 Network Control Gateway device shall be the following Sensor Switch model Series:

- **nGWY2**

.2 Networked System Occupancy Sensors

.1 Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

.2 Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

.3 For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

.4 Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.

.5 All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

.6 Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120

/ 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

.7 Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.

.8 Sensors shall be available in multiple lens options which are customized for specific applications.

.9 Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

.10 All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

.11 All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue.

.12 Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

.13 Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

.14 Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.

.15 Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

.16 Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

.17 Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

.18 Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, and Gray).

.19 Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.

.20 Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:

- **nWSD** or **nWSX** (PIR, 1 Relay)
- **nWSD PDT or nWSX PDT** (Dual Tech, 1 Relay)
- **nWSD NL** (PIR w/ Night Light, 1 Relay)
- **nWSD PDT NL** (Dual Tech w/ Night Light, 1 Relay)
- **nWSX NL LV** (PIR w/ Night Light, No Relay)
- **nWSD PDT NL LV** (Dual Tech w/ Night Light, No Relay)
- **nWSD LV** or **nWSX LV** (PIR, No Relay, Raise/Lower Dim Ctrl)
- **nWSD PDT LV or nWSX PDT LV** (Dual Tech w/ Night Light, No Relay, Raise/Lower Dim Ctrl)

.21 Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.

.22 Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection.

.23 Embedded sensors shall have an optional photocell.

.24 Embedded sensors shall be the following Sensor Switch model number:

- **nES 7** (PIR, No Relay)
- **nES 7 ADCX** (PIR w/ Photocell, No Relay)
- **nES PDT 7** (Dual Technology, No Relay)
- **nES PDT 7 ADCX** (Dual Technology w/ Photocell, No Relay)

.25 Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.

.26 Fixture mount sensors shall be capable of powering themselves via a line power feed.

.27 Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

.28 Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

.29 Sensors shall be the following Sensor Switch model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCMR(B) 9	1	1	Standard	PIR
nCMR(B) 9 2P	2	2	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCMR(B) PDT 9	1	1	Standard	Dual
nCMR(B) PDT 9 2P	2	2	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCMR(B) 10	1	1	Extended	PIR
nCMR(B) 10 2P	2	2	Extended	PIR
nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCMR(B) PDT 10	1	1	Extended	Dual
nCMR(B) PDT 10 2P	2	2	Extended	Dual
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCMR(B) 6	1	1	High Bay	PIR
nCMR(B) 6 2P	2	2	High Bay	PIR
nCMR(B) 6 480	1	2	High Bay	PIR

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR(B) 9 => nRMR 9)

.30 System shall have Wi-Fi enabled fixture mountable sensors available.

.31 Embedded sensors shall have an optional photocell and 0-10 VDC dimming output.

.32 Wi-Fi enable sensors shall be one of the Sensor Switch model numbers:

- **nCMRB 6 WIFI** (PIR, w/ Relay)
- **nCMRB 10 WIFI** (PIR, w/ Relay)
- **nCMRB 50 WIFI** (PIR, w/ Relay)
- **nCMRB 9 WIFI** (PIR, w/ Relay)

.3 **Networked System Daylight (Photocell and or Dimming) Sensors**

.1 Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

.2 Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

.3 Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

.4 Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).

.5 Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

.6 Combination units that have all features of on/off photocell and dimming sensors shall also be available.

.7 A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

.8 Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.

.9 Sensor shall be the following Sensor Switch model numbers, with device options as specified:

- **nCM(B) PC** (on/off)
- **nCM(B) ADC** (dimming)
- **nCM(B) PC ADC** (on/off, 0-10 VDC dimming)
- **nCMR(B) PC** (on/off, single relay)
- **nCMR(B) PC ADC** (on/off, 0-10 VDC dimming, single relay)

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR(B) PC => nRMR PC)

.10 Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

.11 Embedded sensors shall be the following Sensor Switch model number:

- **nES ADCX** (Dimming Photocell)

.4 **Networked System Power (Relay) Packs**

.1 Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

.2 Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.

.3 All devices shall have two RJ-45 ports.

.4 Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

.5 Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

.6 When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

.7 Power Packs and Power Supplies shall be available that are Wi-Fi enabled.

.8 Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.

.9 Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.

.10 Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.

.11 Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

.12 Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.

.13 Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.

.14 Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.

.15 Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.

.16 Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.

.17 Specific Secondary Packs shall be available that control louver/damper motors for skylights.

.18 Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

.19 Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:

- **nPP16** (Power Pack w/ 16A relay)
- **nPP16 WIFI** (Power Pack w/ 16A relay, WIFI enabled)
- **nEPP5 D** (Power Pack w/ 5A relay and 0-10VDC dimming output)
- **nSP16** (Secondary Pack w/ 16A relay)
- **nSP5 2P** (Secondary Pack w/ two 5A relays)
- **nSP5 D** (Secondary Pack w/ 5A relay and 0-10VDC dimming output)
- **nPP16 ER** (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
- **nSP5 D ER** (UL924 Listed Secondary Pack w/ 5A relay and 0-10VDC dimming output for switching emergency power circuits)
- **nSP5 PCD 2W** (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
- **nSP5 PCD 3W** (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
- **nSP5 PCD MLV** (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
- **nSP5 PCD ELV 120** (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
- **nSP5 480** (Secondary Pack w/ 5A relay for switching 208/240/480 VAC loads)
- **nSP5 2P LVR** (Louver/Damper Control Pack)
- **nSHADE** (Pulse On/Off Control Pack)
- **nPS 80** (Auxiliary Bus Power Supply)
- **nPS 80 WIFI** (Auxiliary Bus Power Supply, Wi-Fi enabled)
- **nAR 40** (Low voltage auxiliary relay pack)

.5 **Networked System Relay & Dimming Panels**

.1 Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.

.2 Relays shall be rated to switch up to a 30A ballast load at 277 VAC.

.3 Panel shall provide one 0-10VDC dimming output paired with each relay.

.4 Panel shall power itself from an integrated 120/277 VAC supply.

.5 Panel shall be capable of operating as either two networked devices or as one.

.6 Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.

.7 Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.

.8 Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:

- **nPANEL 4** (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
- **nPANEL 2 480** (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

.6 **Networked Auxiliary Input / Output (I/O) Devices**

.1 Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.

.2 Devices shall have two RJ-45 ports.

.3 Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

.4 Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).

.5 Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.

.6 Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output.

.7 Specific I/O devices shall sense state of low voltage outdoor photocells.

.8 Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

.9 Specific I/O devices shall sense.

.10 Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:

- **nIO D** (I/O device with 0-10 dimming output)
- **nIO 1S or nIO RLX** (I/O device with contact closure or 0-10VDC dimming input)
- **nIO NLI** (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
- **nIO X** (Interface device for communicating with RS-232 enabled AV Touch Screens)

.7 **Networked LED Luminaires**

.1 Networked LED luminaire shall have a mechanically integrated control device.

.2 Networked LED luminaire shall have two RJ-45 ports.

.3 Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers).

.4 Networked LED luminaire shall provide low voltage power to other networked control devices.

.5 System shall be able to turn on/off LED luminaire without using a relay.

.6 System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).

.7 System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).

.8 LED Luminaires shall be the following Lithonia model families:

- **RTLED**
- **TLED**
- **VLED**
- **ACLED**
- **AL LED**
- **WLED**
- **STLED**
- **MINO**

.8 **Networked System Wall Switches & Dimmers**

.1 Devices shall recess into single-gang switch box and fit a standard GFI opening.

.2 Devices shall be available with zero or one integrated Class 1 switching relay.

.3 Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

.4 All sensors shall have two RJ-45 ports.

.5 All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.

.6 Devices shall be available in four colors (Ivory, White, Light Almond, and Gray).

.7 Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).

.8 Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.

.9 Devices with mechanical push-buttons shall provide tactile and LED user feedback.

.10 Devices with mechanical push-buttons shall be made available with custom button labeling.

.11 Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

.12 Wall switches & dimmers shall be the following Sensor Switch model numbers, with device options as specified:

- **nPOD** (single on/off, capacitive touch, audible user feedback)
- **nPOD 2P** (dual on/off, capacitive touch, audible user feedback)

- **nPODR** (single on/off, one relay, capacitive touch, audible user feedback)
- **nPODM** (single on/off, push-buttons, LED user feedback)
- **nPODM 2P** (dual on/off, push-buttons, LED user feedback)
- **nPODM DX** (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
- **nPODM 2P DX** (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
- **nPODM 4P** (quad on/off, push-buttons, LED user feedback)
- **nPODM 4P DX** (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

.9 **Networked System Graphic Wall Station**

.1 Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.

.2 Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.

.3 Device shall enable user supplied .jpg screen saver image to be uploaded.

.4 Device shall surface mount to single-gang switch box.

.5 Device shall have a micro-USB style connector for local computer connectivity.

.6 Device shall have two RJ-45 ports for communication.

.7 Device shall be the following Sensor Switch model number:

- **nPOD GFX**

.10 **Networked System Scene Controllers**

.1 Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

.2 Device shall recess into single-gang switch box and fit a standard GFI opening.

.3 Devices shall provide LED user feedback.

.4 Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

.5 All sensors shall have two RJ-45 ports.

.6 Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.

.7 Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

.8 Device shall have LEDs indicating current selection.

.9 Scene Selector device shall be the following Sensor Switch model number:

- **nPODM 2S** (2 Scene, push-button)
- **nPODM 4S** (4 Scene, push-button)
- **nPODM 4S DX** (4 Scene, push-button, On/Off/Raise/Lower)
- **nPODM 4L DX** (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

.11 **Communication Bridges**

.1 Device shall surface mount to a standard 4" x 4" square junction box.

.2 Device shall have 8 RJ-45 ports.

.3 Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

.4 Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

.5 Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

.6 Communication Bridge devices shall be the following Sensor Switch model numbers:

- **nBRG 8** (8 Ports)

2.4. LIGHTING CONTROL PROFILES

.1 Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

.2 Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

.3 All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

.4 Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

.5 All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

.6 Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

.7 Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

.8 Daylight savings time adjustments shall be capable of being performed automatically, if desired.

.9 Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

.10 Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5. MANAGEMENT SOFTWARE

.1 Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software.

.2 The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

.3 The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

.4 A printable network inventory report shall be available via the software.

.5 A printable report detailing all system profiles shall be available via the software.

.6 Software shall require all users to login with a User Name and Password.

.7 Software shall provide at least three permission levels for users.

.8 All sensitive stored information and privileged communication by the software shall be encrypted.

.9 All device firmware and system software updates must be available for automatic download and installation via the internet.

.10 Software shall be capable of managing systems interconnected via a WAN (wide area network).

2.6. BMS COMPATIBILITY

.1 System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

.2 BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

.3 BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

.1 System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

.2 Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

.3 An “Energy Scorecard” shall be displayed that shows calculated energy savings in dollars, kWh, or CO2.

.4 Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).

.5 Energy savings data shall be calculated for the system as a whole or for individual zones.

.6 A time scaled graph showing all relay transitions shall be presented.

.7 A time scaled graph showing a zones occupancy time delay shall be presented.

.8 A time scaled graph showing the total light level shall be presented.

.9 User shall be able to customize the baseline run-time hours for a space.

.10 User shall be able to customize up to four time-of-day billing rates and schedules.

.11 Data shall be made available via a .CSV file.

2.8. START-UP & SUPPORT FEATURES

.1 To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

.2 All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

.3 Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

.4 All system devices shall be capable of being given user defined names.

.5 All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

.6 All sensor devices shall have the ability to detect improper communication wiring and blink it’s LED in a specific cadence as to alert installation/startup personnel.

END OF SECTION

Part 1 General

1.1 HARMONICS PERFORMANCE, POWER QUALITY AND EFFICIENCY REQUIREMENTS

.1 This Section includes Energy Efficient Dry-type harmonic mitigating transformers, rated 600V.

.2 The transformers per this specification shall be designed to treat all major harmonics produced by phase-neutral, phase-phase, and 3-phase six-pulse electronic equipment: 3rd, 5th, 7th and 9th.

.3 Efficiency: Efficiency of the transformer shall be according to NEMA TP-1 and EPA ENERGY STAR requirements (97.5% for 30kVA, 97.7% for 45kVA, 98.0% for 75kVA, 98.2% for 112.5kVA, 98.3% for 150kVA, 98.5% for 225kVA, 98.6% for 300kVA, 98.7% for 500kVA, 98.8% for 750kVA, 98.9% for 1000kVA).

.4 Nonlinear Load Efficiency: 98% minimum for all transformers 75kVA and above, 97.5% for transformers 45kVA and smaller.

.5 3rd Harmonic Treatment: The transformer design shall be in such a way that 3rd, 9th and other zero sequence currents shall not be coupled into the primary winding.

.6 5th & 7th Harmonic Treatment: The transformer design shall be in such a way that 5th, 7th, 17th, 19th harmonics are treated by introducing the appropriate primary-to-secondary phase-shift in the transformers such that the currents produced by these harmonics shall be subtract at the common bus with those produced by other similar sources.

.7 Phase shift: primary to secondary phase shift shall accommodate treatment of the targeted harmonics.

.8 Voltage Distortion: Transformers shall be designed in such a way to minimize the voltage THD to facilitate conformity with IEEE 519 requirements.

.9 Fundamental current imbalance: Transformer design shall be in such a way to reduce the current imbalance on the primary side compared to the secondary side.

.10 Load Compatibility: Transformer shall accept load profile of up to K-30 up to its nameplate kVA rating without derating

1.2 SUBMITTALS

.1 Cut Sheet: Shall include benefits, features, model numbers, available options and warranty period.

.2 Enclosure Cut Sheet: Shall include the enclosure drawing, all the external dimensions, mounting dimensions and the maximum conduit entrance height.

.3 Installation Guidelines: Shall include wiring, neutral to ground bond, connection terminations and configurations.

.4 Operation and Maintenance: Shall include storage, installation inspections, energizing and de-energizing conditions and maintenance directions.

.5 Engineering Technical Data Sheet: Shall include the rating, frequency, primary voltage with the number of taps, secondary voltage, transformer type, phase shift between primary and secondary, primary and secondary connections, rating of the neutral bus, insulation class, maximum temperature rise, noise attenuation, maximum ambient temperature, winding material, core material, location of the anti-vibration pads, excitation at nominal voltage, no load losses, Load losses at 100% load, efficiency at ¼, ½, ¾, and full load, positive and negative sequence Impedance, zero sequence Impedance, Inrush current, audible noise, enclosure type, paint type, enclosure size, weight, primary and secondary BIL.

1.3 QUALITY ASSURANCE

.1 Listing and Labeling: Provide transformers specified in this Section that are listed by Underwriters Laboratories (UL), Canadian Underwriters Laboratories (ULc) and bear the EPA ENERGY STAR logo. Provide CE mark when requested.

.2 Transformers shall meet relevant NEMA, UL, ANSI, EPA and IEEE standards.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Material and Equipment. Transport, handle, store and protect products.

.2 Deliver transformers individually wrapped for protection and mounted on shipping skids.

.3 Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

.4 Do not stack transformers.

.5 Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

1.5 WARRANTY

.1 Provide 20-year pro-rated warranty (linearly distributed) against defects in materials and workmanship.

.2 Show the warranty period on the product catalogue.

.3 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

Part 2 Products

2.1 TRANSFORMERS

2.2 REQUIREMENTS AND MANUFACTURERS

.1 Manufacturer must be a US Environmental Protection Agency (EPA) ENERGY STAR Partner.

.2 The transformer must bear the EPA ENERGY STAR logo and maintain the specified efficiency under the nonlinear loading.

.3 The transformer must be a standard item in manufacturer's published catalog. A custom product, one that requires design and/or packaging modifications to meet this specification, is not acceptable.

.4 Acceptable Manufacturer: Synergy Energy Inc.

.5 Alternative manufacturer and product are subject to full compliance with this specification, and must be approved by Contract Administrator at least 10 days prior to bid closing. No exception to this requirement is permitted.

2.3 CONSTRUCTION DETAILS

.1 Description: Transformer shall be of two winding, three coil (two coil is not accepted) natural convection air cooled (forced air is not accepted).

.2 Frequency: Transformer shall be rated for 60 Hz. (OPTION: 50Hz)

.3 System Voltage: Primary and secondary voltages shall be according to the technical drawings. Typical primary voltage is 600V, 3-phase primary to 208/120V secondary.

.4 Core: Core material shall be Grain-oriented, non-aging silicon steel, 3-leg, common core.

.5 Coils: Winding material shall be copper, continuously wound without splices, except for taps.

.6 Internal Coil Connections: Brazing shall be used to interconnect the coils using silver alloy rods.

.7 Primary Winding: Each phase shall have one coil on one leg, 3-phase, and 3-wire.

.8 Secondary Winding: Each phase shall have multiple coils on multiple legs, 3-phase, and 4-wire.

.9 Insulation class: Insulation class shall be 220 ºC rated. Any other insulation class is not acceptable.

.10 Rated Operating Temperature Rise: 130 ºC above 40 ºC Ambient. 150 ºC temperature rise is not acceptable.

.11 Varnishing: The varnish shall be water based, Polyester to minimize the environmental effect and shall incorporate vacuum pressure impregnation for transformers over 1000 Volts rating.

.12 Taps: Transformers shall have 2x2.5% full capacity taps above nominal voltage (FCAN) and 2x2.5% full capacity taps bellow nominal voltage (FCBN) on the primary side.

.13 Product Nameplate: The product nameplate shall be UL approved Aluminum based and show the kVA rating, number of phases, Phase angle between primary and secondary, primary voltage and connection points, secondary voltage and connection points, maximum temperature rise, insulation class, number of taps, noise attenuation level, sound level, impedance, enclosure type, serial number, weight, manufacturing date, tap connection points and vector diagram of the transformer windings together with clear indication of the separation required between the ventilated sides and adjacent surfaces.

.14 Enclosure Finish: The enclosure shall be powder coated.

.15 Enclosure Color: The enclosure color shall be ANSI 61 Grey (Standard electrical equipment grey). Other colors optional.

.16 Enclosure type: The enclosure shall be of outdoor, ventilated, rainproof, NEMA-3R type. The transformer shall have louvers to protect it from rain or fire extinguishing sprinklers. Rain shields are not acceptable due to increased footprint.

.17 Enclosure Mounting: The enclosures for 15 kVA and under shall have standard wall mounting brackets. Transformers 30 kVA and up should have the ventilation openings to the side so that they can be mounted against the wall without the need for extra ventilation space.

.18 Sound Levels: Sound Levels shall be according to NEMA ST 20 standard and factory tested according to IEEE C57.12.91 (10-50kVA: 45dB, 51-150kVA: 50dB, 151-300kVA: 55dB, 301-500kVA: 60dB, 501-700kVA: 62dB, 701-1000kVA: 64dB).

.19 Electrostatic Shielding: Each winding shall be independently shielded with a full-width copper electrostatic shield between the primary and secondary windings. The leads from the electrostatic shields shall be brought to an IEC finger safe terminal block. (OPTION: dual shield).

.20 Neutral conductor rating shall be 200 percent of phase rating.

.21 Connection Points: Transformers with primary or secondary not exceeding 175 Amps shall have IEC finger safe terminal blocks. Transformers exceeding 175 Amps shall have appropriately sized copper busbar drilled with holes for ease of installation

.22 Transformer, with characteristics and options specified, must deliver the energy efficiency level specified in NEMA TP-1 and required under the EPA ENERGY STAR program.

.23 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47.

Part 3 Execution

3.1 INSTALLATION

.1 Mount transformers as indicated. Wall mount with vibration resistant isolation pads or floor mount with housekeeping pad and vibration resistant isolation pads.

.2 Ensure adequate clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

.5 Loosen isolation pad bolts until no compression is visible.

.6 Make primary and secondary connections in accordance with wiring diagram.

.7 Energize transformers after installation is complete.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Service equipment and installation.

1.2 RELATED SECTIONS

.1 Section 26 05 28 - Grounding - Secondary.
.2 Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
.3 Section 26 28 21 - Moulded Case Circuit Breakers.
.4 Section 26 28 23 - Disconnect Switches - Fused and Non-Fused.
.5 Section 26 24 16 - Panelboards Breaker Type.
.6 Section 26 28 20 - Ground Fault Circuit Interrupters - Class "A".

Part 2 Products

2.1 EQUIPMENT

.1 Fused disconnect switch: in accordance with Section 26 28 23 - Disconnect Switches - Fused and Non-Fused, rating as per drawings.

.2 Enclosed circuit breaker: in accordance with Section 26 28 21 - Moulded Case Circuit Breakers, rating as per drawings.

.3 Panelboard breaker type: in accordance with Section 26 24 16 - Panelboards Breaker Type, rating as per drawings.

.4 Cabinet type 'A' for utility revenue metering, Junction box, Pull box and Splitter boxes: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets, size as per drawings.

.5 Equipment shall be sprinkler-proof.

.6 Main Distribution shall be equipped with a 200kA TVSS and indicator lights.

Part 3 Execution

3.1 INSTALLATION

.1 Install service equipment.
.2 Connect to incoming service.
.3 Connect to outgoing load circuits.
.4 Install ground fault equipment.
.5 Make grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.
.6 Make provision for power supply authority's metering.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for service entrance board.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

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

1.3 REFERENCES

.1 CAN/CSA-C22.2 No.31-M89(R2000), Switchgear Assemblies.

1.4 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate on shop drawings.

- .1 Floor anchoring method and foundation template.
- .2 Dimensioned cable entry and exit locations.
- .3 Dimensioned position and size of bus.
- .4 Overall length, height and depth.
- .5 Dimensioned layout of internal and front panel mounted components.

.3 Include time-current characteristic curves for circuit breakers and fuses.

1.5 QUALITY ASSURANCE

.1 Submit copies of certified test results.

1.6 CLOSEOUT SUBMITTALS

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

.2 Submit copies maintenance data for complete assembly including components.

1.7 EXTRA MATERIALS

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

Part 2 Products

2.1 SERVICE ENTRANCE BOARD

.1 Service Entrance Board: to CAN/CSA-C22.2 No.31.

.2 Confirm access requirements, provide narrow depth board if required.

.3 Rating: as indicated.

.4 Cubicles: sprinkler proof, wall-mounted, or free standing, size as indicated.

.5 Barrier metering section from adjoining sections.

.6 Provision for installation of power supply authority metering in barriered section.

.7 Manitoba Hydro metering.

.8 Distribution section.

.9 Access panels with captive screws.

.10 Bus bars and main connections: 99.3% copper.

.11 Cable from load terminals of main breaker to metering section and cable from metering section to lugs of distribution section.

.12 Identify phases with colour coding.

.13 Panel cover shall be hinged. Doors on covers shall be lockable.

2.2 MOULDED CASE CIRCUIT BREAKERS

.1 Refer to 26 28 21.

2.3 FUSIBLE DISCONNECTS AND FUSES

.1 N/A.

2.4 GROUNDING

.1 Copper ground bus extending full width of cubicles and located at bottom.

.2 Lugs at each end for size 4/0grounding cable.

.3 Provide external Ground Bus bonded to main Ground bus as well.

2.5 TVSS Unit

.1 Provide TVSS unit with digital indication and 200kA rating.

2.6 POWER SUPPLY AUTHORITY METERING

.1 Separate cubicle compartment and metal raceway for exclusive use of power supply authority metering.

.2 Mounting accessories and wiring for metering supplied by Contractor in accordance with power supply authority:

.1 potential transformers.
.2 current transformers.
.3 Watthour meter.
.4 Demand meter with kW.h register.

2.7 FINISHES

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

.1 Service entrance board exterior: grey.

2.8 EQUIPMENT IDENTIFICATION

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

.2 Nameplates:

.1 White plate, black letters, size 7.
.2 Complete board labelled: "347/600V."
.3 Main disconnect labelled: "Main Breaker".
.4 Branch disconnects labelled: as indicated.

2.9 SOURCE QUALITY CONTROL

.1 Contract Administrator to witness final factory tests.

.2 Notify Contract Administrator in writing 5 days in advance that service entrance board is ready for testing.

Part 3 Execution

3.1 INSTALLATION

.1 Locate service entrance board and fasten to wall and/or floor as applicable.

.2 Connect main secondary service to line terminals of main breaker.

.3 Connect load terminals of distribution breaker's to feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run two grounding conductors 4/0 AWG bare copper in conduit from ground bus to building ground.

.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

.7 Provide labelling indicating “Arc-Fault Hazard” as per the NFPA requirements.

.END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Integrated Power Center 'IPC'– Furnish and install an integrated solution as specified herein and where shown on the associated drawings.

.2 The section shall include:

- .1 Main Service Section
- .2 Main Disconnect Device
- .3 Utility Metering Compartment
- .4 Power Distribution Interior
- .5 Dry Type Transformer
- .6 Lighting and Appliance Panel Interiors
- .7 Individually Mounted Circuit Breakers
- .8 Customer Metering
- .9 TVSS Devices
- .10 Third Party Equipment

1.2 REFERENCES

.1 The equipment referenced herein shall be designed and manufactured according to the latest revision of all applicable standards, codes or specifications, including the following: Note standards may be met through harmonization of the corresponding UL Standards.

- .1 CSA 22.2 No. 94.1 – Standards for enclosures for electrical equipment
- .2 CSA 22.2 No. 29 – Standards for panelboards
- .3 CSA 22.2 No. 14 – Standards for Industrial Controls
- .4 CSA 22.2 No. 31/244 – Standards for switchboards
- .5 CSA C22.2 No. 5 - Molded Case Circuit Breakers

1.3 SUBMITTAL AND RECORD DOCUMENTATION

.1 Approval documents shall include drawings. Drawings shall contain overall switchboard enclosure dimensions. The location of the main, branches, and solid neutral shall be shown clearly. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems. Record drawings shall be made available to the customer through electronic transmission. The customer may request any of the following formats: DXF, DWG or PDF.

1.4 QUALIFICATIONS

.1 Company specializing in assembly of integrated equipment with a minimum of twenty-five (25) years documented experience.

.2 Panelboards shall be manufactured in accordance with standards listed in "References". Operating voltages: to CAN3-C235.

.3 The company that assembles and provides the integrated equipment enclosure(s) shall be the same company that manufactures the panelboards, circuit breakers and dry type transformers.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Inspect and report concealed damage to carrier within their required time period.

.2 Handle carefully to avoid damage to panelboard internal components, enclosure and finish.

.3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

.1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 – "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.7 WARRANTY

.1 Manufacturer shall warrant specified equipment free from defects in materials and workmanship for eighteen (18) months from the date of invoice.

Part 2 Products

2.1 MANUFACTURERS

.1 Shall be Square D by Schneider Electric 'IPC-2', or approved equal in accordance with B7. Substitutions must be submitted in writing with supporting documentation demonstrating that the alternate manufacturer meets all aspects of the specification herein.

2.2 RATINGS

.1 600Y/347, 120Y/208 volt power panels, lighting panels, individually mounted circuit breakers, shall be rated to withstand mechanical forces exerted during short circuit conditions when connected to a power source having an available fault current of 42,000 amperes symmetrical at rated voltage as shown on the drawing Control wiring and conduit below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

.2 The short circuit current rating of section shall be limited to the lowest short circuit rating or series connected rating of any installed device in that section.

.3 The equipment shall be suitable for and certified to meet applicable seismic requirements of the Canadian National Building Code (NBC), International Building Code (IBC), 2009 ICC Edition and ASCE 7-02, or later, for the site-specific location. Guidelines for the installation shall be provided by the equipment manufacture and based on testing of representative equipment. Equipment capacity shall be determined from tri-axial seismic shake table results as defined in ICC ES AC 156.

2.3 ENCLOSURES

.1 Enclosure: Type 1 - General Purpose 1 With Drip Hood

.1 Enclosures shall be constructed in accordance with UL 891/ CSA 22.2 No. 244 requirements.

.2 Sections shall be aligned front and rear.

.3 Removable steel base channels (1.5 inch floor sills) shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.

.4 Enclosure shall be painted on all exterior surfaces. The paint finish shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.

.5 All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.

.6 Each line up shall consist of the required number of vertical sections bolted together to form a rigid assembly.

.7 Sections shall allow for top and/or bottom cable entry and exit.

.8 Single section shipping splits shall not exceed 48 in. (1218 mm) wide maximum.

.9 Multiple section shipping splits shall not exceed 96 in. (2438 mm) wide maximum.

2.4 BUSSING

.1 The Integrated Power Center switchboard bussing shall be silver-plated copper.

.2 The through bus shall have a maximum ampacity of 2,000A. The bussing shall be of sufficient cross-sectional area to meet the CSA C22.2 No. 31 standard for temperature rise.

.3 The IPC Switchboard shall be rated with a minimum short circuit rating of 35,000A at 600Vac

.4 Provisions shall be made for future splicing of additional sections.

.5 The utility metering compartment shall have provisions for [window type] [bar type] current transformers as supplied by the applicable public utility.

.6 Factory provided power cables shall be used by the installer to connect the transformer to the distribution section.

2.5 MAIN DISCONNECT DEVICES

.1 Main Circuit Breaker shall be electronic trip molded case, full function, circuit breaker

a. Shall be rated for 80% continuous current and be Square D PowerPact R style breaker with MICROLOGIC trip system.
b. Rated ampacity shall be 2,000A
c. Circuit breaker trip system shall be a MICROLOGIC electronic trip unit:

.1 All trip units shall be removable to allow for field upgrades.

.2 Trip Units shall incorporate “True RMS Sensing”, and have LED long-time pickup indications.

.3 MICROLOGIC trip unit functions shall consist of adjustable long-time pickup and delay, short-time pickup and delay, instantaneous and ground-fault pickup and delay.

.4 Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times Ir.

.5 Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir. Short-time delay shall be in nine bands from 0.1–0.4 I 2 t ON and 0–0.4 I 2 t OFF

.6 Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15 times In. The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided.

.7 All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch. [Optional: trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.]

.8 Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.

.9 Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.

.10 Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.

.11 Trip units shall be available to provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the adjustment of the slope of the long-time delay protection.

.12 Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency. Metering accuracy shall be 1.5% current, 0.5% voltage, and 2% power. These accuracy’s shall be total system including CT and meter.

2.6 METERING

.1 Metering shall be Square D PowerLogic 5000 series.

.2 The metering device used to monitor circuits for purposes of network management, energy cost management, energy allocation, and operational efficiency shall have the following minimum features:

.1 Connections and form factor - direct connect to circuits up to 600 VAC, eliminating the need for voltage (potential) transformers; five (5) amperes (A) nominal current inputs. Removable connectors for voltage inputs, control power, communications, inputs and outputs; easily mountable in the pre-made cutout without tools; form factor shall be ¼ DIN with 92 X 92 cut-out and 96 x 96 panel mount integrated display.

.2 Supported monitoring parameters—full range of 3-phase voltage, current, power and energy measurements, power factor, frequency, total harmonic distortion (THD), individual power harmonics (up to 63rd order).

.3 Accuracy standards - use four-quadrant metering and sample current/voltage simultaneously without gaps with 64 samples per cycle (zero bling); comply with ANSI C12.20 class 0.2 and IEC 61557-12 class 0.2 for revenue meters.

.4 Display - Backlit dot-matrix LCD display, anti-glare and scratch resistant with a minimum of 128 x128 pixels, capable of displaying four values in one screen simultaneously; a summary screen to allow the user to view a snapshot of the system; support either integrated or remote display.

.5 Support four (4) digital inputs for Demand Synch Pulse, Time Synch Input, and Conditional Energy Control; have two (2) digital outputs that operate either by user command sent over communication link, or in response to a user defined alarm or event.

.6 Communications - serial RS-485 Modbus, Ethernet Modbus TCP, and Ethernet BACnet IP (BTL certified); provide two Ethernet ports to allow wiring from meter to meter as a daisy-chain; be capable of serve data over the Ethernet network accessible through a standard web browser; the monitor shall contain default pages from the factory.

.7 Onboard data logging capabilities - to log data, alarms and events; logged information will include data logs, minimum/maximum log files of selected parameter values, and alarm logs for each user defined alarm or event log; support the following on-board nonvolatile memory—14 parameters every 15 minutes for 90 days.

.8 Alarming capabilities - support 29 set-point driven alarms, four (4) digital alarms, (4) unary alarms, 10 Boolean alarms and five (5) custom alarms; user definable alarm events; set-point driven alarms shall be available for voltage/current parameters, input status, and end of interval status.

.9 Firmware-upgradeable to enhance functionality through the Ethernet or serial communication connection and shall allow upgrades of individual meters or groups.

.10 Integrated gateway functionality, enabling the capability to connect via Ethernet to downstream, serially connected devices if specified.

2.7 DISTRIBUTION SECTION DEVICES

A. Circuit Breakers Group Mounted:

.1 Breakers and all components shall be designed, manufactured and tested in accordance with applicable UL and CSA standards.

.2 Circuit breaker(s) shall be rated for 80% continuous current. Circuit breakers shall be CDP-type PowerPact as manufactured by Schneider Electric, with thermal-magnetic or MICROLOGIC® electronic trip units as specified on the associated drawings. Circuit breakers shall have voltage and interrupting ratings that meet the application requirements.

.3 Circuit breakers(s) shall have 35 kA interrupting capacity at 600Vac. Two tier CSA or UL listed series ratings are acceptable. When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided showing the CSA or UL approved series ratings including:
- Voltage
- Size and type of upstream fuses or breakers
- Size and type of branch devices that can be used

.4 Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

.5 The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

.6 Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.

.7 All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

B. Trip Units:

.1 The metering used to monitor circuits for purposes of network management, energy cost management, energy allocation, and operational efficiency shall be integral to the circuit breaker.

.2 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

.3 Circuit breaker trip system shall be a microprocessor-based true RMS. Sensor ampere ratings shall be as indicated on the associated drawing.

.4 Local visual trip indication for overload, short circuit and ground fault trip occurrences.

.5 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

.6 Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided as required by diagram.

.7 Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.

.8 Neutral current transformers shall be available for four-wire systems.

.9 Trip units shall have the capability to be electronically adjusted the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments shall be 1 ampere. Fine increments for delay adjustments shall be one second

.10 Trip units shall be available to provide real time metering. Metering functions shall include, but shall not be limited to, the following:

a. Current (phases, neutral, average, maximum).
b. Voltage (phase-to-phase, phase-to-neutral, average, unbalance).
c. Power (active [kW], reactive [kVAR], apparent [kVA], power factor).
d. Energy (active [kWh], reactive [kVAR], apparent [kVA]).
e. Frequency.
f. Total harmonic distortion (current, voltage).
g. Metering accuracy shall be 1.5 percent current (above 600A), 1.0 percent current (600A and below), 0.5 percent voltage, and 2 percent energy. These accuracy's shall be total system, including, but not limited to, CT and meter.

.11 Measurement chain shall be independent from the protection chain.

.12 The measurements shall be displayed on the breaker itself and/or on a remote display and/or on a remote system via Modbus communication.

.13 Connections from circuit breaker to remote display and/or communication module shall be plug-n-play via RJ45 connector No special tools or programming shall be required.

.14 Optional features for applications 600A and smaller, choose all that apply:

a. Zone Selective Interlocking
b. Contact wear indication
c. Operation, trip and alarm counters
d. Operating hours counter
e. Load profile

.15 Optional features for applications above 600A, choose all that apply:

a. Inverse definite minimum time lag (IDMTL)
b. Zone selective interlocking

c. Protective relaying functions (Current unbalance, maximum demand current, reverse power, etc)
d. Phase loading
e. Contact wear indication
f. Wave form capture
g. Data logging

C. Accessories:

.1 Circuit breakers shall be equipped with cUL-listed electrical accessories as noted on the drawings or schedules or they may be field-installable.

.2 The addition of auxiliaries shall not increase the volume of the circuit breaker.

2.8 FRONTS

.1 Trim front shall meet strength and rigidity requirements of applicable CSA/UL standards.

.2 The manufacturer shall provide a hinged door with a key lock over the dead-front of each panelboard interior.

.3 All panelboards shall have door-in-door construction.

.4 All individually mounted circuit breakers and/or equipment space compartments shall have a full width hinged door. The hinged door shall be secured with captive screws.

.5 The transformer front cover shall be secured with screws.

.6 Directory cardholder with typed circuit directory shall be included with each panel interior.

2.9 WIRING / TERMINATION

.1 Factory installed type THHN copper power cables shall electrically connect the transformer to the power panel interior or lighting and appliance panel interiors in the section or lineup.

.2 All control wire shall be type [MTW], [SIS] bundled and secured with nylon ties.

.3 Wire markers shall be provided at each end of controlled branch circuits for lighting contactors (line side wiring only)

.4 When shipping splits are required, power cables shall be cut to length, stripped, labeled and rolled back in one of the adjacent enclosures. Control wiring that bridges shipping splits shall be provided with male/female connectors.

2.10 PANEL INTERIORS

.1 Panel interiors shall be flush mounted with the front of the enclosure to allow easy access to line and/or load conductor’s entering/exiting top or bottom. Recessing the panel interior more than 3 inches from the front of the enclosure will not be acceptable.

.2 Power panel interiors shall be Square D I-LINE circuit breaker type rated 600 Vac maximum – Refer to product specification 16440-3.3 to obtain interior and circuit breaker specifications.

.3 Lighting and Appliance panel interiors shall be NQ circuit breaker type rated 240 Vac maximum - Refer to product specification 16440-3.2 to obtain interior and circuit breaker specifications.

.4 Lighting and Appliance panel interiors shall be NF circuit breaker type rated 480Y/277 Vac maximum - Refer to product specification 16440-3.1 to obtain interior and circuit breaker specifications.

2.11 INDIVIDUALLY MOUNTED CIRCUIT BREAKERS

.1 Individually mounted molded case circuit breaker cell shall have a door to access the wiring compartment.

.2 Individually mounted molded case circuit breaker handles shall be accessible from the front of the section without opening a door.

.3 Circuit breaker options shall include shunt trip

2.12 TVSS UNITS

.1 Integrated surge protective devices shall be Listed and Component Recognized in accordance with UL 1449 Fourth Edition to include Section 37.3 highest fault current category. SPD shall be UL 1283 listed.

.2 Each mode including N-G shall be fused with a 200kA UL recognized surge rated fuse and incorporate a thermal cutout device. SPD shall safely reach an end of life condition when subjected to fault current levels between 0 and 200kA, including low level fault current from 5 to 5000 amperes.

.3 SPD devices in the NQ and NF lighting and appliance panel interiors shall be bus connected.

.4 I-LINE power panel interiors shall have a SPD unit that is branch breaker connected.

.5 Audible diagnostic monitoring shall be by way of audible alarm. The alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided. Provide a set of dry contacts for remote diagnostic monitoring capability as standard. Strike counter and remote strike monitoring shall be provided as an option when shown on the drawings.

.6 See the associated drawings for SPD surge current ratings.

.7 SPD devices shall be free from defects for a period of ten (10) years from the date of invoice by the manufacture or its authorized sales channel.

.8 SPD devices shall be Square D Model EMA, IMA or HWA for service entrance, power distribution, and lighting and appliance panelboard applications. - Refer to product specification 164280-1.2 for in depth SPD specifications.

2.13 INTEGRATED TRANSFORMERS

.1 Shall be Square D by Schneider-Electric Energy Efficient dry type lighting transformers or approved equal in accordance with B7.

.2 Transformer coils shall be copper wound construction and shall be impregnated with non-hygroscopic thermosetting varnish.

.3 Transformer(s) shall be factory installed in a freestanding enclosure as shown on the associated drawings.

.4 Transformers shall be Square D by Schneider-Electric type or approved equal in accordance with B7with the kVA rating as specified on the drawings. - Refer to product specification 26 12 17to obtain general lighting and distribution transformer specifications.

.5 Fan cooled transformers will not be allowed.

.6 An Energy Efficient transformer in combination with a panelboard, individually mounted circuit breaker or lighting controls, shall not exceed 300kVA 150º C Rise. 115ºC, 80ºC or K-Factor are available options but may change the maximum kVA rating.

.7 Energy Efficient stacked transformers shall not exceed 112.5kVA over a 150kVA 150º C Rise. 80ºC or K-Factor are available options but may change the maximum kVA rating.

Part 3 Execution

3.1 INSTALLATION

.1 Install the Integrated Power Center in accordance with manufacturer's written instructions, NEMA B 2.1 “Proper Handling, Installation, Operation and Maintenance of Dead-front Switchboards Rated 600 volts or Less” and CEC / NEC standards.

3.2 FIELD QUALITY CONTROL

.1 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

.2 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 The Contractor shall furnish and install the panelboards as specified and as shown on the contract drawings.

1.2 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures.

.2 Section 26 05 00 – Common Work Results – Electrical.

1.3 REFERENCES

.1 The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of EEMAC and CSA.

.1 CSA C22.2 No.29, Panelboards and enclosed panelboards.

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

.1 The following information shall be submitted to the Contract Administrator in accordance with Section 01 33 00 - Submittal Procedures:

.1 Breaker layout drawing with dimensions indicated and nameplate designation
.2 Component list
.3 Conduit entry/exit locations
.4 Assembly ratings including:
.a Short-circuit rating
.b Voltage
.c Continuous current
.5 Cable terminal sizes

.2 Where applicable, the following additional information shall be submitted to the Contract Administrator:

.1 Busway connection.
.2 Key interlock scheme drawing and sequence of operations

1.5 SUBMITTALS – FOR CONSTRUCTION

.1 The following information shall be submitted in accordance with Section 01 33 00 Submittal Procedures for record purposes:

.1 Final as-built drawings and information for items listed in Paragraph 1.4, and shall incorporate all changes made during the manufacturing process
.2 Installation information

1.6 QUALIFICATIONS

.1 The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.

.2 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Contract Administrator, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.8 OPERATION AND MAINTENANCE MANUALS

.1 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

Part 2 Products

2.1 MANUFACTURERS

.1 Eaton

.2 Square D

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Contract Administrator seven (7) days prior to bid date.

2.2 RATINGS

.1 Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

.2 Panelboards rated 600 Vac shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 14,000 amperes RMS symmetrical.

.3 Panelboards shall be labeled with a CSA short circuit rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the CSA series ratings including:

.1 Size and type of upstream device.

.2 Branch devices that can be used.

.3 CSA series short circuit rating.

2.3 CONSTRUCTION

.1 Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

.2 Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the Contract Administrator's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

.3 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

.4 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides and shall be constructed to allow trim contact on all sides with box when mounted in flush wall.

.5 A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.

.6 All locks shall be keyed alike.

2.4 BUS

.1 Main bus bars shall be copper sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.

.2 A bolted ground bus shall be included in all panels.

.3 Full-size (100%-rated) insulated neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.5 BRANCH CIRCUIT PANELBOARDS

.1 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated. Panelboards shall be Eaton type Pow-R-Line 1a, Pow-R-Line 2a or Pow-R-Line 3a.

.2 Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.

.3 Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be CSA listed as type SWD for lighting circuits.

.1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

.4 Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts, and 14,000 amperes symmetrical at 600 volts, unless otherwise noted on the drawings.

2.6 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

.1 Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings. Panelboards shall be fully rated. Panelboards shall be Eaton type Pow-R-Line 3a or Pow-R-Line 4B. Panelboards shall have molded case circuit breakers as indicated below.

.2 Where indicated, provide circuit breakers CSA listed for application at 100% of their continuous ampere rating in their intended enclosure.

.3 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

2.7 SURGE PROTECTIVE DEVICES

.1 Provide SPD unit with digital indication and 100kA rating.

2.8 ENCLOSURE

.1 Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the Canadian Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.

.2 Enclosures shall be provided with one (1) blank end and one end with knockouts.

.3 Where indicated on the drawings, branch circuit panelboards shall be column width type.

2.9 NAMEPLATES

.1 Provide an engraved nameplate for each panel section.

2.10 FINISH

.1 Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 61 paint applied.

2.11 SPRINKLER PROOF-EQUIPMENT

.1 All electrical equipment installed in areas where sprinklers are also installed shall be constructed so that exposure to water from the sprinkler heads will not impair the effectiveness of the equipment.

.2 A separate and complete non-combustible cover or roof shall be provided on all equipment. An overhang at the front, rear and sides shall effectively prevent the entrance of water either at the top or through projecting face plates, meters, etc.

.3 Ventilation louvers shall be of the outdoor type where falling water or water running down the sides of the enclosure will not enter the enclosure. Where openings in the top are required for outgoing conduits, etc. a removable gasketted plate shall be provided and conduits or cables shall be installed using waterproof fittings.

.4 Surface mounted panelboards installed in the same areas as sprinkler heads shall be complete with drip hoods (and shall have gasketted covers and doors. Flush mounted panel boards shall have gaskets between trim and wall and shall have gasketted doors.)

.5 All sprinkler proofing shall comply with the latest Code requirements and with requirements of the local inspection authorities.

Part 3 Execution

3.1 FACTORY TESTING

.1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of EEMAC and CSA standards.

3.2 INSTALLATION

.1 The Contractors shall install all equipment per the manufacturer’s recommendations and the contract drawings.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

1.2 SUBMITTALS

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

.2 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.

.3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.

.4 Submit shop drawings and indicate:

.1 Outline dimensions.

.2 Configuration of identified compartments.

.3 Floor anchoring method and dimensioned foundation template.

.4 Cable entry and exit locations.

.5 Dimensioned position and size of busbars and details of provision for future extension.

.6 Schematic and wiring diagrams.

.5 Closeout Submittals: provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.1 Include data for each type and style of starter.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Collect, package and store existing busbars, wireways, sills, copper ground straps and other associated components for recycling and reuse.

1.4 EXTRA MATERIALS

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

Part 2 Products

2.1 SUPPLY CHARACTERISTICS

.1 347/600 V, 60Hz, 3 phase, 4 wire, grounded neutral.

2.2 GENERAL DESCRIPTION

.1 Compartmentalized vertical sections with common power busbars.

.2 Floor mounting, free standing, enclosed dead front.

.3 Indoor CSA sprinklerproof enclosure, front mounting.

2.3 VERTICAL SECTION CONSTRUCTION

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 165 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.

.5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at top with terminals.

.8 Provision for outgoing cables to exit via top or bottom with terminals.

.9 Removable lifting means.

.10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.

.11 Divide assembly for shipment to site, complete with hardware and instructions for re-assembly.

2.4 BUSBARS

.1 Main horizontal and branch vertical, three phase and neutral tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:

.1 Main horizontal busbars: 600 A.

.2 Branch vertical busbars: 300 A or as indicated.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 22 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.5 GROUND BUS

.1 Copper ground bus extending entire width of motor control centre.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.6 MOTOR STARTERS AND DEVICES

.1 As Specified. All units complete with HOA selector switch, LED indicator lights for run power and fault, electronic programmable overloads and local disconnect.

2.7 STARTER UNIT COMPARTMENTS

.1 Units EEMAC size 5 and smaller, circuit breaker units 225A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Pushbuttons and indicating lights mounted on door front.

.7 Devices and components by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.8 WIRING IDENTIFICATION

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

2.9 EQUIPMENT IDENTIFICATION

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

.1 Motor control centre main nameplate: size No. 7, engraved.

.2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.10 FINISHES

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

.2 Paint motor control centre exterior light gray and interiors white.

2.11 SOURCE QUALITY CONTROL

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Contract Administrator to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

Part 3 Execution

3.1 INSTALLATION

.1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload heater elements are installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - For Electrical.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hour period.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.2 REFERENCES

.1 The Munsell System of Colour Notation.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

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/m^2 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.

2.2 **SPRINKLER PROOF-EQUIPMENT**

.1 All electrical equipment installed in areas where sprinklers are also installed shall be constructed so that exposure to water from the sprinkler heads will not impair the effectiveness of the equipment.

.2 A separate and complete non-combustible cover or roof shall be provided on all equipment. An overhang at the front, rear and sides shall effectively prevent the entrance of water either at the top or through projecting face plates, meters, etc.

.3 Ventilation louvers shall be of the outdoor type where falling water or water running down the sides of the enclosure will not enter the enclosure. Where openings in the top are required for outgoing conduits, etc. a removable gasketted plate shall be provided and conduits or cables shall be installed using waterproof fittings.

.4 Surface mounted panelboards installed in the same areas as sprinkler heads shall be complete with drip hoods (and shall have gasketted covers and doors. Flush mounted panel boards shall have gaskets between trim and wall and shall have gasketted doors.)

.5 All sprinkler proofing shall comply with the latest Code requirements and with requirements of the local inspection authorities.

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 33 00 - Submittal Procedures.

.2 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: 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 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers, and ground-fault circuit-interrupters.

.2 Text to complete:

.1 Section 26 24 02 - Service Entrance Board.

.2 Section 26 28 18 - Ground Fault Equipment Protection.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 23 00 - Low Voltage Switchgear.

.3 Section 26 24 02 - Service Entrance Board.

1.3 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).

1.4 SUBMITTALS

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

.2 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 35kA 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 Sprinkler proof.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated on drawings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for fused and non-fused disconnect switches.

.2 Text to complete:

.1 Section 26 24 02 - Service Entrance Board.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

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

.3 Section 26 24 02 - Service Entrance Board.

1.3 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.

1.4 SUBMITTALS

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

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 SCOPE OF WORK

.1 Supply and install starters, motors and disconnects as indicated on drawings, stated herein and as required.

.2 Contractor shall wire and connect all motors, starters, disconnects, controls and appliances that form a part of the buildings heating, ventilation, and/or air conditioning systems and other such items which form a part of the construction documents including; door operators, elevators, Contract Administrator supplied equipment, etc. Prior to tender confirm and co-ordinate with other divisions exact requirements.

.3 Additional control information and wiring diagrams may be available at a later date when the exact type of equipment being supplied is established. Supply and install wiring and equipment in accordance with wiring diagrams.

.4 The Contractor shall co-ordinate with trades and ensure that all motor and controls which form a part of, or function with, the particular apparatus, or motorized equipment, are installed in conjunction with mechanical plans and specifications.

.5 Prior to tender closing the Contractor must coordinate with trades and ensure that all motor wiring and control thereof is allowed for in Electrical Tender.

1.3 DIVISION OF RESPONSIBILITY

.1 Contractor shall supply and install the line voltage service to all equipment provided by Division 21, 22 and 23. Low voltage control wiring is generally included in Division 21, 22 and 23. See Mechanical Specification for reference.

1.4 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.

1.5 EXTRA MATERIALS

.1 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 ENCLOSURES

.1 All products shall be complete with CSA type enclosures suitable for installation location. Unless otherwise noted, or required, CSA Type 1 shall be used as a minimum standard required.

2.2 MOTORS

.1 Motors less than ½ HP shall be 120 volts, single phase, 60 hertz. All motors ¾ HP and larger to be 600 volt, 3 phase, 60 hertz.

2.3 DISCONNECTS

.1 Horsepower rated disconnect switches which properly interrupt all phase conductors on a motor circuit shall be installed at all motor locations in accordance with Section 26 of the Canadian Electrical Code.

.2 Motors controlled by automatic devices shall always be equipped with disconnect switches at motor location.

.3 On outdoor installations, these disconnect switches shall be weatherproof unless approved for installation within the weatherproof housing of the apparatus driven by the motor. This disconnect switch must be accessible before the motor can be reached and worked on. Disconnect switches exposed to weather and in sprinkler rooms shall be CSA Enclosure 3 (EEMAC 3) weatherproof.

.4 On roof fans and similar outdoor apparatus driven by fractional horsepower motors running at 120 volt single phase, the disconnect means may be a single pole, horsepower rated tumbler type switch installed within the fan housing in a #1110 box.

.5 Plug receptacles and plug assemblies will not be used as disconnecting means for any fixed equipment on this installation, unless otherwise noted for special application.

.6 Locking devices on branch circuit breakers or panels, power distribution or motor control centres will not be accepted as a substitute for disconnect switches at motor location, unless otherwise noted for special application.

.7 Single phase disconnects shall be single and/or 2 pole, toggle key switches as required.

.8 3 phase motor disconnect switches shall be 3 pole, un-fused, 600 or 208 volts as required.

.9 Supply and install all disconnect switches, whether an integral part of panel or used as an isolating switch. Disconnect switches shall be heavy-duty type, quick make-quick break, horsepower rated, with visible blades, voidable cover interlock, side operated handle shall operate in a vertical plane with positive ON and OFF indication. Padlocking provision for door, and the OFF position of the handle.

.10 Disconnect switches shall have cable lugs rated CU-AL and sized to suit the specified wire sizes.

.11 Disconnect switches shown may be unfused or fusible. When fusible, have provision for fuse types as specified in the Fuse Section.

.12 Supply and install disconnect switches ahead of motors when required by code whether or not shown on Drawings.

.13 All separately mounted disconnect switches shall be by the same manufacturer.

.14 In finished areas, where disconnect switches are required provide circuit breaker in flush-mounted enclosures.

.15 Disconnect switches shall be as manufactured by Square D or Eaton Cutler Hammer.

2.4 STARTERS

.1 Three-phase motors shall be controlled with combination magnetic starters except where specifically noted on the plans or otherwise specified.

.2 Single phase manual motor protection switches to be either toggle and/or key operated complete with pilot light. Flush and/or surface mounted as indicated, key operated where indicated.

.3 Single phase motors running at not more than 120 volts shall be controlled and protected with manual motor starting switches overload and over-current protection except where otherwise specified.

.4 Magnetic starting switches shall be of EEMAC sizes to suit the horsepower rating of the motor which they control and protect. Contactors shall be of sizes as specified. Half size starters will not be allowed.

.5 Each magnetic motor starter shall incorporate the following facilities:

.1 Contractor with three overload relays.

.2 120 volt holding coil with under voltage protection.

.3 Pilot light and cover, red LED type.

.4 Reset button, HOA switch in cover, field convertible to off/auto or start/stop push-button as indicated.

.5 Two sets of normally open auxiliary contacts in addition to the standard auxiliary contacts supplied with each starter. One set of auxiliary contacts, convertible to normally closed.

.6 Control transformer 600 or 208/120 Volt of sufficient VA to handle operating coil and associated controls.

2.5 Combination Starters

.1 Combination starters shall be complete with type MCP motor circuit protector breaker operating on the magnetic principle with a single trip point adjustment and lock-off facility.

.2 Motor protection switch enclosure "opening" shall be restricted by the use of a defeater screw unless the switch is in the "off" position.

.3 Each combination magnetic motor protection switch shall house the following facilities:

.1 Type MCP motor circuit protector

.2 Contactor with three overload relays.

.3 120 volt holding coil with under voltage protection.

.4 Pilot light and cover, red neon type.

2.6 INTERLOCK & RELAY

.1 Where interlock required separate interlocks shall be provided and inter connected on all forced air blower system magnetic starters, separately and barriered, to shut down the units when fire alarm is initiated.

.2 Relay heaters to be coordinated with the name plate rating of the motor. Failure to do so renders the Contractor liable for any damage that may occur to the motors.

2.7 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.

2.8 MANUFACTURERS

.1 Pre-approved Manufacturers: Eaton Cutler Hammer and Square D.

2.9 FINISHES

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

2.10 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 CONNECTIONS

.1 Use flexible hanging feeder loop for connection to motors.

3.2 CO-ORDINATION

.1 Consult with Mechanical Subcontractor for actual locations of units, starters, controls, etc., and provide all connections and devices as required.

3.3 INSTALLATION

.1 Confirm final connections, load and locations of all motors prior to installation.

.2 Motors for mechanical equipment to be installed under Division 21, 22 and 23. Locations of motors conduit and connection points indicated for equipment supplied are for estimating purposes only. Refer to shop drawings of the actual equipment for exact connection points, feeder size and over-current protection.

.3 Provide line voltage power supply connections for all mechanical equipment motors.

.4 Label and identify all junction boxes, controls, wiring, etc., as per Section 26 50 00.

.5 Install motor and circuit disconnect switches as required by the Canadian Electrical Code or called for in this specification.

.6 Motor protection switches installed in finished areas shall be complete with stainless steel cover plates.

.7 Select heaters to suit full load current of motors installed. Refer to shop drawings and/or actual nameplate data for full load current of each motor.

.8 Magnetic motor starters shall be installed where indicated on the drawings.

.9 Select overload device trip setting for magnetic starters and combination starters to suit motors installed.

.10 Conduit, wire and connections for control L.V. wiring for mechanical equipment motors generally is unless otherwise specified the responsibility of Division 15. (Refer to Division 15 for details).

.11 Install and wire line voltage thermostats for single-phase motors as required.

3.4 FIELD QUALITY CONTROL

.1 Operate switches, contactors to verify correct functioning.

.2 Perform starting and stopping sequences of contactors and relays.

.3 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION