PART 1 - GENERAL

1.1 RELATED SECTIONS AND SUMMARY

.1 The General Conditions, Supplements and Amendments shall govern this Section (read in conjunction with Instructions to Bidders. This section covers items common to all Electrical sections and is intended only to supplement the requirements of Division 01.

.2 Reference to "Electrical Divisions" shall mean all related Electrical Sections and components including Divisions 26, 27 and 28.

.3 Reference to "Mechanical Divisions" shall mean all related Mechanical Sections and components including Divisions 21, 22, 23 and 25.

.4 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.

.5 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available. Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, establishing orderly completion and the delivery of a fully commissioned installation.

.6 The most stringent requirements of this and other sections in Divisions 01, 26, 27 and 28 shall govern.

.7 All work shall be in accordance with the Project Drawings and Specifications and their intents, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.

.8 Connect power supply to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate electrical equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories

1.2 REFERENCES

.1 Install in accordance with CSA C22.1-12, Canadian Electrical Code Part 1 (22nd Edition), Safety Standard for Electrical Installations except where specified otherwise.

.2 Canadian Standards Association (CSA International)
.1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
.2 CSA C22.2 No. 65-03(R2008), Wire Connectors (Tri-National standard with UL 486A-486B and NMX-J-543-ANCE-03).
.3 CAN/CSA C22.3 No. 1-10, Overhead Systems.
.4 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.3 Underwriters Laboratories of Canada (ULC)
.1 CAN/ULC-S115-11, Standard Method of Fire Tests of Firestop Systems, Fourth Edition.

.4 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 DEFINITIONS

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

1.4 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 SCOPE OF WORK

.1 Contractor shall supply, install, commission and provide warranty for complete and fully documented electrical systems as per contract drawings and specified herein. The Work includes all hardware, and services necessary to provide

1.5 SCOPE OF WORK (Cont'd)

.1 (Cont'd)
fully functional, coordinated electrical system. Refer to Division 01 for hours of work.

.2 Component subsystems of the electrical system will include, but are not limited to the following:
.1 Upgrade existing hydro service from 500 kVA at 27.6 kV to 1,500 kVA at 44 kV. Provide new overhead and underground feeders complete with concrete encased duct banks, manholes and/or handholes, poles, crossarms, insulators, load break switches and fuse cut-outs as indicated. Coordinate termination of primary high voltage cables to Hydro One system with Hydro One.
.2 Provide electrical power distribution system. Tie into new service via a network of underground ducts and manholes and/or handholes as indicated.
.3 Provide receptacles and direct connections for all equipment.
.4 Provide lighting equipment including emergency and non-emergency lighting and exit signs.
.5 Provide heat tracing cable system complete with controller, power kits, end seals and all other components for a complete, operational system.
.6 Provide fire alarm system and tie into existing network.
.7 Provide power feeders to all mechanical equipment.
.8 Provide all required motor starters and associated control wiring greater than 50 V.
.9 Provide complete raceway for power, lighting, life safety, security and communications systems.

.3 Provide grounding/bonding equipment as per CSA C22.1 or as indicated in the contract drawings and specifications.

.4 Provide fire stopping as per Section 07 84 00.

.5 Perform commissioning as per Section 01 91 00.

.6 Provide as-built drawings and maintenance manuals.

.7 Provide seismic restraint for all electrical equipment and installations.

1.6 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.2 Submit shop drawings, product data and samples in accordance with Division 01. The submission shall be reviewed, signed and processed as described in Division 01.

.3 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.

.4 Where applicable, include wiring, line and schematic diagrams. Include wiring drawings or diagrams showing interconnection with work of other Sections.

.5 Content:

.1 Shop drawings submitted in accordance Section 01 33 00.

.2 Data shall be specific and technical.

.3 Identify each piece of equipment.

.4 Information shall include all scheduled data.

.5 Advertising literature will be rejected.

.6 The project and equipment designations shall be identified on each document.

.7 Information shall be given in S.I. units.

.8 The shop drawings/product data shall include:

.1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with all equipment weight and mounting point loads.

.2 Mounting arrangements.

.3 Detailed drawings of bases, supports and anchor bolts.

.4 Control explanation and internal wiring diagrams for packaged equipment.

.5 A written description of control sequences relating to the schematic diagrams.

.6 Format

.1 Black line prints 216 mm x 280 mm (8-1/2" x 11") or 280 mm x 430 mm (11" x 17").

.2 Larger drawings may be submitted on single sheet media (ie not bound) with space for stamps and signatures - master set plus one working copy or digital format.

.3 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.

1.6 SUBMITTALS (Cont'd)

.7 Number of copies
.1 Provide number of copies indicated in Section Division 01 with a minimum of 2 copies to be retained by the Departmental Representative.

.8 Coordination
.1 Where electrical equipment requires support or backing by other trades or mechanical connections, the shop drawings shall also be circulated through the other "services" contractor(s) prior to submission to the Departmental Representative.

.9 Keep one copy of shop drawings and product data, on site, available for reference.

.10 Quality Control: in accordance with Section 01 45 00.
.1 Provide CSA certified equipment and material. Where CSA certified equipment and/or material is not available, submit such equipment and/or material to the authority having jurisdiction for special approval before delivery to site.
.2 Submit test results of installed electrical systems and instrumentation.
.3 Submit, upon completion of Work, the electrical "load balance" report.

.11 Permits and Fees:
.1 Submit to Electrical Inspection Department, Local Fire Authorities and Supply Authority the necessary number of drawings and specifications for examination and approval prior to commencement of work. Obtain all required permits and pay all fees.
.2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.7 QUALITY ASSURANCE

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

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians in accordance with authorities having jurisdiction.
.1 Employees registered in apprentices program: permitted, under direct supervision of

1.7 QUALITY ASSURANCE (Cont'd)

.2 Qualifications:(Cont'd)
.1 (Cont'd)
qualified licensed electrician, to perform specific tasks.
.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings: In accordance with Section 01 32 16.07.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

1.9 SYSTEM STARTUP

.1 Instruct Departmental Representative and 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 with aspects of its care and operation.

1.10 OPERATING INSTRUCTIONS

.1 Provide operating instructions for each system and principal item of equipment as specified in technical sections, for use by operation and maintenance personnel.

.2 Operating instructions to include following:

1.10 OPERATING INSTRUCTIONS (Cont'd)

.2 (Cont'd)

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.11 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.12 DRAWINGS AND MEASUREMENTS

.1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings. Obtain accurate dimensions from the Architectural and Structural drawings.

.2 Consult the architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from the Departmental Representative where definite locations are not indicated.

1.12 DRAWINGS AND MEASUREMENTS (Cont'd)

.3 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.

1.13 PROJECT COORDINATION

.1 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost without the Departmental Representative's written approval.

.2 The drawings indicate the general location and route to be followed by the electrical services. Where details are not shown on the drawings or only shown diagrammatically, the services shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All services in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All electrical services shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

.3 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Departmental Representative and all affected parties.

.4 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Departmental Representative of space problems before installing any material or equipment. Demonstrate to the Departmental Representative on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.14 SPRINKLER PROOF REQUIREMENTS

.1 In sprinklered rooms where electrical equipment is installed surface mounted, electrical equipment contained in these rooms to be protected by non-combustible driphoods, shields, and gasketed doors as applicable to inhibit water ingress into electrical equipment. Exposed conduits connected to equipment to utilize watertight connectors.

1.15 EQUIPMENT RESTRAINT

.1 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

1.16 SECURITY FASTENERS

.1 Fastening devices used in areas accessible to inmates shall be TORX with pin, stainless steel screws, which require a special tool to remove the fastener.

.2 Standard screws are not acceptable in areas accessible to inmates.

.3 Use fasteners compatible with material through which they pass.

1.17 WARRANTY

.1 Use of installed equipment by the contractor or sub-contractor during construction shall not shorten or alter the warranty period as specified in the Division 01.

.2 Provide extended warranty for equipment and systems as specified in technical sections.

.3 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one year from the date of substantial performance.

.4 Promptly investigate any electrical or control malfunction, and repair or replace all such defective work and all other damages thereby which becomes defective during the time of the warranty.

1.18 EXAMINATION

.1 Visit the site before preparing the tender and examine all existing conditions are beneficent to the contractor. No extra cost will be considered for any misunderstanding of work to be done resulting from not visiting the site.

.2 Examine the documents for details of work included. Obtain a written clarification in the event of conflict within the specification, between the specification and the drawing, or in the drawing. Obtain written clarification from the Departmental Representative if work affecting the installation is not clear.

1.19 RESPONSIBILITIES

.1 Provide all devices and equipment to form complete systems as indicated in both the drawings and the specifications.

.2 Protect equipment and material from the weather, moisture, dust and physical damage.

.3 Cover equipment openings and open ends of conduit, piping and pullboxes as work progresses. Failure to do so will result in the Trade being required to adequately clean or replace materials and equipment at no extra cost to the Departmental Representative.

.4 Protect all existing services encountered. Obtain instructions from the Departmental Representative when existing services require relocation or modification.

.5 Refinish damaged or marred factory finish to factory finish.

1.20 EQUIPMENT LIST

.1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, 10 days after the award of the Contract.

.2 The equipment list shall be a full list of materials or systems intended for installation.

1.21 PROJECT CLOSE-OUT REQUIREMENTS

.1 Refer to detailed specifications in each section for detailed requirements. Provide the following list of required substantial completion submissions.
.1 Fire Alarm verification report.
.2 Final electrical inspector certificate.
.3 As-built record drawings.
.4 Operating and maintenance manual.
.5 Contractors letter of guarantee.
.6 Complete Demonstration and Training of systems.

.2 Record drawings to be submitted to the Departmental Representative and all life safety systems must be operational, verified and tested and demonstrated to Departmental Representative prior to issuance of Schedule C.

1.22 SUBSTANTIAL PERFORMANCE REQUIREMENTS

.1 Before the Departmental Representative is requested to make an inspection for substantial performance of the work, the Contractor shall:
.1 Commission all systems and ensure proper working order of all components, interlocks and safety devices.
.2 Submit a letter certifying that all work is complete for the intended use, operational, clean and all required submissions have been completed.
.3 Submit a complete list of incomplete or deficient items shall be provided. If, in the opinion of the Departmental Representative, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.

.2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:
.1 All reported deficiencies have been corrected.
.2 Operating and Maintenance Manuals completed and submitted.
.3 "As Built" Record Drawinsg reviewed and corrections made.
.4 Systems Commissioning has been completed and has been verified by Departmental Representative.
.5 All demonstrations to the owner have been completed.
.6 All documents required have been submitted.

1.22 SUBSTANTIAL PERFORMANCE REQUIREMENTS (Cont'd)

.3 Letters of Assurance will not be issued until the following requirements have been met:
.1 All items listed in .1 above have been completed or addressed.
.2 Certificate of Penetrations through separations have been sealed with certified fire stopping material.
.3 Certificate of Substantial Performance.

1.23 SEISMIC RESTRAINT

.1 Design and construct electrical services and their fastenings and supports including but not limited to equipment, fixtures, and raceways to be in accordance with article 4.1.8.18 of the 2010 National Building Code of Canada with an importance factor I sub E, as specified in the code.

1.24 ARC FLASH STUDY

.1 All power distribution equipment, including panel boards, service entrance boards, motor control centres, disconnect switches, starters and transformers that are effected by the work of this project, shall be tested for arc flash hazard rating by the supplier prior to the equipment arriving on site.

.2 As part of the arc flash hazard rating testing, the equipment shall be subject to an incident energy study. Based on this study, warning labels (orange <40 cal/cm2) or danger labels (red > 40 cal/cm2) are to be installed on each piece of equipment as specified in "Section A" in accordance with ANSI Z535.4-2002. The label must be readable in both indoor and outdoor environments for at least 3 years and contain the following information:
.1 Arc hazard boundary (centimetres)
.2 Working distance (centimetres)
.3 Arc flash incident energy at the working distance (calories/ cm2)
.4 PPE category and description including the glove rating.
.5 Voltage rating of the equipment
.6 Limited approach distance (centimetres)
.7 Restricted approach distance (centimetres)
.8 Prohibited approach distance (centimetres)
.9 Equipment/bus name
.10 Date prepared
.11 Supplier name and address

1.25 COORDINATION STUDY

.1 Perform coordination study for overcurrent devices of main swithcboard and main distribution panel. Set overcurrent device trip settings based on study to mitigate damage due to fault current.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Division 01 and as follows.

.2 Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval.

.3 Where equipment or materials are specified by technical description only, they are to be of the best commercial quality available for the intended purpose.

.4 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Provide all power and electrical system related control wiring above 50 V, conduit, wire, fittings, disconnect switches, motor starters, for all mechanical equipment unless otherwise specified.

.2 Ground all motors to conduit system with separate grounding conductor in flexible conduit or bonding conductor in the flexible conduit.

.3 Connections shall be made with watertight flexible conduit complete with watertight connectors.

.4 Control wiring and conduit standards are specified in the Electrical Divisions. Refer to Mechanical Divisions for scope of work and particular details.

2.3 WARNING SIGNS

.1 Provide warning signs, as specified or to meet requirements of Departmental Representative, and authorities having jurisdiction.

.2 Use decal signs, minimum 175 x 250 mm (7" x 10") size.

2.4 WIRING TERMINATIONS

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

2.5 EQUIPMENT IDENTIFICATION

.1 Identify all electrical equipment including but not limited to starters, disconnects, remote ballasts and controls with nameplates and labels as follows:

.2 Nameplates

.1 Electrical Equipment:

COMPONENT	**LABEL TYPE**	**INFORMATION**
Main Distribution Centre	A	Year installed and name of facility; Name of Electrical Engineer and Electrical Contractor
Main Breaker	A	Voltage, phase, amps
Sub-distribution panel	A	Name of panels it is feeding (i.e. Panel A, Panel B)
Panelboards	B	Panel designation (i.e. Panel A, Panel B)
Terminal Cabinet	B	System and voltage
Disconnect switches	B	Indicate equipment controlled and voltage
Starters/contactors	B	Indicate equipment controlled and voltage
Motor control centre	B	Indicate equipment controlled and voltage
Transformers	B	Transformer designation Circuit and panel designation

2.5 EQUIPMENT IDENTIFICATION (Cont'd)

.2 (Cont'd)

.1 Electrical Equipment:(Cont'd)

Junction boxes, pull boxes	D	Circuit and panel designation
On/Off switches	C	If it is not obvious then indicate area being served
Fire Alarm Devices (i.e. pull stations, bell, smoke detector end-of-line)	C	Zone number and device number in that zone (i.e. Zone 1-#3 Zone 10-#7)
Receptacles	C	Circuit and panel designation
Special receptacles	C	Circuit/panel designation and voltage, phase, amps

.2 Label Type

	LETTER HEIGHT	**TYPE**	**COLOUR**
Label Type A	9.5 mm	Lamacoid	White lettering/ black background
Label Type B	6.0 mm	Lamacoid	White lettering/ black background
Label Type C	3.0 mm	Lamacoid	White lettering/ black background
Label Type D	3.0 mm	Adhesive label	As specified

.1 Good quality vinyl, self-laminating label as T&B E-Z Code WSL, Dymo Letratag or Brother P-Touch equivalent printable markers. Embossed Dymo or any labels with edges and corners that are prone to lift will be rejected.

.4 Provide plastic covered type written panel directory with circuits and areas served print in, and mounted on inside of door. Directory shall conform to Record Drawings.

2.6 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA-C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.7 CONDUIT, CABLE AND PULLBOX IDENTIFICATION

.1 All junction boxes, pull boxes and their cover shall be painted according to the colour coding schedule and labelled to indicate system voltage and point of feed.

.2 All entries to panels, junction boxes, pull boxes and device boxes shall be colour coded per the component contained in the box. Colour coding shall be at entry to and exit from the box by paint or coloured tape.

.3 Code with 25 mm plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor and at 15 m intervals.

.4 Colour coding to be as follows unless otherwise specified:

2.7 CONDUIT, CABLE AND PULLBOX IDENTIFICATION (Cont'd) .4 (Cont'd)

COMPONENT	**RACEWAY AND JUNCTION BOXES**	**RECEPTACLES AND OTHER**
Normal 120/208, 240 volt	Gray	White
Normal 347/600 volt	Sand	White
Emergency 120/208, 240 volt	Green with red bands	Red
Emergency 347/600 volt	Sand with red bands	n/a
Fire Alarm	Red	Strobe (red)
Low voltage:		
-switching/controls	Black	
-emergency/exit lighting	Black with red bands	
-security	Black with blue bands	Strobe (blue)
mechanical alarms	Black with yellow bands	Strobe (amber)

2.8 FINISHES .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside and at least two coats of finish enamel.

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

.3 Clean and prime paint exposed hangers, racks, fastenings to prevent rusting. Finish painting shall be provided by Division 09.

2.9 ACCESS PANELS (DOORS)

.1 Unless otherwise noted, access doors shall be minimum: 450 mm x 450 mm (18" x 18") for body entry; 300 mm x 300 mm (12" x 12") for hand entry.

.2 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, keyed and self closing.

.3 Minimum Requirements:
.1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.
.2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.
.3 Masonry or drywall construction: 16 gauge for 400 mm x 400 mm (16" x 16") and smaller, 14 gauge for 450 mm x 450 mm (18" x 18") and larger bonderized steel face of wall type with exposed flange.
.4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.
.5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.
.6 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.
.7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label.

.4 Provide access doors for all junction boxes and pull boxes concealed in gypsum board wall or ceiling.

2.10 FASTENING TO BUILDING STRUCTURE

.1 General:
.1 Do not use inserts in base material with a compressive strength less than 13.79 MPa (2000 psi).
.2 All inserts supporting conduit racks shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.

2.10 FASTENING TO BUILDING STRUCTURE (Cont'd)

.2 Types:

.1 Cast-in-place type:

.1 Channel type - U shape, size 41 x 41 mm, 2.5 mm thick.

.2 Wedge type galvanized steel concrete insert for up to 200 mm (8") pipe size.

.3 Universal type malleable iron body insert for up to 200 mm (8") pipe size.

.2 Drilled, mechanical expansion type:

.1 Heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa (2840 psi).

.2 Stud anchor for concrete. (Do not use in seismic restraint applications).

.3 Drop-in anchor for concrete.

.4 Sleeve Anchor (medium and light duty) for concrete and masonry.

.5 Pin bolt (light duty) for concrete and masonry.

.3 Drilled, adhesive type:

.1 Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.

.2 Anchor rod with a 2 part adhesive system.

.3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.

.4 Rod assemblies shall extend a minimum of 50 mm (2") into the concrete slab below the housekeeping bases.

.3 Note:

.1 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.

.2 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.

.3 Where specifically called for, drills shall include a dust vacuum system.

2.11 EQUIPMENT SUPPORTS

.1 Provide stands and supports for equipment and materials supplied.

.2 Lay out concrete bases and curbs required under Electrical Divisions. Coordinate with Concrete Divisions.

2.11 EQUIPMENT SUPPORTS (Cont'd)

.3 Concrete bases for floor mounted electrical equipment in the main electrial room 002 and in the main mechanical room 007 shall be a minimum of 100 mm (4") thick, or as noted and shall project at least 150 mm (6") outside the equipment base, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.

.4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise them 25 mm (1") above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink metallic-aggregate grout.

.5 Construct equipment supports of structural steel. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.

.6 Support ceiling hung equipment with rod hangers and/or structural steel.

2.12 MISCELLANEOUS METAL

.1 Be responsible for all miscellaneous steel work relative to Electrical Divisions of the Specifications, including but not limited to:
.1 Support of equipment.
.2 Hanging, support, anchoring, guiding and relative work as it applies to wiring raceways and electrical equipment.
.3 Earthquake restraint devices - refer also to "Seismic Restraint" sections.
.4 Bridle rings - secure to structure or steel supports.

.2 All steel work shall be prime and undercoat painted ready for finish under the related Division.

2.13 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into maintenance manual specified in Division 01 and as follows.

.2 Include in operations and maintenance data:
.1 Details of design elements, construction features, component function and maintenance requirements, to permit effective operation,

2.13 OPERATION AND MAINTENANCE DATA (Cont'd)

.2 (Cont'd)

.1 (Cont'd)

maintenance, repair, modification, extension and expansion of any portion or feature of installation.

.2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.

.3 Wiring and schematic diagrams.

.4 Names and addresses of local suppliers for items included in maintenance manuals.

.3 Include in the manual the following major sections:

.1 Title page (in plastic cover).

.2 Comprehensive description of the operation of the systems, including the function of each item of equipment within the system.

.3 Detailed instructions for the normal maintenance of all systems and equipment installed including procedures and frequency of operational checks and service and trouble shooting instructions.

.4 Local source of supply for each item of equipment.

.5 Wiring and control diagrams.

.6 Spare parts list.

.7 Copies of guarantees and certificates.

.8 Manufacturer's maintenance brochures and shop drawings.

.4 The manual information shall be bound in a three "D-ring" hard back reinforced vinyl covered binder c/w index tab separators to divide the different sections.

.5 Submit a draft copy to the Departmental Representative for approval thirty days prior to start up of the systems and equipment.

.6 Submit three copies in the final approved form.

.7 Submit three CDs containing all record as-built drawings and maintenance manual in pdf format.

2.14 PROJECT RECORD DRAWINGS

.1 Provide project record documents as specified in Division 01 as further called for in this Division.

2.14 PROJECT RECORD DRAWINGS (Cont'd)

.2 During the construction period, keep on Site a clean set of drawings marked up to reflect the "As-Built" state, for examination by the Departmental Representative on a regular basis. Include elevations and detailed locations of buried services, empty conduit systems and junction and pull boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA-C22.1-12 except where specified otherwise.

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

.3 Comply with CSA Electrical Bulletins and Local Authorities having jurisdiction.

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.
.1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.

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

.3 Install roof jacks where conduit and cables penetrate roofs. Apply water-tight sealant after installation.

.4 All cables and conduits shall be concealed in finished areas.

3.4 LOCATION OF OUTLETS

.1 Refer to Architectural detail drawings for outlet locations.

.2 Do not install outlets or wall switches back-to-back or in the same stud space in wall; allow minimum 400 mm (16") horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors.

.5 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

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

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

.3 Refer to detail on architectural drawings.

.4 In the absence of a drawing detail or drawing note, use the following:

Device	Height	Comment
Local switches	1200 (48")	
Wall receptacles/data	300 (12")	General
Wall receptacles/data	175 (7")	Above top counters or counter splash backs - coordinate with architectural detail
Wall receptacles/data	1400 (56")	In mechanical rooms
Panelboards		As required by Code and as indicated
Wall mounted telephone	1500 (60")	
Fire alarm pull	1200 (48")	As required by ULC S524

3.5 MOUNTING HEIGHTS (Cont'd)

.4 (Cont'd)

stations		
Fire alarm bells/ audio/visual	2300 (90")	ULC S524 requires not less than 1800 mm. In any event not closer than 50 mm to the ceiling
End of line resistors	1800 (72")	
Television outlets		As receptacles - coordinate with equipment location
Wall mounted speakers and clocks	2100 (84")	Coordinate with equipment location
Door bell pushbuttons	1200 (48")	Coordinate with location
Emergency lighting (wall mounted)		150 mm below ceiling or 2300 mm maximum

3.6 DELIVERY AND STORAGE

.1 Store all electrical equipment and devices other than conduits, fittings, boxes, and ducts in a heated and ventilated space, and protect from construction damage.

.2 Conduits, fittings, boxes, and ducts may be stored outside if properly protected against the weather.

.3 Ship and store floor mounted equipment in upright position.

.4 Ship equipment in adequate containers to assure it arrives undamaged at the site.

.5 Keep equipment doors locked. Protect equipment from damage and dust.

.6 Block moving parts when necessary to prevent damage during movement and shipment of equipment.

.7 Remove from the site, and replace with new, all materials showing evidence of damage or rust.

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Coordinate and pay for all tests specified herein including further tests as required by authorities having jurisdiction.

.2 All testing shall be performed after each system installation has been completed. Prior to commissioning, all motors, MCCs, transformers and switchgear shall be meggered for insulation integrity and the results recorded prior to the systems being put into operation.

.3 Perform the testing, adjusting, and balancing only when conditions are commensurate with actual operating conditions for the given system.

.4 Advise the Departmental Representative 48 hours in advance of each test. Carry out tests in the presence of Departmental Representative.

.5 Submit detailed printed test reports in duplicate to the Departmental Representative within 7 days after the completion of each test. Include all test reports in the Maintenance Manuals. Each test shall clearly indicated, in a line-by-line format, that the components (not as a group) have been tested, test results, and whether test results are within acceptable limits. Each test report shall be accompanied by a front cover sheet briefly outlining what the test report is for and clearly summarizing all items that have failed the tests. The cover sheet shall indicate names of individuals who conducted the tests and their signatures as well as the date and time the test was performed.

3.8 SYSTEM COORDINATION STUDY

.1 Provide with shop drawings a family of neatly drawn coordination curves on standard EEI-NEMA sheets, showing service feeder relays, together with manufacturer's proposed tripping characteristics for main service and feeder overcurrent relays, transformer, thermal damage curves. The curves shall also include short circuit and protective device coordination. For each coordination curve, attach a separate blank page with a neatly drawn single-line diagram with cross-reference between protecting devices and their corresponding coordination curves. The coordination study shall include for selective tripping such that downstream loads are isolated at the point as far downstream in the distribution system as possible. The

3.8 SYSTEM COORDINATION STUDY (Cont'd)

.1 (Cont'd)
Departmental Representative reserves the right to make changes in the rating and setting of the protection devices to ensure a properly coordinated "selective" protection system. Such changes shall be done at no extra cost to the Departmental Reprentative.

.2 The approved coordination study will be the basis for the verification testing of all other applicable equipment.

.3 Ensure circuit protective devices such as overcurrent trips, relays, and fuses are installed to required values and settings and further adjusted in accordance with the approved coordination study.

.4 Coordination study shall be signed and sealed by a Professional Engineer registered in the province of Ontario, Canada.

3.9 FIELD QUALITY CONTROL

.1 Load Balance:
.1 Measure voltage and phase & neutral currents 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 Conduct and pay for the following tests:
.1 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
.2 Systems: fire alarm system, communications systems.
.3 Main ground resistance (at all grounding locations).

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

.4 Reports:
.1 Provide written reports in a timely manner upon completion of the testing and load balance. Indicate test hour and date.

3.10 DEMONSTRATION

.1 Demonstrate to and instruct the Departmental Representative on operating and maintenance procedures for all electrical systems using the assistance of specialist sub-trades and manufacturer's representatives for instruction and include all costs in the tender. Systems to be demonstrated shall include, but not be limited to, the following:
.1 Routing and installation of major feeders, duct banks and manholes, grounding and cable trays.
.2 Lighting control system.
.3 Fire alarm system.
.4 Uniterruptible power supply (UPS) system.

.2 Arrange an acceptable time with the Departmental Representative and submit a program of instruction and demonstration for the Departmental Representative's approval. Assume that the Departmental Representative is not familiar with any of the special equipment and/or systems installed.

.3 Submit to the Departmental Representative, at the time of Substantial Performance inspection, a complete list of systems. State for each system:
.1 Date of instruction.
.2 Duration of instruction.
.3 Name of persons instructed.
.4 Other parties present (manufacturer's representative, etc.).
.5 Signature of the Departmental Representative stating that they properly understood the system installation, operation, and maintenance requirements and identifying any systems or equipment which were not demonstrated to their satisfaction and which must be re-demonstrated.

3.11 CLEANING

.1 Do final cleaning in accordance with Section 01 74 11.

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

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

3.11 CLEANING (Cont'd)

.4 Clean and prime paint exposed non-galvanized hangers, racks and fastenings to prevent rusting. Coordinate finish painting with Division 09.

3.12 WORKMANSHIP

.1 Workmanship shall be in accordance with well established practice and standards accepted and recognized by the Departmental Representative and the Trade.

.2 The Departmental Representative shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and appearance.

.3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for inspection by the Departmental Representative.

3.13 PROTECTION OF WORK

.1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.

.2 Mask machined surfaces. Secure covers over equipment openings and open ends of equipment and conduit, as the installation work progresses.

.3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.

.4 Refinish damaged or marred factory finish.

3.14 PROTECTION OF ELECTRICAL EQUIPMENT

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

.2 Shield and mark live parts, e.g. "LIVE 120 VOLTS".

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

3.15 CONCEALMENT

.1 Conceal wiring and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

.2 Do not install wiring and conduit on outside walls or on roofs unless specifically directed.

3.16 SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS

.1 All cabling, wiring, conduits, cable trays, etc. passing through rated fire separations shall be smoke and fire stopped to a ULC or cUL tested assembly system, in accordance with CAN/ULC-S115, that meets the requirements of the Building code in effect.

.2 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings. Where this is not indicated assume a minimum of one hour for walls and two hours for floors.

.3 Install firestopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions. The Applicator shall be approved, licensed and supervised by the manufacturer in the installation of firestopping and are to follow the requirements of a rated system as detailed above.

.4 Contractors are expected to submit system information detailing firestopping product, backing, penetration, penetrated assembly, fire and temperature rating, and ULC or cUL system number.

.5 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be re-penetrated.

.6 Allow openings for 100% capacity of raceway or 200% capacity of J-hooks.

.7 Provide split systems where existing cables are involved.

3.17 SERVICE PENETRATIONS IN NON-RATED FIRE SEPARATIONS

.1 Metal sleeves for all cabling, wiring, conduits, cable trays, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with caulking or silicon sealant to prevent the passage of smoke and/or transmission of sound.

3.18 CONDUIT SLEEVES

.1 Provide conduit sleeves for all conduit and wiring passing through rated and non-rated walls and floors. Sleeves shall be concentric with conduit or wiring.

.2 Except as otherwise noted conduit sleeves are not required for holes formed or cored in interior concrete walls or floors.

.3 Conduit sleeves shall extend 50 mm (2") above floors in unfinished areas and wet areas and 6 mm (1/4") above floors in finished areas.

.4 Conduit sleeves shall extend 25 mm (1") on each side of walls in unfinished areas and 6 mm (1/4") in finished areas.

.5 Conduit sleeves shall extend 25 mm (1") beyond exterior face of building. Caulk with flexible caulking compound.

.6 Sleeve Size: 12 mm (1/2") clearance all around, between sleeve and conduit or wiring.

.7 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.

.8 Packing of Sleeves:
.1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and conduit shall be caulked with waterproof fire retardant non-hardening mastic.
.2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.19 ACCESSIBILITY AND ACCESS PANELS

.1 Install all equipment, controls and junction boxes so as to be readily accessible for future modification, adjustment, operation and maintenance as appropriate.

3.19 ACCESSIBILITY AND ACCESS PANELS (Cont'd)

.2 Provide access panels where required in building surfaces. Do not locate access panels in panelled or special finish walls, without prior approval of the Departmental Representative.

.3 Access panels in U.L.C. fire separations and fire walls shall have a compatible fire rating and U.L.C. label. Acquire approval in writing from the local fire authority if required.

.4 Access panels shall be painted with a primer coat if applicable and then with a finish coat, colour and type to the Departmental Representative's approval.

.5 Locate equipment and junction boxes in service areas wherever possible.

3.20 EQUIPMENT INSTALLATION

.1 Provide means of access for servicing equipment.

.2 CSA identification and equipment labels to be clearly visible after installation.

3.21 CUTTING, PATCHING, DIGGING, CANNING, CORING AND CONCRETE

.1 Lay out all cutting, patching, digging, canning and coring required to accommodate the electrical services. Coordinate with other Divisions. The performance of actual cutting, patching, digging, canning and coring is specified under other Divisions.

.2 Be responsible for correct location and sizing of all openings required under Electrical Divisions, including piped sleeves.

.3 Openings through structural members of the building shall not be made without the approval of the Departmental Representative.

.4 Openings in Concrete:
.1 Be responsible for the layout of all openings in concrete, where openings are not left ready under previous contract.
.2 All openings shall be core drilled or diamond saw cut.
.3 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls.

3.21 CUTTING, PATCHING, DIGGING, CANNING, CORING AND CONCRETE (Cont'd)

.4 Openings in Concrete:(Cont'd)
.4 Refer to structural drawings for locations of steel reinforcing.
.5 Be responsible for repairing any damage to steel reinforcing.

.5 Openings in building surfaces other than concrete:
.1 Lay out all openings required.

.6 Poured concrete for duct encasements, pole bases, transformer pads and housekeeping pads shall be provided by other Divisions, coordinated and supervised by the Electrical Divisions.

.7 Precast concrete items such as transformer pad bases and light pole bases to be provided and installed by the Electrical Divisions unless otherwise specified.

.8 Excavation and backfilling will be provided by other Divisions. This division to superintend the work and provide all layouts and parameters.

3.22 PAINTING

.1 Clean exposed bare metal surfaces supplied under the Electrical Divisions removing all dirt, dust, grease and mill scale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

.2 Paint all hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.

.3 Repaint all marred factory finished equipment supplied under the Electrical Divisions, to match the original factory finish.

.4 Coordinate paint specifications and standards with Division 09.

.5 Finish painting of all equipment and materials, supplied under the Electrical Divisions, installed in Electrical Rooms of the building or exposed outside the building, is included under Section 09 91 00 of the Specification.

END