

**1 GENERAL**

**1.1 RELATED SECTIONS & SUMMARY**

- .1 The General Conditions, Supplements and Amendments shall govern this Section (read in conjunction with Instructions to Tenderers / 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 Division 26 in the Master Format Specifications.
- .3 Reference to "Mechanical Divisions" shall mean all related Mechanical Sections and components including Divisions 23 and 25 in the Master Format Specifications.
- .4 The word "Provide" shall mean "Supply, Install and Connect" 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 electrical sections 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 Provide seismic restraints for all required equipment, piping and ductwork.
- .9 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate 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 C22.1-2012 except where specified otherwise.
- .2 Comply with CSA Electrical Bulletins and Local Authorities having jurisdiction.

**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.
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**1.4 DESIGN REQUIREMENTS**

- .1 Operating voltages to CAN3-C235-83.
- .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 a complete and fully documented electrical system as per contract drawings and specified herein. The Work includes all hardware, and services necessary to provide 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 Connect exterior mechanical equipment via a system of interior surface mounted conduit and exterior underground conduit. Equipment shall be connected to an existing distribution system.
  - .2 Connect interior mechanical equipment via surface mounted conduit. Equipment shall be connected to an existing electrical distribution system.
  - .3 Provide all required motor starters, associated control wiring and local disconnect switches.
- .3 Provide grounding/bonding equipment as per CEC or as indicated in the contract drawings and specifications.
- .4 Provide fire stopping in accordance with Division 01.
- .5 Perform commissioning in accordance with Division 01.
- .6 As-built drawings and maintenance manuals.
- .7 Seismic restraint for all electrical equipment and installations.

**1.6 SUBMITTALS**

- .1 Submittals to be in accordance with Division 01.
  - .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.
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- .5 Content
    - .1 Shop drawings submitted in accordance with Division 01.
    - .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 Electronic copy (PDF format).
    - .2 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.
  - .7 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.
  - .8 Keep one copy of shop drawings and product data, on site, available for reference.
  - .9 Quality Control: in accordance with Division 01 - Quality Control
    - .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.
  - .10 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.
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**1.7 QUALITY ASSURANCE**

- .1 Quality Assurance in accordance with Division 01
- .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 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 Division 01
- .4 Health and Safety Requirements in accordance with Division 01.

**1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 4 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and/or recycling in accordance with Division 01.

**1.9 SYSTEM START-UP**

- .1 Refer to Division 01, and as follows.
- .2 Instruct the Departmental Representative and operating personnel in the operation, care and maintenance of equipment.
- .3 Arrange and pay for services of manufacturer's factory service Engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
- .4 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 for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
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- .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 Division 01.
- .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.
- .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.
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- .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 Related Section: 26 05 25 Seismic Restraint.
- .2 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 WARRANTY**

- .1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the Division 01.
- .2 Take note of any extended warranties specified.
- .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.

**1.17 TENDER INQUIRIES**

- .1 All contractor queries during the tender period shall be made in writing to the Departmental Representative. Contractor queries will be collected and suitable addenda will be issued for clarification. No verbal information will be considered valid or issued by the Departmental Representative's office during tender. All tender queries may be emailed, faxed, mailed or couriered to the Departmental Representative's office. No telephone questions will be answered.
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**1.18 EXAMINATION**

- .1 Visit the site before the close of tender and examine all existing conditions affecting the contractor's work. 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 specifications and the drawings, or in the drawings. Obtain written clarification from the Departmental Representative if work affecting the installation is not clear. Where this is not done in advance, allow in the tender sum for providing the more costly alternative.

**1.19 RESPONSIBILITIES**

- .1 Ensure that equipment does not transmit noise and/or vibration to other parts of the building, as a result of poor installation practice.
- .2 Where the Contract Documents do not contain sufficient information for the proper selection of equipment for bidding, notify the Departmental Representative during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the Contractor of responsibility to provide the intended equipment.
- .3 Protect equipment and material from the weather, moisture, dust and physical damage.
- .4 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 Owner.
- .5 Protect all existing services encountered. Obtain instructions from the Departmental Representative when existing services require relocation or modification.
- .6 Refinish damaged or marred factory finish to factory finish.
- .7 The specifications and drawings form an integral part of the Contract Documents. Neither the drawings nor the specifications shall be used alone. Work omitted from the drawings but mentioned or reasonably implied in the specifications, vice versa, shall be considered as properly and sufficiently specified and shall be provided. Misinterpretation of any requirement of either plans or specifications shall not relieve this Contractor of the responsibility of properly completing his trade to the approval of the Departmental Representative.

**1.20 EQUIPMENT LIST**

- .1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, including the names of the subtrades, 10 days after the award of the Contract.
  - .2 The equipment list shall be a full list of materials or systems intended for installation.
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**1.21 PROGRESS CLAIM AND CHANGE ORDER BREAKDOWNS**

- .1 Ten days after the award of contract, submit detailed progress claim breakdown for each division. Items to be included but shall not be necessarily limited to the following:
  - .1 Site services
  - .2 Distribution
  - .3 Feeders
  - .4 Cable tray
  - .5 Branch circuit wiring, conduit and boxes
  - .6 Wiring devices
  - .7 Lighting
  - .8 Mechanical equipment and wiring
  - .9 Low tension; each system listed under Division 24 to be separately identified
  - .10 Testing and commissioning
  - .11 As-built drawings and maintenance manuals
  - .12 Mobilization; not to exceed 2% of the contract value
- .2 Progress claims will not be certified nor payment made beyond 95% of the overall Electrical contract until commissioning and verification of the systems are complete. This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.
- .3 Change order breakdowns shall include but not be necessarily limited to the following:
  - .1 Labour hours per unit of material or equipment to be added, deleted or altered
  - .2 Units of material or equipment to be added or deleted.
  - .3 Per unit cost of material, equipment and labour broken down by category of labour and type of material or equipment
  - .4 Extensions of the above to arrive at total costs
  - .5 Miscellaneous and identifiable charges such as re-stocking, overhead, profit, etc

**1.22 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 system verification report.
  - .2 Seismic engineer report and schedules.
  - .3 Final electrical inspector certificate.
  - .4 Drafted as-built drawings.
  - .5 Operating and maintenance manual.
  - .6 Contractors letter of guarantee.
  - .7 Complete Demonstration of systems to Departmental Representative.
- .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.



**1.23 SUBSTANTIAL PERFORMANCE REQUIREMENTS**

- .1 Before the Departmental Representative is requested to make an inspection for substantial performance of the work:
  - .1 Commission all systems and prove out 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 A complete list of incomplete or deficient items shall be provided by the Contractor. 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.
  - .3 "As Built" Record Drawing ready for review.
  - .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.
- .3 Letters of Assurance will not be issued until the following requirements have been met:
  - .1 All items listed in 1.23.2.1 above have been completed or addressed.
  - .2 Certificate of penetrations through separations have been sealed and labelled with certified fire stopping material.
  - .3 Provincial Electrical Inspection - Certificate of inspection.
  - .4 Seismic Engineers letter of Assurance and final inspection report.
  - .5 Certificate of Substantial Performance.
  - .6 Fire alarm system verification report.

**2 PRODUCTS**

**2.1 SUSTAINABLE REQUIREMENTS**

- .1 Materials and products in accordance with Division 01.
- .2 Do verification requirements in accordance with Division 01.

**2.2 MATERIALS AND EQUIPMENT**

- .1 Provide materials 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.
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- .4 Factory assemble control panels and component assemblies.

**2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Provide all power and electrical system related control wiring, 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 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.

**2.4 WARNING SIGNS**

- .1 Provide warning signs, as specified or to meet requirements of Inspection Department and Departmental Representative.
- .2 Use decal signs, minimum 175 x 250 mm size.

**2.5 WIRING TERMINATIONS**

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

**2.6 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:

<b>COMPONENT</b>	<b>LABEL TYPE</b>	<b>INFORMATION</b>
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
Transformer	B	Transformer designation Circuit and Panel designation
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/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

.3 Adhesive Labels:

.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 typewritten panel directory with circuits and areas served and mounted on inside of door. Directory shall conform to Record Drawings.

**2.7 WIRING IDENTIFICATION**

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

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code to CSA C22.1.

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

**2.8 CONDUIT, CABLE AND PULLBOX IDENTIFICATION**

.1 All junction boxes, pull boxes and their covers shall be painted according to the colour coding schedule.

- .2 Code with 25 mm plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor and at 15 m intervals.
- .3 Colour coding to be as follows unless otherwise specified:

<b>COMPONENT</b>	<b>RACEWAY AND JUNCTION BOXES</b>	<b>RECEPTACLES AND OTHER</b>
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	Strobe (blue)
-security	Black with blue bands	Strobe (amber)
-mechanical alarms	Black with yellow bands	

**2.9 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.

**2.10 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 Types:
  - .1 Cast-in-place type:
    - .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.
    - .2 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 200 mm [8"] pipe size.
    - .3 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 200 mm [8"] pipe size.
  - .2 Drilled, mechanical expansion type:
    - .1 Hilti HSL or UCAN LHL heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa [2840 psi].
    - .2 Hilti Kwik-Bolt or UCAN WED stud anchor for concrete. (Do not use in seismic restraint applications).
    - .3 Hilti HDI or UCAN IPA drop-in anchor for concrete.

- .4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.
- .5 Hilti ZBP or UCAN Zamac pin bolt (light duty) for concrete and masonry.
- .3 Drilled, adhesive type:
  - .1 Hilti HVA or UCAN Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.
  - .2 Hilti HY150 consisting of 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, Hilti SAV 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.
- .3 Concrete bases shall be a minimum of 100 mm thick, or as noted and shall project at least 150 mm 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 25mm 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 grout - Embeco or In-Pakt.
- .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.
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- .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 primed 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, 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 ("bar lock" post type where more than 50mm rings required) binder c/w index tab separators to divide the different sections. The binder cover shall be black with white lettering. Printing of the binder cover shall be completed before the binder is manufactured and the wording shall be approved by the Consultant before printing.
- .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 interactive pdf format.

### **2.14 PROJECT RECORD DRAWINGS**

- .1 During the construction period, maintain on Site a clean set of drawings and specifications marked up clearly and indelibly in red, indicating "As-Built" conditions where such conditions deviate from the original directions of the Contract Documents and indicating final installation of feeders and branch circuits.
- .2 "As-Built" drawing markings shall include but shall not be limited to the following:
  - .1 All changes in circuiting.
  - .2 Size and routing of all conduits for all branch circuits including power, lighting and systems. Note that branch circuit wiring is generally not shown on Drawings. Accurately record "As-Built" drawings the size and routing of all installed raceways and cables.
  - .3 Number and size of conductors (#10 AWG and larger) in raceways and cables.
  - .4 Location of all junction boxes and pullboxes.
  - .5 Location of all conduits or duct stubs, installed equipment, devices and fixtures.
  - .6 All changes to electrical installation resulting from Addenda, Change Orders and Field Instructions.
  - .7 Exact location of all services left for future work.
  - .8 Location by accurate horizontal and vertical dimensions of the routes and terminations of all raceways and cables installed underground beyond the building.
- .3 At completion of construction and prior to substantial performance of the work, the Contractor shall arrange and pay for a computer drafting service to update the electronic drawing files showing the "As-Built" drawing markings. The "As-Built" drawings must conform to the electronic file structure already established on the drawing files (for example, layering schemes, fonts, dimensioning, etc.). All as-built drawings shall be stamped, signed and dated by the Contractor.
- .4 Provide hard and soft copies of the "As-Built" drawings as specified in Division 01.

**3 EXECUTION**

**3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 2012 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with 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 manufacturers nameplates and CSA labels are visible and legible after equipment is installed.
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**3.3 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete. 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 sealant after installation.
- .4 All cables and conduits shall be concealed in finished areas.

**3.4 LOCATION OF OUTLETS**

- .1 Coordinate outlet locations with Architectural Drawings.
- .2 Do not install outlets back-to-back or in the same stud space in wall; allow minimum 400mm 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 unless otherwise indicated.
- .5 Locate disconnect devices in mechanical and elevator machine rooms on latch side of doors.

**3.5 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not indicated verify before proceeding with installation. Confirm the height of devices in handicapped facilities before 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	400	[12"]	General
Wall receptacles/data	175	[7"]	Above top of counters or counter splash backs – coordinate with Architectural detail
Wall receptacles/data	1400	[56"]	In mechanical rooms
Panelboards			Panelboards: as required by Code or as indicated.
Wall mounted telephone	1500	[60"]	
Fire alarm stations	1200	[48"]	As required by ULC S524.
Fire alarm bells/audio/visual	2300	[90"]	ULC S524 requires not less than 1800mm. In any event not closer than 50mm to the ceiling



End of line resistors	1800	[72"]	
Television outlets			As receptacles –coordinate with equipment location
Wall mounted speakers & clocks	2100	[84"]	Coordinate with equipment location
Door bell pushbuttons	1200	[48"]	Coordinate with location
Emergency Lighting (wall mounted)			150mm below ceiling or 2300mm max.

- .5 Confirm mounting height with Departmental Representative prior to rough-in.

**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. Include in the tender price all costs related to such storage.
- .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, dated and signed 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.

### **3.8 FIELD QUALITY CONTROL**

- .1 Load and 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.

### **3.9 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 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 stating 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.

**3.10 CLEANING**

- .1 Do final cleaning in accordance with Division 01.
- .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.
- .4 Clean and prime paint exposed non-galvanised hangers, racks, fastenings to prevent rusting. Coordinate finish painting with Division 09.

**3.11 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.

**3.12 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.
-

**3.13 PROTECTION 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.

**3.14 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.

**3.15 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 CAN4-S115-95, that meets the requirements of the Building code in effect.
  - .2 The scope includes new services which pass through existing rated separations and also all existing services which pass through a new rated separation or existing separations whose rating has been upgraded.
  - .3 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.
  - .4 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.
  - .5 Contractors are expected to submit system information detailing firestopping product, backing, penetration, penetrated assembly, fire and temperature rating, and ULC or cUL system number.
  - .6 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be re-penetrated.
  - .7 Allow openings for 100% capacity of raceway.
  - .8 Provide split systems where existing cables are involved.
-

**3.16 SERVICE PENETRATIONS IN NON-RATED SEPARATIONS**

- .1 Provide 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.

**3.17 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 above floors in unfinished areas and wet areas and 6 mm above floors in finished areas.
- .4 Conduit sleeves shall extend 25 mm on each side of walls in unfinished areas and 6 mm in finished areas.
- .5 Conduit sleeves shall extend 25mm beyond exterior face of building. Caulk with flexible caulking compound.
- .6 Sleeve Size: 12 mm 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.

**3.18 EQUIPMENT INSTALLATION**

- .1 Provide means of access for servicing equipment.
- .2 CSA identification and equipment labels to be clearly visible after installation.

**3.19 CUTTING, PATCHING, DIGGING, CANNING , CORING & 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.
  - .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 supervise the work and provide all layouts and parameters.

**3.20 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 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 Division 09 of the Specification.

END OF SECTION

**1 GENERAL**

**1.1 RELATED WORK**

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

**1.2 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
- .2 CSA G22.1-12
- .3 National Electrical Manufacturers Association (NEMA)

**1.4 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**1.6 TERMS OF REFERENCE**

- .1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.
  - .2 Armoured cable (BX) is permitted for branch circuits only; use of BX for feeders and home runs is not permitted. Where flexible connections are required provide wiring in flexible conduits.
  - .3 Aluminium conductors not permitted.
  - .4 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 having a PVC jacket with FT-4 flame spread rating.
  - .5 Provide all control wiring except HVAC controls as specified in Mechanical Divisions. Refer to Equipment Schedule(s) for detailed responsibilities.
  - .6 Non-metallic sheathed wiring not to be used on this project.
-

## **2 PRODUCTS**

### **2.1 WIRING & CABLES – GENERAL**

- .1 Conductors: stranded for 12 AWG and larger. Minimum size #12 AWG.
- .2 Insulation to be 600 volt RW90XLPE (X link) for the general building wiring in conduit.
- .3 Main feeders to be conduit and insulated copper wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.
- .4 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors shall not be painted.

### **2.2 TECK CABLE**

- .1 Conductors:
  - .1 Grounding conductor: copper
  - .2 Circuit conductors: copper, size as indicated.
- .2 Insulation: Chemically cross-linked thermosetting polyethylene, type RW90, rated 600 V.
- .3 Inner jacket: polyvinyl chloride material.
- .4 Armour: interlocking aluminum.
- .5 Overall covering: polyvinyl chloride material FT-4 flame test rated.
- .6 Connectors: Watertight, approved for Teck cable installation.

### **2.3 LOW VOLTAGE CONTROL CABLES**

- .1 Type LVT: soft annealed copper conductors, with thermoplastic insulation, outer covering of thermoplastic jacket. Minimum size #18 AWG.
- .2 Unless otherwise specified wiring to be multicore individually identified and colour coded with grey sheath enclosed in conduit or (EMT).

### **2.4 BUILDING WIRE AND CABLE**

- .1 Unless otherwise directed, building wire and cable shall be copper conductors, sized as indicated.
  - .2 Except where otherwise directed or required by Code or other applicable regulations, building wire and cable insulation shall be Type RW90, cross-linked polyethylene insulated 600 volts rated for not less than 90°C.
-



- .3 All conductors within cable trays shall have FT4 type outer jacket to comply with all applicable regulations and bylaws.
- .4 Use of NMD90 (Loomex) not permitted.

## **2.5 ARMoured CABLE**

- .1 Type: AC 90
- .2 Armour: flexible interlocked aluminium

## **2.6 WIRE AND BOX CONNECTORS AND MISCELLANEOUS MATERIALS**

- .1 Connectors for wire and cable splices and taps: Unless otherwise directed, use 3M Co. 'Scotchlok,' Thomas & Betts PT Series, Buchanan 'B,' IDI Electric 'Super Nut,' or approved equal, for conductors #8 AWG or smaller; Burndy 'Servit' Type KSU or approved equal for conductors #1/0 AWG and smaller; and Burndy 'OKlip' Type KVSU or approved equal for conductors 750 MCM or smaller.
- .2 Clamps, glanding connectors, or box connectors for armoured cable, and flexible conduit as required.
- .3 Lugs, terminals, screws used for termination of wiring to be suitable for copper conductors.
- .4 Plastic electrical insulation tape: Scotch #88 or approved equal.

## **3 EXECUTION**

### **3.1 INSTALLATION GENERAL**

- .1 Unless specifically indicated otherwise, all wiring shall be installed in conduit. Use flexible conduits for final connections to suspend light fixtures and vibrating equipment.
  - .2 Use no wire smaller than #12 AWG, unless otherwise directed.
  - .3 Control circuit conductors for motors and mechanical equipment controls shall be not less than #14 AWG except where specifically directed otherwise.
  - .4 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; 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. Do not pull wires into incomplete conduit runs.
  - .5 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.
  - .6 The number of splices in any circuit shall be kept to an absolute minimum consistent with available coil length and installation conditions.
-

- .7 Conductors for lighting, receptacle, appliance and equipment branch circuits shall have ampacity not less than the rating of the over-current device protecting the branch circuit and shall be sized for a maximum voltage drop of 2% from panelboard to the last outlet of a circuit. The length of the branch circuit to be used in the determination of the required wire size shall be the combined vertical and horizontal distances from the panelboard to the last device in the circuit. In no case shall the wire sizes as determined above, be less than that indicated in the following table.

120 Volts, 1 Phase

15 Ampere Circuits	20 Ampere Circuits
0-25 m - min. #12 AWG	0-20 m - min. #12 AWG
Over 25 m - min. #10 AWG	0 m-30 m - min. #10 AWG
	Over 30 m - min. #8 AWG

347 Volts, 1 Phase

15 Ampere Circuits	20 Ampere Circuits
0-75 m - min. #12 AWG	0-55 m - min. #12 AWG
Over 75 m - min. #10 AWG	Over 55 m - min. #10 AWG

- .8 Make final connections to recessed incandescent or gas-discharge lamp fixtures, and other heat-producing equipment with thermoplastic insulated, lacquered glass-braid-jacketed "equipment wire," except that where higher temperature rating of insulation or larger conductor size than #10 AWG is required, use wire specifically approved for the purpose.
- .9 Exercise care in stripping insulation from wire. Do not nick conductors; if nicked replace with new.

**3.2 INSTALLATION OF BUILDING WIRES**

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

**3.3 INSTALLATION OF ARMoured CABLE**

- .1 Unless specifically directed to the contrary, use armoured cables only for:
- .1 Final connections from a junction box above accessible suspended ceilings to recessed light fixtures to a maximum length of 1500mm.
-

- .2 Final connections from a junction box above accessible suspended ceilings down stud and drywall partitions to receptacles. Ceiling junction box to be located as close as possible to the partition wall and not further away than 900 mm.
- .2 Armoured cables are not permitted to run around corners. Interconnection of electrical devices on adjacent walls shall be done via the ceiling space.
- .3 Armoured cables in accessible ceiling spaces shall not be dragged on ceiling tiles but shall be fastened to the underside of the structure using manufacturer's approved fastening devices. Armoured cables shall not run draped below pipes and ducts but shall be fished over such obstructions
- .4 Do not attach cables to the ceiling suspension system or to mechanical ductwork or piping.

### **3.4 IDENTIFICATION, CODING AND BALANCING**

- .1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 00 – Common Work Results.
- .2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on the records drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.

### **3.5 TESTING**

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Departmental Representative.

END OF SECTION

**1 GENERAL**

**1.1 RELATED WORK**

- .1 Section 26 05 00 – Common Work.

**1.2 REGULATORY REQUIREMENTS**

- .1 Restraints shall meet the requirements of the latest edition of the National Building Code and amendments.
- .2 The Seismic Engineer should be able to provide a proof of professional insurance and the related practice credentials if requested by the Consultant.
- .3 The Contractor's Seismic Engineer shall submit original signed National Building Code "Letters of Assurance" "Schedules B1, B2, and C-B" to the Consultant.
- .4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

**1.3 SCOPE**

- .1 The total electrical seismic restraint design, field review and inspection will be by a structural engineer who specializes in the restraint of building elements and is registered with the local engineering association. Contractor shall allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This Engineer herein referred to as the Seismic Consultant, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.
  - .2 It is the 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.
  - .3 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.
  - .4 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.
  - .5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.
  - .6 The Seismic Consultant shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.
-

- .7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.
- .8 The Seismic Consultant shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.
- .9 Include all costs associated with the seismic installation and certification in the base tender.

#### **1.4 SHOP DRAWINGS & SUBMITTALS**

- .1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic consultant.
- .2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Consultant.

### **2 EXECUTION**

#### **2.1 GENERAL**

- .1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.
- .2 Ensure that seismic restraints do not adversely affect the proper functioning of any vibration isolation mounts or hangers.

#### **2.2 CONDUITS**

- .1 Provide restraint installation information and details on conduit and equipment as indicated below:
- .2 Vertical Conduit:
  - .1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.
  - .2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m o.c.
  - .3 Riser joints shall be braced or stabilized between floors.
- .3 Horizontal Conduits:
  - .1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
  - .2 EMT tubing - tubing shall be supported at approximately 1.2 m intervals for tubing.

- .4 Provide transverse bracing at 12.2 m o.c. maximum unless otherwise noted. Provide bracing at all 90° bend assemblies, and pull box locations.
- .5 Provide longitudinal bracing at 24.4 m o.c. maximum unless otherwise noted.
- .6 Do not brace conduit runs against each other. Use separate support and restraint system.
- .7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.
- .8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.
- .9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
- .10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.
- .11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic consultant and submit shop drawings to the Consultant for his reference.

### **2.3 FLOOR MOUNTED EQUIPMENT**

- .1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.
- .2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

### **2.4 LIGHT FIXTURES**

- .1 Fluorescent fixtures in suspended ceilings shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by at least two taught cables which are connected to the fixture at diagonal points.
  - .2 Surface and recessed style fixtures shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by taught cables.
  - .3 Fixtures which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the fixture. Seismic restraint cables shall be secured into the concrete or structural deck above.
  - .4 Cables shall be corrosion resistant and approved for the application.
-

- .5 Fixtures which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

**1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 26 05 00 - Common Work Results

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
- .2 CSA C22.1-12
- .3 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
- .4 Transformer grounding shall comply with CSA C22.2 No.41-M87 (R99).
- .5 All grounding conductors to be stranded soft annealed copper unless otherwise noted.

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**2 PRODUCTS**

**2.1 MATERIALS**

- .1 Grounding equipment to: CSA C22.2 No.41-M87 (R99).

**2.2 EQUIPMENT**

- .1 Clamps for grounding of conductor, size as required.
- .2 Copper conductor at least 6m long for each concrete encased electrode, bare, stranded, soft annealed, size as indicated. If not indicated, use 3/0AWG which is the maximum in Table 43 CEC.
- .3 Rod electrodes, copper clad steel 20mm dia by 3m long as indicated.
- .4 System and circuit, equipment, grounding conductors, bare stranded copper, soft annealed, sized as indicated. Insulation where specified to be green.
- .5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.



- .6 Non-corroding accessories necessary for grounding system, type, size material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Thermit welded type conductor connectors.
  - .5 Bonding jumpers, straps.
  - .6 Pressure wire connectors.

### **3 EXECUTION**

#### **3.1 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- .2 Provide separate, insulated, copper bonding conductor in EVERY conduit used for power, lighting, fire alarm and every low tension system required in the building. Where wire size is not indicates, provide minimum size per applicable CEC tables.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or permanent mechanical connectors approved for the use.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Install bonding wire for flexible conduit, connected at both end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit. Provide a ground conductor in all flexible conduit and secure to system grounding lugs at both the equipment and source.
- .9 Install separate ground conductor to each outdoor lighting standard.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.
- .13 Ground secondary service pedestals in raised computer floors.
- .14 Coordinate ground rod installation with local soil conditions to assure proper grounding system.

**3.2 GROUNDING ELECTRODES**

- .1 Provide and install an artificial ground consisting typically of a minimum of four 3000mm x 20mm copperweld ground rods, interconnected by bare stranded copper #3 AWG conductor and terminating to the Main Electrical Room ground bus. Conductors shall be connected to the ground rods with compression type fittings and shall be buried 600 mm below grade. Check and measure the installation to ensure an adequate resistance to ground before covering.
- .2 Provide ground test well over one of the rods on the ground grid to allow access to the grid for testing.

**3.3 BUILDING SERVICES GROUNDING**

- .1 **WATER** - From the main electrical room ground bus, connect #3 AWG insulated ground conductor in 27mm conduit to water main with approved ground clamp ahead of water meter. Install 1#3/0 ground conductor jumper strapped around water meter and associated unions and valves to ground building side of water system.
- .2 **METALLIC WASTE WATER PIPING** - Each metallic waste water piping system to the building to be grounded by bonding it to the interior metallic water supply system by copper bonding jumper of not less than #3 AWG
- .3 **GAS PIPE GROUNDING** - All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.

**3.4 GROUNDING BUSSES**

- .1 Provide a ground bus in the main electrical room and main communication room.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size #3 AWG or as indicated.
- .3 Copper or bronze lugs required for termination of all copper conductors at ground busses.

**3.5 EQUIPMENT GROUNDING AND BONDING**

- .1 Install bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, starters, UPS, control panels, building steel work, raised floor systems, generators, distribution panels and outdoor lighting.
- .2 Provide grounding conductor(s) from all major switchgear to solidly ground the secondary system. This includes equipment located in the main electrical room as well as each sub-electrical room. Grounding conductors to be sized to Canadian Electrical Code and switchgear manufacturer's requirements.

**3.6 MECHANICAL EQUIPMENT BONDING**

- .1 Ground wires to be installed in all conduit serving motor feeder circuits and to extend to ground screws on junction and outlet boxes for bonding.

**3.7 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions.
- .3 Measure ground grid resistance with earth test megohmmeter and install additional ground rods and conductors as required until resistance to ground complies with Code requirements and is less than  $1\Omega$ . Submit test results to Department Representative.
- .4 Carry out all tests required by the Electrical Inspection Authority and provide all required reports and copied to the Departmental Representative. Include all associated costs.
- .5 Ensure test results are satisfactory before energizing the electrical system.

END OF SECTION

**1 GENERAL**

**1.1 WORK INCLUDED**

- .1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

**1.2 RELATED WORK**

- .1 Section 26 05 00 – Common Work:
- .2 Section 26 05 25 - Seismic Restraints:

**2 PRODUCT**

**2.1 FRAMING AND SUPPORT SYSTEM**

- .1 Materials:
  - .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
  - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
- .2 Finishes:
  - .1 Outdoors, wet locations: Hot dipped galvanized.
  - .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
  - .3 Nuts, bolts, machine screws: Cadmium plated.
- .3 Unistrut:
  - .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

**2.2 CONCRETE AND MASONRY ANCHORS**

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
  - .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
-

**2.3 NON-METALLIC ANCHORS**

- .1 Material: Plastic anchors for sheet metal screws.

**2.4 CONDUIT SUPPORTS**

- .1 General: Malleable iron two-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.
- .2 Structural Steel: Bolt on clamp type supports.
- .3 Masonry, concrete, stone, etc.: Anchors.
- .4 Title: Toggle bolts.
- .5 Metal studs, ceiling hangers, etc.: Push-on, snap in type supports
- .6 Unistrut: Unistrut conduit clamps.

**2.5 CABLE SUPPORTS AND CLAMPS**

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous or approved stainless steel or aluminum clamps shall be used.

**3 EXECUTION**

**3.1 GENERAL**

- .1 Do not cut or drill beams, joists or structural steel unless written permission of the Engineer is obtained.
  - .2 Distance between conduit or cable supports not to exceed code requirements.
  - .3 Supports to be suitable for the real loads imposed by equipment.
  - .4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.
  - .5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
  - .6 Provide conduit rack with 25% spare capacity for multiple runs.
  - .7 Provide channel support with fittings for vertical runs of conduit and cables.
-

**3.2 INSTALLATION**

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .5 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.
- .6 Shot driven pins may only be used with written approval of the structural engineer.
- .7 Use round or pan head screws for fastening straps, boxes, etc.
- .8 Do not support heavy loads from the bottom chord of open web steel joists.
- .9 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .10 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.
- .11 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .12 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Departmental Representative.

END OF SECTION

---

**1 GENERAL**

**1.1 WORK INCLUDED**

- .1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

**1.2 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work
- .3 Section 26 05 25 - Seismic Restraints

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data for cabinets in accordance with Division 01.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**2 PRODUCTS**

**2.1 SPLITTERS**

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs 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 less than 400 A.

**2.2 JUNCTION BOXES AND PULL BOXES, INDOOR DRY LOCATIONS**

- .1 Materials:
    - .1 Code gauge sheet steel, welded construction, phosphatised and/or galvanized.
  - .2 Components:
    - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
    - .2 Use rolled edges for surface boxes.
    - .3 Size shall be in accordance with Canadian Electrical Code for the given conduit sizes and arrangement and number of conductors and splices in the boxes.
    - .4 Surface or flush with trim and hinged door, latch and lock and two keys and keyed to match panelboard keys.
    - .5 Backboards: 19 mm GIS Fir plywood backboard.
-

- .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

## **2.3 CABINETS**

- .1 Materials:
  - .1 Cabinets: Code gauge sheet steel, welded construction, phosphatised and factory paint finish, suitable for field painting.
  - .2 Locks: to match panelboards.
  - .3 Backboards: 19 mm GIS fir plywood, one piece per cabinet, covering entire cabinet interior.
- .2 Components:
  - .1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.
  - .2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to Canadian Electrical Code for the given conduit sizes and arrangement and number of conductors and splices in the boxes. Keyed to match panelboard keys.

## **3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Junction Boxes and Pull Boxes:
  - .1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation.
  - .2 Boxes installed in party walls to be offset by a minimum of one stud space.
  - .3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.
  - .4 Identify with system name and circuit designation as applicable.
  - .5 Size in accordance with the Canadian Electrical Code, as a minimum.
- .2 Cabinets:
  - .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.
  - .2 Install terminal block where indicated.
- .3 Identification
  - .1 Provide equipment identification in accordance with drawings.

END OF SECTION



**1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work

**1.2 REFERENCES**

- .1 CSA C22.1-12 - Canadian Electrical Codes, Part 1.

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**2 PRODUCTS**

**2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1-12.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

**2.2 OUTLET BOXES FOR METAL CONDUIT**

- .1 Materials:
  - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 350 g/m<sup>2</sup> minimum zinc coating.
  - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.

**2.3 JUNCTION & PULL BOXES**

- .1 Electro-galvanized sheet steel type boxes for flush mount in walls with matching extension and plaster rings as required.
- .2 Install pull boxes in inconspicuous but accessible locations.
- .3 Install pull boxes after cumulative bend total of 270 degrees between boxes.
- .4 Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

**2.4 CONDUIT BOXES**

- .1 Cast FS or electro-galvanized sheet steel boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

**2.5 FITTINGS - GENERAL**

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

**3 EXECUTION**

**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
  - .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
  - .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
  - .4 Provide correct size of openings in boxes for conduit, and armoured cable connections. Reducing washers are not allowed.
  - .5 Install all outlets flush and surface mounted as required for the installation.
  - .6 Surface mount above suspended ceilings, or in unfinished areas.
  - .7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.
  - .8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
  - .9 Use plaster rings to correct depth. Use 30 mm on concrete block.
  - .10 Do not use sectional boxes.
-

- .11 Provide boxes sized as required by the Canadian Electrical Code.
- .12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.
- .13 Outlets installed in partition walls to be offset by a minimum of one stud space.
- .14 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
- .15 Primary bushings in termination box for cable connection.
- .16 Secondary bushings in termination box for bus duct connection.
- .17 For telecom raceways provide a pull box where: (1) the length is over 30 m and (2) where there are more than two 90 degree bends.

END OF SECTION

---

**1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work
- .3 Section 26 05 25 – Seismic Restraints

**1.2 REFERENCES**

- .1 CSA C22.1-12.
- .2 Canadian Standards Association (CSA) .CAN/CSA C22.2.

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**1.5 SCOPE OF WORK**

- .1 Drawings do not show all conduits. Those shown are in diagrammatic form only.
- .2 Conceal all conduits in finished areas. Conduits may be surface mounted either only where indicated or in service areas accessible only to authorized personnel.
- .3 Note particular requirements for routing of conduits where detailed.
- .4 Provide polypropylene pull cord in all "empty" conduits.
- .5 Conduits and boxes penetrating rated fire walls, ceilings and floors shall be properly firestopped and sealed for fire and smoke travel.

**2 PRODUCTS**

**2.1 CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No.45 Galvanized Steel.
  - .2 Electrical Metallic Tubing (EMT): to CSA C22.2 No.83.
  - .3 Flexible conduits: to CSA C22.2 No. 56.
  - .4 Minimum conduit size in the project to be 21mm [3/4"] diameter (for power as well as low tension services).
-

**2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 27 mm and smaller. Use two hole steel straps to conduits larger than 27 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 10 mm threaded rods to support suspended channels.

**2.3 CONDUIT FITTINGS**

- .1 Fittings manufactured for use with conduits specified. Coating same as conduit.
- .2 Provide factory "ells" where 90 degree bends are required for 35 mm and larger conduits.
- .3 EMT couplings and connectors shall be steel. Regular die-cast alloy fittings and couplings are not acceptable. Provide plastic bushings (insulated throat) for all connectors unless there is no chance of burrs. Provide water-tight connectors in damp or wet locations and for surface equipment (e.g. Panelboards, MCC's, etc) in rooms that are fire sprinkler protected.

**2.4 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable linear expansion.
- .2 Water-tight 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 as required.

**2.5 RIGID P.V.C. CONDUIT**

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured C.G.E. "Sceptre" Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

**2.6 OUTLET AND CONDUIT BOXES IN GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
  - .2 102 mm square or larger outlet boxes as required for special devices.
  - .3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.
  - .4 Blank cover plates for boxes without wiring devices.
  - .5 Combination boxes with barriers where outlets for more than one system are grouped.
-

- .6 Bushing and connectors with nylon insulated throats.
- .7 Knock-out fillers to prevent entry of foreign materials.
- .8 Conduit outlet bodies for conduit up to 35 mm. Use pull boxes for larger conduits.
- .9 Double locknuts and insulated bushings on sheet metal boxes.

## **2.7 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. Larger 102 mm square x 54 mm deep outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.
- .2 For larger boxes use GSB solid type as required.
- .3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.
- .4 Lighting fixture outlets: 102 mm square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).
- .5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

## **2.8 MASONRY BOXES**

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

## **2.9 CONCRETE BOXES**

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

## **2.10 SURFACE CONDUIT BOXES**

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

# **3 EXECUTION**

## **3.1 CONDUIT - GENERAL**

- .1 Generally use electrical metallic tubing (EMT) in the building interior and in above grade slabs except where subject to mechanical injury or where otherwise indicated.
  - .2 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
  - .3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
-

- .4 At all recessed panels cap 4 - 27 mm empty conduits from panel into ceiling above for future use.
  - .5 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Set out the work and coordinate with other services prior to installation. Maintain access to junction and pull boxes.
  - .6 Any conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.
  - .7 All conduit ends to be reamed to ensure a smooth interior finish that will not damage the insulation of the wiring.
  - .8 Ensure grounding continuity in all conduit systems.
  - .9 Use rigid galvanized steel (RGS) threaded conduit where the installation is subject to mechanical injury. In any event, use RGS conduit for surface installations up to 1.5 m [5'] above the finished floor.
  - .10 Field threads on rigid conduit shall be sufficient length to draw conduits ends together.
  - .11 Unless otherwise noted and where practical, all conduits to be routed through the ceiling space rather than in, or below, slabs or floor structures to facilitate future changes.
  - .12 Conduits in walls should typically drop (or loop) vertically from above to better facilitate future renovations. Generally conduits from below and horizontal conduits in walls and concrete structures should be avoided unless indicated.
  - .13 Generally use Rigid PVC conduits in or below ground level slab unless otherwise noted. Transition to RGS conduit in exposed locations: e.g. where conduits emerge from ground level slab.
  - .14 Conduits are not permitted in terrazzo or concrete toppings.
  - .15 Cap turned up conduits to prevent the entrance of dirt or moisture during construction.
  - .16 Locate conduits more than 75 mm parallel to steam or hot water lines with a minimum of 25 mm at crossovers.
  - .17 Bend conduits cold, so that conduit at any point is not flattened more than 1/10th of its original diameter. Conduits bent more than this or kinked to be replaced.
  - .18 Provide polypropylene pull cord in empty conduits to facilitate pulling wiring in future.
  - .19 Where conduits become blocked, the use of corrosive agents is prohibited. Remove and replace blocked section.
  - .20 Damaged conduits to be repaired or replaced.
  - .21 Dry conduits out thoroughly before installing wiring. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
  - .22 Conduits shall not pass through structural members except as indicated.
-

- .23 Conduit sizes indicated on drawings are minimum only. Increase sizes as required to suit alternative wiring types or to comply with Code.
- .24 Conduits and ducts crossing building expansion joints shall have approved conduit expansion fittings to suit the type of conduit used.
- .25 Seal conduits with approved sealant where conduits are run between heated and unheated areas.
- .26 Seal openings with approved sealant where conduits, cables, or cable trays pierce fire separations.
- .27 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction and/or to meet any fire separation integrity.
- .28 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .29 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of standard boxes where box support is not provided.
- .30 Provide necessary roof jacks or flashing where conduits pass through roof or watertight membranes. Apply approved sealant to maintain membrane integrity.
- .31 Use flexible metal conduit for connection to recessed incandescent fixtures without a prewired outlet box and connection to recessed fluorescent fixtures.
- .32 Use liquid tight flexible metal conduit for connection to motors, and other vibrating equipment and transformers.
- .33 Use explosion proof flexible connection for connection to explosion proof motors.
- .34 Install conduit-sealing fittings in hazardous areas, isolation rooms and clean rooms. Fill with compound.

### **3.2 SURFACE CONDUITS**

- .1 Surface conduits are acceptable in mechanical and electrical service rooms and in unfinished areas or where indicated.
- .2 Run parallel or perpendicular to building lines.
- .3 Locate conduits behind infrared or gas fired heaters with minimum 1.5 m clearance.
- .4 Conduits to be run in flanged portion of structural steel.
- .5 Group conduits wherever possible on suspended and/or surface channels.
- .6 Surface conduits will not be accepted in finished areas unless detailed.

### **3.3 SPARE CONDUITS**

- .1 Provide spare conduits as indicated.
-



- .2 Provide 4x27 mm spare conduits up to ceiling space and 4x27 mm spare conduits down to ceiling space below from each flush panel. Terminate the conduits in 150x150x100 mm junction boxes in ceiling spaces or in case of an exposed concrete slab, terminate each conduit in a flush concrete box. Provide coverplates for all junction boxes.

### **3.4 BOXES INSTALLATION**

- .1 Support boxes independently of connecting conduits.
  - .2 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.
  - .3 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of construction material. Remove upon completion of work.
  - .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 not to be used.
  - .6 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.
  - .7 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.
  - .8 No sectional or handy boxes to be installed.
  - .9 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.
  - .10 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.
  - .11 Outlets installed back to back in party stud walls to be off-set by one stud space.
  - .12 Refer to wiring device and communication specification sections and to architectural layouts for mounting heights of outlet boxes.
  - .13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.
  - .14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.
-

- .15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION

**1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work

**1.2 REFERENCES**

- .1 CSA C22.1-12

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01.

**2 PRODUCTS**

**2.1 SWITCHES**

- .1 Extra heavy duty specification grade.
  - .2 20 A, 120 V, single pole, double pole, three-way, four-way switches as indicated.
  - .3 Manually-operated general purpose ac switches as indicated and with following features:
    - .1 Terminal holes approved for No.10 AWG wire.
    - .2 Silver alloy contacts.
    - .3 Urea or melamine molding for parts subject to carbon tracking.
    - .4 Suitable for back and side wiring.
    - .5 White toggle (red toggle for emergency power circuits).
  - .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.
  - .5 Switches of one manufacturer throughout project.
  - .6 Acceptable products or approved equal:
    - .1 Arrow Hart 1900 series
    - .2 Bryant 4900 series
    - .3 Hubbell HBL.1221 series
    - .4 Leviton 1221-2 series
    - .5 Pass & Seymour PS20AC1 120V series
-

**2.2 RECEPTACLES – GENERAL**

- .1 Extra heavy duty specification grade.
- .2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features:
  - .1 White nylon molded housing (red for emergency power circuits, blue for surge protection)
  - .2 Suitable for No.10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and non riveted grounding contacts.
- .3 Duplex receptacles with a CSA Configuration of 5-15R and 5-20R installed within the Living Unit shall be tamper-resistant. Receptacles dedicated for microwaves, refrigerators, freezers or kitchen counters are excluded.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable products or approved equal:
  - .1 Arrow Hart 6262
  - .2 Bryant 5262.
  - .3 Hubbell 5262 series
  - .4 Leviton 5262 series
  - .5 Pass & Seymour 5262 series

**2.3 RECEPTACLES – 20A**

- .1 Extra heavy duty specification grade.
- .2 Duplex receptacles, CSA type 5-20 RA, 125 V, 15/20 A, U ground, with following features:
  - .1 White nylon molded housing (red for emergency power circuits)
  - .2 Suitable for No.10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and non riveted grounding contacts.

**2.4 COVER PLATES**

- .1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. For general interior flush mounted wiring devices and surface type FS or FD type boxes.
  - .2 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.
  - .3 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.
  - .4 All plates to be bevelled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.
  - .5 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.
-

- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Coverplates to fasten to box by four screws.
- .7 Gaskets: resilient rubber or close cell foam urethane. All gaskets inside inmate cells shall be air tight type to maintain negative air pressure in the cells.
- .8 Cover plates for all wiring devices to be from one manufacturer throughout project.

### **3 EXECUTION**

#### **3.1 INSTALLATION GENERAL**

- .1 Mount wiring devices to height specified in Section 26 05 00 or as indicated.
- .2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.
- .3 All plates to be installed parallel or perpendicular to building lines.

#### **3.2 INSTALLATION PARTICULAR**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .2 Receptacles:
  - .1 Install all receptacles in the vertical plane unless otherwise noted.
  - .2 Generally install the 5-15/20R U ground pin down unless otherwise noted.
  - .3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
  - .4 Where split receptacles has one portion switched, mount vertically and switch the upper portion.
  - .5 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.
- .3 Cover plates:
  - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
  - .4 Use weatherproof cover plates in wet locations and where indicated.
  - .5 Provide a label on every switch and receptacle cover plate indicating panel and circuit number.

END OF SECTION

**1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - Submittal Procedures
- .2 Section 26 05 00 - Common Work

**1.2 REFERENCES**

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

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01.
- .2 Include time-current characteristic curves for breakers with ampacity of 100A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

**2 PRODUCTS**

**2.1 BREAKERS - GENERAL**

- .1 Moulded-case circuit breakers, and ground-fault circuit-interrupters, and accessory high-fault protectors: to CSA C22.2 No. 5.
  - .2 Breakers shall be of the same manufacturer and have the same interrupting capacity of panel or panelboard into which it is being installed.
  - .3 Bolt-on moulded-case circuit breaker: quick- make, quick-break type, for manual and automatic operation [with temperature compensation for 40°C ambient.
  - .4 Plug-in moulded-case circuit breakers shall not be used.
  - .5 Common-trip breakers: with single handle for multi-pole applications.
  - .6 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.
  - .7 Circuit breakers with interchangeable trips as indicated.
-

**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.

**3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.

END OF SECTION



**1 GENERAL**

**1.1 RELATED WORK**

- .1 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1-12 whether indicated on not on the contract drawings.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 26 05 00.

**2 PRODUCTS**

**2.1 DISCONNECT EQUIPMENT**

- .1 "Heavy Duty" class, enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4.
- .2 Fuseholder assemblies to CSA C22.2 No.39.
- .3 Fusible and non-fusible disconnect switch in CSA enclosure Type 1, size as indicated.
- .4 Provision for padlocking in 'off' switch position.
- .5 Fuses as indicated. Allow for Class J or L for general circuits, Class RK5 for transformer, motor or other high inrush current circuits.
- .6 Fuseholders in each switch suitable without adaptors, for type of fuse as indicated.
- .7 Quick-make, quick-break action.
- .8 ON-OFF switch position indication on switch enclosure cover.
- .9 Weatherproof as required.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide identification lamacoid for main fused switch.

**2.3 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 26 05 00
  - .2 For disconnect switch less than 50A, provide two spare disconnect switches for each different size and type.
  - .3 For disconnect switch 50A or larger, provide one spare disconnect switches for each different size and type.
-



**3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses where indicated or required.
- .2 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated or not on the contract drawings.

END OF SECTION



**1 GENERAL**

**1.1 RELATED WORK**

- .1 Mechanical: Divisions 23 and 25
- .2 Section 26 29 10 – Motor Starters and Controls

**1.2 REQUIREMENTS**

- .1 Provide a complete system of wiring to motors and mechanical controls as specified herein and as shown on the drawings.
  - .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under contracts related to this project or relocated as part of the scope. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other divisions.
  - .3 Unless specifically noted otherwise, supply all disconnects, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
  - .4 Do not operate motors and controls until approval is obtained from the trade providing equipment.
  - .5 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.
  - .6 Assist in placing in operation all mechanical equipment having electrical connections.
  - .7 Provide three phase starters with fused 120 volt control transformers and overload relays.
  - .8 Provide all power wiring for all motors.
  - .9 Provide power wiring for heating ventilating and air conditioning equipment. Provide terminations in starters and MCCs for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.
  - .10 Refer to Mechanical Equipment Schedule (Appendix E).
-

- .11 The motor control work which shall be provided under Division 26 shall include the following:
  - .1 All conduit and control wiring specifically noted on the drawings and outlined in the different parts of the Specification.
  - .2 Conduit and control wiring for baseboard heaters, unit heater and force flow heater thermostats.
  - .3 All control wiring as specified in the Motor Schedule.
  - .4 Control wiring related to air handling shutdown during fire alarm.

## **2 PRODUCTS**

### **2.1 3 PHASE MOTOR DISCONNECT SWITCHES**

- .1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors, switches to be H.P. rated, heavy duty type.

### **2.2 120 VOLT, 1 PHASE DISCONNECT SWITCHES**

- .1 Manual disconnect switch HP rated (starter) without overload relay.

### **2.3 208 VOLT, 1 PHASE MOTOR DISCONNECT SWITCHES**

- .1 Manual disconnect switch HP rated (starter) without overload relay – two pole.

## **3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Provide disconnect switches adjacent to all motors.
- .2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all mechanical components to provide a functional system.
- .3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

**1 GENERAL**

**1.1 RELATED WORK**

- .1 Common Work Requirements: Section 26 05 00
- .2 Section 26 98 00 - Testing, Adjusting and Balancing of Electrical Equipment

**1.2 COORDINATION**

- .1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:
  - .1 Electrical equipment and systems specified in Division 26.
  - .2 Mechanical equipment and systems specified in Division 21, 22, 23 & 25.
  - .3 Other equipment and systems specified in other Divisions.
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

**2 PRODUCTS (NOT USED)**

**3 EXECUTION**

**3.1 STARTING MOTORS**

- .1 Prior to starting motors:
  - .1 Verify phase rotation at motor control centres.
  - .2 Confirm motor nameplate data with motor starter heater overloads.

**3.2 ENERGIZING EQUIPMENT**

- .1 Complete all testing and provide testing result to Departmental Representative prior to energizing equipment.
- .2 Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

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**1 GENERAL**

**1.1 INTENT**

- .1 Except where otherwise specified, arrange testing, adjusting, balancing and related requirements specified herein.
- .2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.
- .3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.
- .4 All tests shall be witnessed by persons designated by the Departmental Representative, who shall also sign the test documentation.

**1.2 RELATED WORK**

- .1 Section 26 05 00: Common Work
- .2 Section 26 96 00: Starting of Electrical Equipment and Systems

**1.3 MANUFACTURER'S PRODUCTION TEST RECORDS**

- .1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

**1.4 SITE TESTING REPORTS**

- .1 Log and tabulate test results on appropriate test report forms. Submit forms to Departmental Representative for approval prior to use.
- .2 Submit completed test report forms as specified, immediately after tests are performed.

**1.5 REFERENCE DOCUMENTS**

- .1 Perform tests in accordance with:
    - .1 The Contract Documents
    - .2 Requirements of authorities having jurisdiction
    - .3 Manufacturer's published instructions
    - .4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards
  - .2 If requirements of any of the foregoing conflict, notify Departmental Representative before proceeding with test and obtain clarification.
-

**1.6 SEQUENCING AND SCHEDULING**

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

**2 PRODUCTS**

**2.1 TEST EQUIPMENT**

- .1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

**3 EXECUTION**

**3.1 TESTING OF WIRING AND WIRING DEVICES**

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.
- .2 Test service grounding conductors for ground resistance.
- .3 Test all wiring devices for correct operation.
- .4 Test all receptacles for proper polarity and circuitry.

**3.2 LOAD BALANCE TESTING**

- .1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.
- .4 If load imbalance exceeds 15%, reconnect circuits to balance loads.

**3.3 VOLTAGE TESTING AND ADJUSTING**

- .1 Test voltage at all panelboards.
- .2 Test voltage at motor starters.
- .3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Departmental Representative.

END OF SECTION

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