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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section includes:
 - .1 Labour, products, equipment and services necessary to complete the work of this Section.
 - 1.2 **RELATED SECTIONS**
 - .1 Not used.
 - 1.3 **CODES, PERMITS AND INSPECTIONS**
 - .1 Applicable Codes and Standards. Contractor to reference latest in force standard.
 - .1 Canadian Electrical Code, CSA C22.1 Part-I, 2018 edition
 - .2 CSA C22.2, Part II
 - .3 CSA C22.3, Part III, Overhead system
 - .4 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .5 Electrical Safety Authority (ESA)
 - .6 Electrical and Electronic Manufacturers Association of Canada (EEMAC)
 - .7 National Electrical Manufacturers Association (NEMA)
 - .8 Alberta Building Code 2014
 - .9 Canadian Standards Association (CSA)
 - .10 Underwriters' Laboratories of Canada (ULC)
 - .11 National Building Code of Canada (NBC) 2015
 - .12 Illuminating Engineering Society (IES)
 - .13 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE)
 - .14 CSA C282-15, Emergency Electrical Power Supply for Buildings
 - .15 CSA Z32-15, Electrical safety and Essential Electrical Systems in Health Care Facilities
 - .16 National Fire Protection Association (NFPA)
 - .17 American Standards Association (ASA or ANSI)
 - .18 Institute of Electrical and Electronic Engineers (IEEE)
 - .19 Electronic Industries Association (EIA)
 - .20 Telecommunications Industry Association (TIA)
 - .21 Building Industry Consulting Services, International (BICSI)
 - .22 Material Safety Data Sheets by product manufacturers
 - .23 Hydro inspection permits
 - .24 Codes, standards, and regulations of local governing authorities having jurisdiction
 - .25 Additional codes and standards listed in Trade Sections
 - .26 Departmental Representative's standards
 - .27 Local Utility Standards
 - .2 Comply with Canadian Electrical Code, all local, provincial and federal laws, where applicable and with authorities having jurisdiction. Make any changes or alterations required by authorized inspector of authority having jurisdiction.
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- .3 Equipment and material must be acceptable to Electrical Safety Authority.
- .4 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the co-operation of the material supplier.
- .5 Obtain and pay for permits and inspections required for work performed.
- .6 Supply and install warning signs, nameplates and glass covered Single Line Diagrams as required by Electrical Safety Authority.
- .7 Submit required Documents and shop drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Contract Drawings and Specifications may be used for this purpose.

1.4 **REFERENCE STANDARDS**

- .1 These Specifications supplement the referenced standards.
- .2 Where standards differ between authorities, the most rigid apply.
- .3 Where requirements of the specifications exceed referenced standards, the specifications apply.
- .4 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .5 Conform to latest issues, amendments and supplements of following standards:
 - .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.40-M - Primer, Structural Steel, Oil Alkyd Type
 - .2 Canadian Institute of Steel Construction (CISC/CPMA)
 - .1 CISC/CPMA 2.75 - Canadian Institute of Steel Construction/
Canadian Paint Manufacturers Association, A Quick Drying Primer
For Use on Structural Steel
 - .3 Canadian Standards Association (CSA):
 - .1 CAN3-C21.1-M - Control Cable - 600V
 - .2 CAN3-C21.2-M - Control Cable for Low Energy Circuits 150V and
300V
 - .3 CAN/CSA C22.2 No. 18 - Outlet Boxes, Conduit Boxes, and Fittings
 - .4 CAN/C22.2 No. 26 - Wireways, Auxiliary Gutters and Associated
Fittings
 - .5 CSA C22.2 No. 38-M - Thermoset Insulated Wires and Cables
 - .6 CSA C22.2 No. 40-M - Cutout, Junction and Pull Boxes
 - .7 CSA C22.2 No. 42-M - General Use Receptacles, Attachment
Plugs and Similar Wiring Devices
 - .8 CSA C22.2 No. 45-M - Rigid Metal Conduit
 - .9 CSA C22.2 No. 49 - Flexible Cords and Cables
 - .10 CAN/CSA C22.2 No. 51-M - Armoured Cables

- .11 CSA C22.2 No. 52-M - Service-Entrance Cables
- .12 CSA C22.2 No. 56 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
- .13 CSA C22.2 No. 62 - Surface Raceway Systems
- .14 CSA C22.2 No. 65 - Wire Connectors
- .15 CSA C22.2 No. 75-M - Thermoplastic Insulated Wires and Cables
- .16 CSA C22.2 No. 76-M - Splitters
- .17 CSA C22.2 No. 79 - Cellular Metal and Cellular Concrete Floor Raceways and Fittings
- .18 CSA C22.2 No. 80 - Underfloor Raceways and Fittings
- .19 CSA C22.2 No. 83-M - Electrical Metallic Tubing
- .20 CAN/CSA-C22.2 No. 85-M - Rigid PVC Boxes and Fittings
- .21 CAN/CSA C22.2 No. 94-M -Special Purpose Enclosures
- .22 CSA C22.2 No. 123-M - Aluminum Sheathed Cables
- .23 CSA C22.2 No. 127 - Equipment Wires
- .24 CAN/CSA-C22.2 No. 131-M - Type Teck 90 Cable
- .25 CSA C22.2 No. 138-M - Heat Tracing Cable and Cable Sets for Use in Hazardous Locations
- .26 CSA C22.2 No. 182.3-M - Special Use Attachment Plugs, Receptacles, and Connectors
- .27 CSA C22.2 No. 208-M - Fire Alarm and Signal Cable
- .28 CSA C22.2 No. 211.2-M - Rigid PVC (Unplasticized) Conduit
- .29 CSA C22.2 No. 214-M - Communications Cables
- .30 CSA C22.2 No. 227.1 - Electrical Nonmetallic Tubing
- .31 CSA C22.2 No. 227.2 - Flexible Liquid-Tight Nonmetallic Conduit
- .32 CSA C22.2 No. 227.3-M - Flexible Nonmetallic Tubing
- .33 CSA C22.2 No. 230-M - Tray Cables
- .34 CSA C22.2 No. 232-M - Optical Fiber Cables

1.5 **DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE STD 100.

1.6 **DRAWING AND SPECIFICATIONS COORDINATION**

- .1 In the case of discrepancies or conflicts between the Drawings and Specifications and local governing authority standards, contact Departmental Representative and obtain direction. If direction is not available prior to close of Bids, include for the most costly arrangement, but ensure that direction is obtained prior to start of the Work.
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1.7 **COORDINATION**

- .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences. Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
- .2 Coordinate Work of this Division such that items will properly interface with Work of other Divisions.
- .3 All embedded openings shall be considered by structural and architectural disciplines.
- .4 Architectural Drawings, all equipment arrangement and cable or cable tray route shall be rechecked with Architectural drawing before starting installation.
- .5 Mechanical Drawings, all mechanical related loads (location and required power / voltage) shall be rechecked by Mechanical final drawing.
- .6 Coordinate work of this Division to ensure that damage does not occur to the fireproofing work of any other Division.

1.8 **SUBSTITUTIONS**

- .1 When manufacturer's catalogued trade name is specified, that material or product is intended to be used as a basis of standard for the item. Any material or product that meets or exceeds that standard can be utilized without prior approval.
- .2 No substitution is allowed upon award of contract.

1.9 **DIMENSIONS AND QUANTITIES**

- .1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to shop drawings and field measurement.
- .2 Quantities or lengths indicated in Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- .3 Make necessary changes or additions to routing of conduit, cables, cable trays, and the like to accommodate structural, mechanical and architectural conditions. Where raceways are shown diagrammatically run them parallel to building column lines.

1.10 **EQUIPMENT LOCATIONS**

- .1 Devices, fixtures and outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3 m, without adjustment to Contract price.
- .2 Switch, control device and outlet locations are shown diagrammatically.

1.11 **WORKING DRAWINGS AND DOCUMENTS**

- .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract. Execute such Work only after verification of dimensions and materials and obtaining Departmental representative's written permission to proceed.

1.12 **INSTALLATION DRAWINGS**

- .1 Prepare installation drawings for equipment, based upon approved Vendor drawings, to check required Code clearances, raceway, busway and cable entries, sizing of
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housekeeping pads and structure openings. Submit installation drawings to Departmental Representative for review.

1.13 **"AS BUILT" RECORD DRAWINGS**

- .1 Maintain a set of Contract Drawings on site and record all deviations from the Contract Documents. As a mandatory requirement, recording must be done on the same day deviation is made. Be responsible for full compliance with this requirement.
- .2 Mark locations of feeder conduits, junction and terminal boxes and ducts or conduits run underground either below the building or outside the building.
- .3 Where conduit and wiring are underground or underfloor, furnish field dimension with respect to building column lines and inverts with respect to finished floor levels or grades.
- .4 Record deviations from branch circuit numbers shown on Drawings.
- .5 Prepare diagrams of interconnecting wiring between items of equipment including equipment supplied by Departmental Representative and under other Specification Sections.

1.14 **SINGLE LINE DIAGRAM**

- .1 Reproduce this diagram in drawing form under glazed frame and mount in Main Electrical Room. Provide a copy of this diagram to the Departmental Representative and include in the Maintenance Manuals.

1.15 **TEST REPORTS**

- .1 For each check and test performed prepare and submit a Test Report, signed by the Test engineer, and where witnessed, by the Departmental representative.
- .2 Include record of all tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number.
- .3 Include calibration record, percentage error and applicable correction factors.
- .4 Submit a Certified Test Report from each manufacturer, signed by the certifying inspector, confirming correct installation and operation of each product and part of Work. Include name of certifying inspector, date and times of inspection, ambient conditions.

1.16 **SUBMITTALS**

- .1 Submittals to be in accordance with Division 01 Submittal Procedures, the articles below and/or as indicated in each electrical specification section.
- .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 Submittal Procedures.
- .4 Submit shop drawings in accordance with Division 01 Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

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- .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .5 Submit to the Departmental Representative, the necessary number of electrical drawings and specifications for examination, special inspection and/or approval, prior to the commencement of the work, and pay for all costs and associated fees. If required prepare any additional drawings/documents required by either Authority.
 - .6 Obtain and pay for permits and inspections required for the work performed.
 - .7 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .8 Quality Control:
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
 - .9 Manufacturer's Field Reports: submit to Departmental Representative the manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
 - .10 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the co-operation of the material supplier.
- 1.17 **QUALITY ASSURANCE**
- .1 Quality Control and Assurance: in accordance with Division 01 Quality Control.
 - .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
 - .3 Health and Safety Requirements: do construction and occupational health and safety in accordance with Division 01 Health and Safety Requirements.
- 1.18 **FACTORY WITNESS TESTS**
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- .1 Prior to Departmental Representative attendance at factory for witness testing, perform the following:
 - .1 Successfully conduct test to be witnessed.
 - .2 Following successful testing, inform the Departmental representative, in writing, that tests to be witnessed have been successfully performed.
 - 1.19 **SYSTEM STARTUP**
 - .1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.
 - .2 Arrange and pay for services of Factory Service Engineer for major systems, to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
 - .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.
 - 1.20 **OPERATING AND MAINTENANCE MANUALS**
 - .1 Refer to and comply with Division 01 and related Sections.
 - .2 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .3 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.
 - .4 Provide a video recording of the training sessions for all major electrical equipment and electrical systems.
 - .5 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
 - .6 Post instructions where directed.
 - .7 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
 - .8 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
 - 1.21 **AREA CLASSIFICATION**
 - .1 No area in the Work is classified as Hazardous.
 - 1.22 **COMMISSIONING**
 - .1 Refer to Division 01 section 01 91 13 for general commissioning requirements.
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- .2 Refer to Mechanical section 25 01 11 - Start Up Verification and Commissioning for mechanical commissioning requirements.
 - .3 The departmental representative may be present for any testing/commissioning activities and are to be notified by the contractor in advance of these activities.
 - .4 Submit a copy of test reports of systems and equipment to the departmental representative, prior to start of commissioning activity or as directed by departmental representative.
 - .5 Where commissioning specifications are included as part of Division 01, the requirements of the Section entitled Electrical Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, the more stringent requirement will apply unless otherwise directed by Departmental representative.
 - .6 Commissioning shall be administered for each electrical system per the criteria listed below.
 - .1 General – for all electrical equipment
 - .1 Verify Equipment is installed to manufacturer’s recommendations.
 - .2 Verify equipment installed matches shop drawings.
 - .3 Verify connections are torqued to manufactures recommended values.
 - .4 Verify all cover plates are installed and undamaged. Replace damaged plates where found.
 - .5 Ensure all equipment labels are installed per specifications.
 - .6 Provide system test reports as called for in the specifications.
 - .2 Power Distribution – Branch circuit panel, receptacles, etc.
 - .1 Spot check operation of circuit breakers. For GFCI breakers utilize breaker test button.
 - .2 Perform spot check of installed receptacles.
 - .3 Check receptacles are installed level and that cover plate is undamaged.
 - .4 At each receptacle checked, verify voltage, polarity and ground connection.
 - .5 For GFCI receptacles check function utilizing test button.
 - .3 Lighting
 - .1 Spot check of installed fixtures
 - .2 Verify fixture operation.
 - .3 Check that fixture is undamaged.
 - .4 Check that all springs, screws and mounting hardware are installed and secured.
 - .7 All testing as recommended by the manufacturer will be completed prior to commissioning.
 - .8 Refer to commissioning checklist below and utilize checklist to perform electrical commissioning.
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Emergency Lighting										
	Battery Pack									- Load test all emergency lighting battery packs. Run each battery pack under load for 30minutes. - Load test to be conducted on all battery packs.
	Remote Heads									- Check operation while load test is being conducted. - Operation check to be performed on all remote heads.
	Exit Lights									- Check operation while load test is being conducted. - Operation check to be performed on all exit lights.
Telephone										
	Telephone Receptacles									- Check receptacles are installed level and that cover plate is undamaged.
	Telephone D-mark									- Check that all equipment installed and terminated.
	Telephone System Function									- Provide telephone cabling transmission test reports for review
CATV										
	CATV Receptacles									- Check receptacles are installed level and that cover plate is undamaged.
	CATV D-mark									- Check that all equipment installed and terminated.
	CATV System Function									- Provide telephone cabling transmission test reports for review
Fire Alarm										
	Fire Alarm System									- Verify fire alarm system in accordance with CAN/ULC S537 - Provide fire alarm verification certificate once complete

1.23 LOCAL ELECTRICAL UTILITY REQUIREMENTS

- .1 Comply with the latest conditions of supply requirements of the local electrical Utility having jurisdiction. Execute infrastructure work related to the local Utility in accordance with requirements and coordinated Utility requirements with the respective Divisions of the Work providing such work. Include for the following in relation to Utility:
 - .1 Two preconstruction meeting;
 - .2 Access for electrical Utility's Inspector to be on duty for duration of work or as required by the Utility;
 - .3 Underground inspection: submission of approval drawings and application for inspection prior to any inspection of work;
 - .4 Approval of work and materials by electrical Utility's Inspector prior to any backfilling work.

1.24 SERIES RATED COMBINATIONS

- .1 Series rated combinations of over-current protective devices are not permitted. Provide full rating distribution as shown on plans.

2 Products

2.1 APPROVALS AND QUALITY

- .1 Provide new materials bearing certification marks or labels acceptable under Canadian Electrical Code.
- .2 Equipment must bear, on manufacturer's label, certification mark or label acceptable under Electrical Safety Authority.
- .3 Provide units of same manufacture where two or more units of same class or type of equipment are required.
- .4 Manufacturer's names are stated in this Specification to establish a definite basis for tender submission and to clearly describe the quality of product that is desired for the work.

2.2 **STANDARD SPECIFICATIONS**

- .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all products provided comply with latest issue of applicable Standard Specifications issued by authorities having jurisdiction, but such Standard Specifications shall not be applied to decrease the quality of workmanship, products and services required by the Contract Documents.

2.3 **MATERIALS AND EQUIPMENT**

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .2 Factory assemble control panels and component assemblies.
- .3 Ensure no counterfeit breakers are used in the project. Do random sample checks in non-factory supplied breakers.
- .4 Enclosure CSA types referred to in this specification to be in accordance to CAN/CSA 22.2 No.94-M91(R2011)-Special Enclosures and/or their EEMAC/NEMA equivalent, whichever is more stringent.
- .5 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .6 Storage and Handling Requirements:
- .7 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .8 Replace defective or damaged materials with new.

2.4 **ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls as indicated.
- .2 Control Wiring and Conduit: in accordance with section 26 05 05 – Electrical Requirements for Mechanical Equipment, except for conduit wiring and connections below 50V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.5 **WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of departmental Representative having jurisdiction.
- .2 Decal signs, minimum size 175 x 250 mm.

2.6 **WIRING TERMINATIONS**

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

2.7 **HOUSEKEEPING PADS**

- .1 Provide 100 mm high concrete pads under floor mounted electrical equipment. Extend pads 50 mm outside the equipment perimeter.

2.8 FIRE STOPPING AND SMOKE SEALS

- .1 Where electrical material or devices pass through fire rated separations, make penetrations and provide fire barrier seals with a fire resistance rating equivalent to the rating of the separation.
- .2 Prior to installation, submit for review, proposed fire barrier seal materials, method of installation and ULC system number.
- .3 Provide fire stopping and smoke seals in accordance with Section 07 84 00.

2.9 MISCELLANEOUS METAL FABRICATIONS

- .1 Provide miscellaneous structural supports, platforms, braces, brackets and preformed channel struts necessary for suspension, attachment or support of electrical equipment in accordance with Section 05 50 00.

2.10 SILICONE

- .1 Products and materials containing silicone are not permitted.

2.11 EQUIPMENT COLOUR CODING

- .1 Exterior finish paint colour for control panels, panelboards and devices on emergency and UPS systems:
 - .1 Emergency systems: red
 - .2 UPS systems: blue

2.12 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: lamicoid 3 mm, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
 - .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
 - .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacturing.
 - .4 Allow for minimum of twenty-five (25) letters per nameplate and label.

- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled, voltage and power source.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages and power source.
- .9 Panelboards: indicate system, rated ampacity, voltage, phase, wire configuration and power source.
- .10 Switchboard: indicate rated ampacity, voltage, phase, wire configuration.
- .11 Receptacles: indicate circuit numbers using P-Touch type labels.

2.13 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1 as follows:
 - .1 Phase A – Red
 - .2 Phase B – Black
 - .3 Phase C – Blue
 - .4 Neutral – White
 - .5 Ground – Green
 - .6 Isolated Ground – Green and Yellow

2.14 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at conduit system couplings.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

System	Normal	Emergency	UPS
up to 15 kV	Yellow	-	-
347/600 V	Orange	Orange/Red	Orange/Blue
120/208 V	Black	Black / Red	Black / Blue
Fire Alarm	Red	-	-
Emergency Voice	Red / Blue	-	-
LAN	Green	-	-
Security	Red/Yellow	-	-
Low Voltage Control	White	-	-

2.15 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

- .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC standard.
- .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1 (ANSI 61).

2.16

PRODUCTS FURNISHED BY DEPARTMENTAL REPRESENTATIVE

- .1 Carefully examine the Vendor or Manufacturers' drawings and provide any incidental and miscellaneous materials, mounting hardware and supports required for complete systems.

2.17 WIRE - LOW VOLTAGE UP TO 1000V SERVICE

.1 Conductors

- .1 ASTM Class B, soft drawn, electrolytic copper
- .2 Stranded for # 10 AWG and larger.

.2 Insulation

.1 CSA type RW90 XLPE (-40°C)

- .1 Heat and moisture resistant
- .2 Low temperature, chemically cross-linked thermosetting polyethylene material
- .3 600V or 1000V rated
- .4 For maximum 90°C conductor temperature
- .5 For installation at minimum -40°C temperature
- .6 To CSA C22.2 No. 38

.2 CSA type RWU90 XLPE (-40°C):

- .1 Heat and moisture resistant
- .2 Low temperature, chemically cross-linked thermosetting polyethylene material
- .3 1000V rated
- .4 For maximum 90°C conductor temperature
- .5 For installation at minimum -40°C
- .6 To CSA C22.2 No. 38

.3 CSA type T90 NYLON (-10°C):

- .1 Heat resistant
 - .2 Flame retardant
 - .3 Thermoplastic PVC material with extruded nylon cover
 - .4 600V rated
 - .5 For maximum 90°C conductor temperature dry and 75°C in wet locations
 - .6 For installation at minimum -10°C
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- .7 To CSA C22.2 No. 75-M
- .4 CSA type TEW:
 - .1 Heat resistant
 - .2 600V rated
 - .3 For maximum 105°C conductor temperature
 - .4 To CSA C22.2 No. 127
- .5 CSA type SEW-2
 - .1 Heat resistant
 - .2 600V rated
 - .3 For maximum 200°C conductor temperature
 - .4 To CSA C22.2 No. 127

2.18 CABLE - LOW VOLTAGE UP TO 1000V SERVICE

- .1 CSA Type AC90 XLPE (-40°C)
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Solid for sizes #10 AWG and smaller
 - .3 Stranded for sizes #8 AWG and larger
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600V rated for sizes #10 AWG and smaller
 - .4 1000V rated for sizes #8 AWG and larger
 - .5 For maximum 90°C conductor temperature
 - .6 For installation at minimum -40°C temperature
 - .7 To CSA C22.2 No. 38
 - .3 Construction
 - .1 2, 3 or 4 insulated conductors
 - .2 Bare ground conductor
 - .3 Overall interlocking aluminium armour
 - .4 To CSA C22.2 No. 51
 - .2 CSA Type TECK90 (-40°C)
 - .1 Conductors
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- .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Stranded
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600V or 1000V rated
 - .4 For maximum 90°C conductor temperature
 - .5 For installation at minimum -40°C temperature
 - .6 CSA type RW90 XLPE
 - .7 To CSA C22.2 No. 38
 - .3 Construction
 - .1 1 or more insulated conductors
 - .2 Bare, stranded, copper ground conductor for multi-conductor cables
 - .3 Bare, solid, served copper ground conductors for single conductor cables
 - .4 Fillers with binder tape to produce a circular cross-section for multi-conductor cables
 - .5 Power cables
 - .1 1, 2, 3 or 4 conductors
 - .2 Conductors 1000V rated
 - .6 Composite cables
 - .1 3 power conductors
 - .2 3 #14 AWG control conductors
 - .3 Conductors 600V rated
 - .7 Extruded PVC inner jacket over conductor assembly
 - .8 Interlocking aluminium armour over inner jacket
 - .9 Extruded PVC overall jacket over armour
 - .1 FT4 flame test rated
 - .2 Colour black unless otherwise indicated
 - .10 Cable assembly for installation at minimum -40°C temperature
 - .11 To CSA C22.2 No. 131 and CSA C22.2 No. 174
 - .3 CSA Type NMD90 (Romex):
 - .1 Non-metallic Sheathed Cable
 - .2 300V rated
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- .4 CSA Type MI
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Solid
 - .2 Insulation
 - .1 Powdered magnesium oxide
 - .2 600V rated for feeders on 208/120V system or control wiring
 - .3 1000V rated for feeders on 600/347V systems
 - .3 Construction
 - .1 Solid conductor
 - .2 Insulation around the conductor compressed to form a solid, homogeneous mass between the conductor and the metal sheath throughout the entire length of cable
 - .3 Soft annealed seamless copper sheath over insulation
 - .4 Extruded PVC overall jacket over sheath
 - .1 FT4 flame test rated
 - .2 Colour black unless otherwise indicated
 - .5 Two (2) hour fire rated where indicated on drawings.
 - .6 Connectors: watertight, field installed approved for MI cable.
 - .7 Termination kits: field installed approved for MI cable
 - .8 To CSA C22.1 No. 124-M
 - .4 Acceptable Manufacturer
 - .1 Pyrotenax

2.19 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath: thermoplastic jacket.
 - .2 Type: low energy 300 V control cable: solid annealed copper conductors sized as indicated:
 - .1 Insulation: TW 40 degrees C.
 - .2 Shielding: tape coated with diamagnetic material over each conductor.
 - .3 Overall covering: PVC jackets.
 - .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
 - .1 Insulation: RW90 (x-link).
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- .2 Shielding: non-magnetic tape over each pair of conductors.
- .3 Overall covering: PVC.

2.20 CABLE CONNECTORS

- .1 Connectors for Type AC90 Cable
 - .1 Steel or malleable iron
 - .2 Insulated throat
 - .3 Acceptable manufacturers
 - .1 Efcor 1000B series
 - .2 Elliott 65200 series
 - .3 Thomas & Betts 3110 series
- .2 Connectors for Type TECK90 Cable
 - .1 Copper free aluminium body
 - .2 Steel or copper free aluminium fittings and locknut
 - .3 Certified for use in hazardous locations Classes I, II, and III
 - .4 Class I hazardous location sealing fitting
 - .5 Acceptable manufacturers
 - .1 Thomas & Betts "STE" series
 - .2 Crouse-Hinds type TMC
 - .3 Commander/Iberville type TEK

2.21 WIRE AND CABLE CONNECTORS

- .1 Copper compression type wire and cable terminations for #8 AWG and larger conductors, colour keyed, sized to suit. Long barrel NEMA 2 hole lugs for sizes #1/0 AWG and larger.
 - .1 Acceptable Manufacturers
 - .1 Thomas & Betts series 54000
 - .2 Ideal Powr-Connect
 - .3 Burndy Hylug
 - .2 Twist type splicing connectors, copper, sized to suit, with nylon or plastic shroud for tee connections in #10 AWG and smaller conductors.
 - .1 Acceptable Manufacturers
 - .1 Thomas & Betts spring type
 - .2 Ideal Twister
 - .3 Marr Marrette
 - .3 Conductor compression splice for #10 AWG or smaller.
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- .1 Acceptable Manufacturers
 - .1 Thomas & Betts STA-Kon series
 - .2 Ideal Splices
 - .3 Burndy

2.22 WIRE PULLING LUBRICANT

- .1 Wire pulling lubricant to be "Ideal Industries", Yellow 77 Plus Wire pulling Lubricant or approved equivalent.

2.23 HEAT SHRINKABLE TUBING INSULATION, HEAVY WALL

- .1 Acceptable Manufacturers
 - .1 Thomas & Betts, Shrink-Kon series
 - .2 Ideal Thermo-Shrink, TS-46
 - .3 Raychem tubing WCSM
 - .4 3M cable sleeve ITCSN

2.24 MOTOR LEAD CONNECTION KITS, 600 VOLT

- .1 Connection kits for low voltage motors.
- .2 Acceptable Manufacturers
 - .1 3M, motor lead splice kit, pigtail, 5300 series
 - .2 Raychem, motor connection kit, MCK, type V

2.25 CONDUIT AND FITTINGS

- .1 Rigid Steel Conduit
 - .1 To CSA C22.2 No. 45-M
 - .2 Rigid thick wall galvanized steel threaded conduit
 - .2 Coated Steel Conduit
 - .1 Corrosive resistant coated rigid thickwall steel threaded conduit, CSA approved.
 - .2 Acceptable Manufacturers
 - .1 Rob Roy Plastibond PVC coated
 - .2 Columbex Green Guard II epoxy polyester coated
 - .3 Rigid PVC Conduit
 - .1 To CSA C22.2 No. 211.2-M
 - .2 Rigid PVC conduit
 - .4 Flexible Steel Conduit
 - .1 To CSA 22.2 No. 56
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- .2 Liquid-tight flexible steel conduit with PVC cover
 - .5 Non-Metallic Flexible Conduit
 - .1 Non-metallic extra flexible PVC conduit
 - .2 Acceptable Manufacturers
 - .1 Carlon, Carflex X-Flex
 - .2 Hubbell, Polytuff Black
 - .6 Rigid Steel Conduit Fittings
 - .1 To CAN/CSA C22.2 No. 18
 - .2 Galvanized or polymer coated cast steel fittings
 - .3 Expansion fittings, watertight with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions
 - .4 Sealing condulets for hazardous areas
 - .5 Corrosive resistant coated cast steel fittings for corrosive resistant conduit
 - .7 Rigid PVC Conduit Fittings
 - .1 To CSA C22.2 No. 85-M
 - .2 Rigid PVC fittings of same manufacture as rigid PVC conduit
 - .8 Liquid Tight Flexible Steel Conduit Fittings
 - .1 Watertight connectors with nylon insulated throat
 - .1 Acceptable Manufacturers:
 - .1 T & B Series 5331 with Sealing O-ring Series 5262
 - .2 Commander/Iberville Series 6300-IT with nitrile O-ring

2.26 EMT AND FITTINGS

- .1 EMT
 - .1 To CSA C22.2 No. 83-M
 - .2 EMT galvanized cold rolled steel tubing
 - .2 EMT Fittings
 - .1 Compression type, steel
 - .1 Gland compression connectors with insulated throats
 - .2 Compression couplings
 - .3 Acceptable manufacturers:
 - .1 T & B Series 5123 & 5120
 - .2 O-Z/Gedney type ZTC series
 - .3 Commander/Iberville Series 5600-IT and 5700
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- .2 Set screw type, steel, concrete-tight
 - .1 Connectors with insulated throats
 - .2 Couplings
 - .3 Acceptable manufacturers
 - .1 Commander/Iberville Series 5400 and 5500

2.27 CABLE TRAY

- .1 Cable Trays and Fittings
 - .1 To EEMAC F5-1
 - .2 To CAN/CSA C22.2 No. 126-M
- .2 Ladder Type
 - .1 Class C1
 - .2 Steel, hot dip galvanized after fabrication
 - .3 Side height, 100 mm
 - .4 Rung spacing, 300 mm
 - .5 Width as indicated on drawings.
- .3 Basket Type
 - .1 Class C1
 - .2 Powder coated with average paint thickness of 30 microns to 75 microns.
 - .3 50 mm x 50 mm grid
 - .4 Side height: 100 mm minimum.
 - .5 Width as indicated on drawings.
- .4 Acceptable manufacturers for ladder and basket types:
 - .1 Legrand Cablofil
 - .2 Cooper B-Line
 - .3 Canadian Electrical Raceways

2.28 WIREWAY

- .1 To CSA C22.1 No. 94-M.
 - .2 Steel with hinged cover to give uninterrupted access.
 - .3 Elbows, tees, couplings and hanger fittings manufactured as accessories for wireway supplied.
 - .4 Acceptable Manufacturers:
 - .1 Amalgamated Electric
 - .2 Canadian Electrical Raceways
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- .3 Schneider Square D
- .4 Pilgrim
- .5 Pursley

2.29 SURFACE RACEWAY

- .1 Surface Raceway to be Legrand Wiremold Model No. 'DS4000 Designer Series'.
- .2 Surface metal raceway, single or complete with snap-in divider to form 2 compartments for power and data, with removable cover. Width to suit application while keeping Code and Telecommunication standard filling ratios.
- .3 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120V power receptacles and mounting only for voice/data.
- .4 Finish: Designer Grey
- .5 Acceptable manufacturer:
 - .1 Legrand/Wiremold or approved equivalent.

2.30 FASTENINGS, SUPPORTS AND SLEEVES

- .1 Fastenings
 - .1 Galvanized steel straps, beam clamps and threaded rods for structural steel
 - .2 Concrete inserts, Crane Canada No.4-M for concrete work for single or double conduit cable tray.
 - .3 Unistrut multiple type inserts for runs of three or more conduits.
 - .4 Concrete fastener type "WEJ-IT" anchors
 - .5 Drywall, plaster or ceiling, 2-wing spring toggles
 - .6 40mm width, galvanized steel channels complete with accessories for metal framing channels.
 - .1 Unistrut
 - .2 Thomas & Betts
 - .7 Metal "J" hooks cable supports systems for communication systems cabling in accessible ceiling spaces where conduit or cable tray is not being provided.
 - .8 Velcro tie wraps for bundling and securing telecommunication cabling
 - .2 Sleeves
 - .1 Schedule 40 steel pipe, minimum I.D. 13 mm larger than O.D. of conduit or cable passing through.
 - .3 Strut
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- .1 Continuous slotted channel
- .2 12 gauge pre-galvanized steel
- .3 41.2 mm x 41.2 mm minimum
- .4 Acceptable manufacturers:
 - .1 B-Line
 - .2 Pilgrim
 - .3 Pursley
 - .4 Unistrut

2.31 ACCESS DOORS

- .1 Access doors to Section 10 00 00, manufactured Specialties.

2.32 SPLITTER BOXES

- .1 Code gauge galvanized sheet steel enclosure EEMAC Type 4 or 12, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Cast steel enclosure EEMAC 7 or 9 with gasketed bolt on cover for and to suit the designated hazardous locations.
- .3 Copper main and branch lugs to match required size and number of incoming and outgoing conductors.
- .4 At least 3 spare terminals on each set of lugs in splitters less than 400 A.

2.33 JUNCTION BOXES

- .1 Galvanized steel EEMAC Type 1, 4, 12, size as required by code for number and size of conduits, conductors and devices, complete with covers, corrosion resistant screws, terminal blocks and mounting rails.
- .2 Screw-on sheet steel covers to match enclosure for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around for flush-mounted junction boxes.
- .4 Galvanized steel barriers as required.

2.34 TERMINAL BLOCKS - SURGE PROTECTION

- .1 Terminal blocks, rail mounted, with surge voltage protection, rated for circuit voltage.
- .2 Acceptable Manufacturers
 - .1 Phoenix Contact Termitrab SLKK5 (Termitrab SLKK5-F) (TT-SLKK5-S).

2.35 PULL BOXES

- .1 Galvanized sheet steel welded construction, EEMAC Type 4 or 12.
 - .2 Screw-on galvanized sheet steel covers for surface mounting boxes.
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- .3 Covers with 25 mm minimum extension around, for flush mounted pull boxes.
- .4 Galvanized steel barriers as required.

2.36 METER CABINET

- .1 Sheet steel CSA Type 2 sprinkler-proof enclosure with meter backplate, to accommodate meters, test terminal block and associated equipment, factory installed and wired.
- .2 Utility metering cabinet to conform with Utilities specifications.

2.37 CONDUIT BOXES - GENERAL

- .1 Boxes for EMT
 - .1 Galvanized pressed steel
- .2 Boxes for Rigid Steel Conduit
 - .1 Galvanized cast iron alloy FS boxes with mounting feet for surface mounted switches and receptacles
 - .2 Gasketed cover plate for exterior location
 - .3 For corrosive resistant coated conduit: cast boxes with same finish as conduit
- .3 Boxes for Rigid PVC Conduit
 - .1 PVC boxes

2.38 OUTLET BOXES - SHEET STEEL

- .1 Pressed steel single and multi-gang flush device boxes, minimum size 100 mm x 50 mm x 38 mm. 100 mm square outlet boxes where more than 1 conduit enters 1 side, with extension rings as required.
- .2 100 mm square or octagonal outlet boxes.
- .3 119 mm square outlet boxes with extension and plaster rings as necessary for flush mounting devices in gypsum board, plaster or panelled walls.

2.39 MASONRY BOXES

- .1 Pressed steel masonry single and multi-gang boxes for devices flush mounted in exposed masonry walls with extension and plaster rings as required.

2.40 CONCRETE BOXES

- .1 Pressed steel concrete type boxes for flush mount in concrete with extension and plaster rings as required.

2.41 OUTLET BOXES - FITTINGS

- .1 Bushings and connectors with nylon insulated throats.
 - .2 Knock-out fillers to prevent entry of foreign materials.
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- .3 Double locknuts and insulated bushings for sheet steel metal boxes.

2.42 WIRING DEVICES - SWITCHES

- .1 Specification grade, general purpose AC switches, manual toggle operated, white and brown colour, 15A, 20A, 120-277V, 347V, single pole, double pole, three-way, four-way switches as required.
- .2 Acceptable manufacturers:
 - .1 Hubbell - HBL1201 Series: HBL1221 Series: HBL18201 Series: HBL18221 Series
 - .2 P & S - 15AC Series: 20AC Series: 370000 Series
 - .3 Arrow Hart - 1891 Series: 1991 Series: 18201 Series: 18221 Series
- .3 Specification grade, general purpose AC switches, manual rocker operated, white colour, 15A, 20A, 120-277V, 347V, single pole, double pole, 3 way, 4 way switches as required.
- .4 Acceptable Manufacturers
 - .1 Bryant, 120-277V, Fashion Series 9000
 - .2 Hubbell, 120-277V, Style Line 2100 Series
 - .3 Leviton, 120-277V and 347V, Decora Plus 5600 Series
 - .4 Pass & Seymour, 120-277V and 347V, Sierraplex Decorator, 2600 and 2600000 Series

2.43 WIRING DEVICES – OCCUPANCY SENSORS

- .1 Occupancy Sensor:
 - .1 Passive infrared sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy.
 - .2 Sensor shall be sealed and gasketed and shall be moisture and dust proof.
 - .3 Sensor shall function in a temperature range of -40°F (-40°C) to +95°F (+35°C).
 - .4 Sensor shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens.
 - .5 Fresnel lens shall be a Poly IR 4 based material (for standard and Long Range lens) to offer superior performance in the infrared wavelengths and filter short wavelength infrared, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception. Aisleway lenses shall be a poly IR 2 based material.
 - .6 Sensor shall provide 270° coverage with the Standard Lens, up to 50 linear feet with the Long Range Lens.
 - .7 Sensor shall have a DIP switch controlled digital time delay setting, adjustable from 15 seconds to 10 minutes approximately.
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- .8 Sensor shall have DIP switch sensitivity setting adjustable from minimum to maximum.
 - .9 Adjustments and mounting hardware shall be concealed under a removable cover to prevent tampering of adjustments and hardware.
 - .10 Sensors shall be capable of being wired in parallel to allow coverage of large areas.
 - .11 To ensure quality and reliability, sensor shall be manufactured by and ISO9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
 - .12 Sensor shall have a standard 5 year warranty.
 - .13 Sensor shall be UL and CUL listed.
- .2 Light Switch Type 'B' - Dual Technology Dual Relay Wall Switch Sensor, WattStopper, Model No. DW-200 or equivalent:
- .1 Sensor shall be capable of detecting presence in the control area by detecting shifts in transmitted ultrasound and passive infrared heat changes.
 - .2 Sensor shall utilize ultrasonic and PIR technologies to reduce likelihood of false operations
 - .3 Sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back On immediately after lights turned Off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
 - .4 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode and 30 seconds or less in manual mode.
 - .5 Sensor shall have 4 occupancy logic options for customized control to meet application needs.
 - .6 Robotic test method as referred in the NEMA WD 7 guide shall be utilized for minor motion coverage verification.
 - .7 Automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
 - .8 Sensor shall utilize two relays capable of simultaneously controlling independent lighting loads or circuits. The secondary relay is isolated, allowing for two-circuit control.
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- .9 Sensor shall have no minimum load requirement and shall be capable of switching from 0 to 800 Watt incandescent; 0 to 800 Watt fluorescent or 1/6 hp @ 120 VAC, 60Hz; and 0 to 1200 Watt fluorescent @ 277 VAC, 60Hz.
- .10 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by a DIP switch.
- .11 To avoid false ON activations, the sensor shall examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
- .12 Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 degree
- .13 Sensor shall have automatic-ON or manual-ON operation on both relays adjustable with DIP switch.
- .14 Sensor shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5 to 30 minutes, set by DIP switches.
- .15 In automatic mode, sensor shall be capable to automatically return to Automatic-ON after lights are turned off manually.
- .16 Each sensing technology shall have a LED indicator that remains active at all times in order to verify detection within the area to be controlled.
- .17 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.
- .18 Sensor shall be able to control electronic low voltage, and fluorescent loads.
- .19 Sensor shall have a built-in light level featuring simple, one-step daylighting setup that works from 8 to 180 foot candles.
- .20 Switching mechanism shall be a relay(s). Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.
- .21 The Dual Technology wall switch sensor shall be a completely self contained control system that replaces a standard toggle switch
- .22 Sensor shall have standard 5 year warranty and shall be UL and CUL listed
- .3 Light Switch Type 'OS' – as type 'B' except single relay switch.

2.44 WIRING DEVICES - RECEPTACLES FOR GENERAL SERVICE

- .1 Receptacles: specification grade suitable for back and side wiring, complete with grounding terminal, white colour for straight blade devices and black colour for twistlock devices.
- .2 All receptacles shall be from one manufacturer.
- .3 Acceptable Manufacturers:
 - .1 15A, 125V, (5-15R) Single Straight Blade

- .2 15A, 125V, (5-15R) Duplex Straight Blade
- .3 20A, 125V, (5-20R) Single Straight Blade
- .4 20A, 125V, (5-20R) Duplex Straight Blade
- .5 15A, 125V, (5-15R) Duplex GFCI, Straight Blade
- .6 15A, 125V, (5-15R) Duplex Isolated Ground Straight Blade
- .7 20A, 125V, (L5-20R) Single locking, 2 pole, 3 wire grounding
- .8 20A, 250V, (L6-20R) Single locking, 2 pole, 3 wire, grounding
- .9 30A, 250V, (L6-30R) Single locking, 2 pole, 3 wire, grounding
- .10 30A, 250V, (L15-30R) Single locking, 3 pole, 4 wire, phase, grounding
- .11 20A, 347V (L24-20R) Single locking, 2 pole, 3 wire grounding
- .12 15A, 125V (5-15R) Quad straight blade, 2 pole, 3 wire grounding
- .13 15A, 347V, (24-15R) Quad straight blade, 2 pole, 3 wire grounding
- .14 15A, 125V, (5-15R) Duplex straight blade
- .15 15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, surge suppression indicator light, blue (ivory) colour
- .16 15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, isolated ground surge suppression indicator light, blue (ivory) colour

2.45 WIRING DEVICES - COVER PLATES

- .1 Stainless steel Type 302 alloy, vertically brushed, 0.8 mm thick cover plates.
- .2 Nylon, smooth, high impact strength.
- .3 Pressed steel, galvanized.
- .4 Cast covers for cast boxes with gaskets.
- .5 Outdoors:
 - .1 Marine grade outlet box hood
 - .2 Weather proof die cast alloy 360 copper free aluminum
 - .3 Nema 3R rating for in-use protection
 - .4 Gaskets are closed-cell foam
 - .5 Latching covers hold securely
 - .6 Large cord openings
 - .7 Holes for padlocks are 6.4 mm diameter
- .6 Cover plates of same manufacture as devices.

2.46 FUSES

- .1 Form I, Class "J" HRC for continuous loads
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- .2 Form II, Class "C" HRC for cycling loads

2.47 **PUSHBUTTONS OPERATORS**

- .1 Rockwell Automation, 800T Series
- .2 Exact type and rating to suit application

2.48 **ROOFTOP CONDUIT SUPPORT SYSTEM**

- .1 Cooper B-Line "Dura – Blok" series rooftop support systems

2.49 **PLYWOOD BACKBOARDS**

- .1 Plywood backboards, good one side, 1220 mm x 222 mm unless indicated otherwise. Treat with primer and two coats of fire retardant paint.
- .2 Mount plywood on vertical strapping, on 40 mm centres to provide 10 mm clearance between wall and rear of plywood. Treat strapping similar to plywood.

2.50

3 Execution

3.1 **EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 **INSTALLATION**

- .1 Do complete installation in accordance with the Canadian Electrical Code except where specified otherwise.
 - .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.
 - .3 Complete installation in accordance with Alberta Building Code and Canadian Electrical Code.
 - .4 Elevator Systems: Provide for "Related Work" listed and identified under Section 14 20 00, Elevators, to be executed by Electrical Contractor.
 - .5 Mechanical Systems: Provide for 'Related Work' listed and identified for Divisions 26, 27 and 28, under Mechanical Divisions 21, 22, 23 and 25, to be executed by Electrical Contractor.
 - .6 Feature Water Fountain Systems: This contractor is to provide all electrical branch wiring tight-ins at panelboard 'RP-RBA' in Fountain Pump Room (B135) Room for electrical wiring brought to panelboard by Water Fountain Contractor electrical subcontractor.
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3.3 **MANUFACTURER'S ATTENDANCE**

- .1 Provide manufacturer's representatives to initially start-up each part of the Work, as specified, to check, adjust, calibrate and balance as applicable all components including controls and field wiring. Provide these services for such period and for as many visits as necessary to achieve complete working order in the subject Work.

3.4 **FIELD INSPECTION**

- .1 Provide Field Engineer for inspection and certification of equipment during installation, testing and commissioning as required.

3.5 **HOUSEKEEPING PADS**

- .1 Provide concrete pads to the requirements of Division 03.

3.6 **FIRE BARRIERS**

- .1 Provide fire stopping to the requirements of Division 07

3.7 **PAINTING**

- .1 Touch up finishes on electrical equipment found to be marred on completion of the Work using same colour and type of finish as originally used.
- .2 Prime paint field fabricated metalwork.
- .3 Other painting will be provided under Section 09 91 00.

3.8 **CORE DRILLING**

- .1 Core Drilling Procedure
 - .1 Examine locations to be core drilled where:
 - .1 Diameter is greater than 25 mm
 - .2 Multiple drillings required and where the distance between centres is less than 10 times the diameter of the hole
 - .2 Examine by most suitable method including:
 - .1 X-ray
 - .2 Ferro scan
 - .3 Cable detection
 - .3 Examine from both sides of the structure to be drilled.
 - .4 Examine proposed core drilling locations to determine:
 - .1 Possible interference with
 - .1 Services
 - .2 Structural components
 - .5 Select locations as suitable for core drilling and label them:
 - .1 Uniquely number each drilling location and core so that markings will be legible after drilling
 - .2 Mark each core with a north pointing arrow where drilling a slab or upward pointing arrow where drilling a wall
 - .6 Without interfering with or damaging any services or structural elements, drill pilot holes sufficient to verify location of potential obstructions or for alignment purposes.

- .7 Use impact drill when drilling holes of 25 mm diameter or less. For holes of greater diameter use core drill.
- .8 Prepare report showing intended core drill locations including printouts, X-ray images. Submit the report for approval prior to drilling to Departmental representative.
- .9 Proceed with core drilling only after approval has been received from Departmental representative.
- .10 Confine drilling operation to time-of-day as stipulated by Departmental representative.
- .11 Position suitable warning notices of a type acceptable to Departmental Representative and exercise caution to ensure safety and protection of personnel and property during drilling especially from effects of water, dust damage, or falling objects below the slab or behind the wall being drilled.
- .12 Stop drilling immediately, and report to Departmental representative, if contact is made with foreign objects such as reinforcing steel (rebar), electrical conduit, water pipes, drainage pipes.
- .13 Cover open holes with secured covers to guard against fall through of objects.
- .14 Provide necessary firestopping, temporary or otherwise, sufficient to firestop holes that would be otherwise open during hours that the location is unattended. Coordinate placement of firestopping with Departmental representative.
- .15 Store all cores or core fragments on site and make them available for inspection by Departmental representative. Dispose of the cores or core fragments after permission is received from Departmental representative.

3.9

SLEEVES, CONDUIT AND CABLE INSTALLATION

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

3.10

LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back in wall; install boxes in adjacent stud wall partitions to preserve STC ratings of compartments.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .3 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.11

MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
 - .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
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.3 Install electrical equipment at following heights unless indicated otherwise.

- .1 Light switches and Dimmer Controls: 1400 mm.
- .2 Wall receptacles:
 - .1 Mount vertically, unless directed otherwise on drawings.
 - .2 General: 300 mm.
 - .3 Above top of continuous baseboard heater: 200 mm.
 - .4 Above top of counters or counter splash backs: 175 mm.
 - .5 Mechanical Rooms: 1400 mm
 - .6 Hazardous Areas: 1400 mm
- .3 LAN Outlets: 300 mm.
- .4 Fire alarm pull stations: 1500 mm
- .5 Fire alarm horn strobes: 2100 mm
- .6 Fire alarm mini horns: 1400 mm
- .7 Wall mounted speakers, horns or strobes: 2300 mm or 150 mm below ceiling
- .8 Card readers: 900 mm
- .9 Door operators: 900 mm
- .10 Television outlets: 300 mm.
- .11 Panelboards: as required by Canadian Electrical Code or as indicated on plans
- .12 Clocks: 2100 mm.
- .13 Door bell pushbuttons: 1500 mm.
- .14 Wall mounted exit signs: 150 mm above door frame
- .15 Wall mounted exit signs: 150 mm below ceiling

3.12 **COORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as determined in accordance with Section 26 05 73.
- .2 Ensure all distribution equipment is labelled in accordance with the Arc Flash Study.
- .3 Provide a signed letter from a Professional Engineer licensed in the Province of Alberta confirming the following:
 - .1 Settings of the protective devices have been adjusted as per the short circuit coordination study.
 - .2 Arc flash classification labels to all items of electrical distribution equipment have been installed as per the Arc-flash study.

3.13 **FIELD QUALITY CONTROL AND COMMISSIONING**

- .1 Carry out testing and commissioning for electrical systems and equipment in presence of Departmental Representative and in accordance with relevant standards such as CSA, ULC, ANSI. Comply with the Acceptance Testing Specifications for the International Electrical Testing Association Inc (NETA).
 - .2 Refer to Sections 019113, 019131, 019133 and 019141 for all commissioning requirements.
 - .3 Conduct and pay for all testing and commissioning.
 - .4 Refer to each Section of Division 26, 27 and 28 for additional testing requirements for specific equipment components.
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- .5 Provide the instruments, meters, equipment and personnel required to conduct the tests during and at the conclusion of the project.
 - .6 In addition to the requirements of Division 1, all the electrical generic commissioning forms in connection with the equipment or systems have been structured in 3 parts: product identification, installation/operational check list and performance verification. All available commissioning forms are included in Division 1. Make those forms project specific and develop new ones where not available. Structure any new forms in 3 parts as described and provide all details to capture all requirements. The contractor shall utilize and follow procedures for testing as outlined in the NETA 2001 standard for acceptance testing and in addition as described in various electrical sections.
 - .7 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
 - .8 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power generation, distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm, communications.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
 - .9 Advise Departmental representative, when testing to be performed.
 - .10 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation, testing and commissioning in accordance with manufacturer's instructions.
 - .11 Ten months after the building has been completed and occupied, and all load balancing and adjustments have been completed, carry out or engage and pay for a specialist to carry out an Infra Red Scan using AEGMA or equivalent instrument, on all major equipment
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and submit report complete with pictures and recommendations. Scanning time to be fully coordinated with the Departmental representative, at least two (2) weeks in advance, and shall meet all site operational requirements. Submit scanning plan to Departmental Representative and Engineer for review and approval.

- .1 Major equipment shall include at least the following:
 - .1 All Low Voltage Switchboards
 - .2 All Distribution Panels, branch circuit Panels and disconnect switches.
 - .3 All motor starters (including VFDs) and all motor connections.
 - .4 Busway
 - .5 Transformers
- .2 Submit to the Departmental Representative scan results within 48 hours of scanning. Adjust and modify the equipment as instructed by the Engineer. For equipment requiring adjustment or modification, rescan under load, until Engineer accepts results. Resubmit results for Engineer's review.
- .3 All work to be performed on weekends and after hours.

3.14 CLEANING

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

3.15 WIRE AND CABLE

- .1 Install wiring in raceways unless noted otherwise.
- .2 Install separate and dedicated neutral wires for each circuit fed from:
 - .1 Harmonic mitigation transformers/panelboards (e.g. RP-Hxx)
 - .2 UPS panelboards (e.g. RP-Uxx)
 - .3 Lighting panelboards (e.g. LP-Lxx)
- .3 Provide 600 V rated cable for up to 208 V application; 1000V rated cable for up to 600 V application.
- .4 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .5 Minimum wire sizes:
 - .1 Power and lighting No. 12 AWG
 - .2 Control No. 14 AWG
 - .3 Fire alarm No.: to Section 28 31 00 Fire Detection and Alarm Systems
- .6 Wire and cable application and type:

Application	Type
Lighting branch circuits	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas

Receptacle branch circuits	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas
Ceiling boxes to luminaires in suspended ACT	T90 nylon or AC90 cable (max. length as noted below)
Ceiling boxes to luminaires in non-accessible ceilings.	T90 nylon or AC90 cable (max. length as noted below)
Ceiling boxes to receptacles	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas
Wiring inside high temperature equipment (including final connection)	TEW or SEW-2
Underground and under slab raceways, duct banks, direct burial	RWU90
All distribution feeders and equipment feeders	RW90 or Mineral Insulated
Life safety feeders and equipment feeders	Mineral insulated – 2 hr rated.
Hazardous locations	RW90 or mineral insulated (as per OESC Class 1 zone 2.

- .7 Type AC90 cable length limitations:
 - .1 Ceiling box to luminaire:
 - .1 2 m maximum in non-accessible ceilings;
 - .2 3 m in accessible ceilings
 - .2 Junction box to outlet:
 - .1 4 m maximum
- .8 Load current limitations:
 - .1 Conductors rated for more than 90°C:
 - .1 75°C code ampacity rating
 - .2 90°C code ampacity rating if terminating device and/or equipment maximum conductor termination temperature is 90°C rated.
 - .2 Motor connection:
 - .1 75°C code ampacity rating
- .9 Use wire lubricant when pulling wires into conduit. Wires shall be kept straight and not twisted.

3.16 CONNECTORS

- .1 Install compression terminations and splices in accordance with manufacturer's written instructions.
- .2 Make splices in junction boxes.
- .3 Make connections in lighting circuits with twist type splicing connectors.

- .4 Terminate and splice conductors No. 8 and larger at terminal blocks in junction boxes.
- .5 Seal terminations and splices exposed to moisture, corrosive conditions or mechanical abrasions with heavy wall heat shrinkable insulation.
- .6 Install fixture type connectors and tighten. Replace insulating cap.

3.17 MOTOR LEAD CONNECTION KITS, 600 VOLT

- .1 Install motor lead connection kits for low voltage motors.

3.18 CONDUIT AND EMT - GENERAL

- .1 Run parallel or perpendicular to building lines.
- .2 Group raceways wherever possible. Support on channels.
- .3 Install expansion joints as required.
- .4 Run raceways in web portion of structural steel columns and beams.
- .5 Do not drill structural members to pass through.
- .6 Locate raceways behind infrared or unit heaters with 1500 mm clearance.
- .7 Locate raceways not less than 125 mm clear where parallel to steam or hot water lines with a minimum of 75 mm at crossovers.
- .8 Do not install horizontal runs in masonry walls.
- .9 Use metallic raceway where temperatures exceed 75°C or where enclosed in thermal insulation.
- .10 EMT and non-metallic conduits to contain insulated green ground wire.
- .11 Install 6 mm diameter nylon pull cord in empty raceways.
- .12 Conduit shall be concealed in all locations unless explicit permission is provided by the departmental representative.

3.19 CONDUIT AND FITTINGS

- .1 Minimum conduit sizes:
 - .1 Surface installation: 21 mm trade size conduit
 - .2 Embedded in concrete: 27 mm trade size conduit
 - .3 Directly buried: 53 mm trade size conduit
- .2 Conduit application and type:

Application	Type
Outdoor areas	EMT or rigid PVC
Embedded in concrete	rigid PVC
In or below grade slab	Rigid PVC

Exposed in unfinished areas up to 3 m above finished floor. Use EMT above 3m	EMT, TECK or NMD90
Connection to motors and equipment subject to vibration	TECK or NMD90
Wiring in walls	NMD90
Unheated parking garage area	Rigid steel

- .3 Use field threads on rigid conduit of sufficient length to draw conduits up tight.
- .4 Do not bend coated steel conduit. Use elbows for deflections.
- .5 Do not install conduit under slab on grade.
- .6 Do not install conduit in slab, unless indicated otherwise on drawings.
- .7 Use factory "ells" where 90° bends are required for 27 trade size and larger conduits.
- .8 Bend conduit offsets cold. Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Prevent the entrance of water and lodging of concrete, plaster, dirt, or trash in conduit, boxes, fittings, and equipment during course of construction.
- .9 Where conduit joints occur in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible.
- .10 Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, etc., with standard galvanized plumber's pipe caps.
- .11 Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.
- .12 Install conduit sleeves for all exposed conduits and cables passing through walls, ceilings, or floors, and fill void between sleeve and conduit with caulking. If fire-rated caulking is required by code, use same class as walls, ceilings or floors.
- .13 Terminate conduit stubbed up through concrete floor for connection to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except where required, use flexible conduit from a point 150 mm above floor.
- .14 Install double locknuts and bushings on all rigid conduit terminations into threadless openings. Increase length of conduit threads at terminations sufficiently to permit bushing to be fully seated against end of conduit.
- .15 Mechanically bend steel conduit.
- .16 Install sealing condulets in conduits at hazardous area boundaries.
- .17 Conduits in Poured Concrete
 - .1 Locate to suit reinforcing steel. Secure firmly to prevent movement during pour.

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- .2 Clear each conduit with mandrel and brush before concrete sets.
 - .3 Protect conduits from damage where they stub out of concrete.
 - .4 Install sleeves where conduits pass through slab or wall.
 - .5 Provide oversized sleeve before membrane is installed where conduits pass through waterproof membrane. Use cold mastic between sleeve and conduit.
 - .6 Encase conduits completely in concrete; provide 50 mm minimum concrete cover.
 - .7 Replace with exposed conduit, any conduit run found to be obstructed after concrete sets.

3.20 EMT AND FITTINGS

- .1 Minimum EMT size: 21 mm trade size conduit.
- .2 EMT Application
 - .1 Exposed in unfinished areas, above truss level and for drops in column web to 3 m above finished floor. Use rigid steel conduit below 3 m.
 - .2 In block walls and stud partitions.

3.21 CABLE TRAY

- .1 Install cable tray systems.
 - .2 Provide barriers where required by Code.
 - .3 Support cable trays from structural members. Support cable tray on both sides or on cantilever brackets to provide continuous open access to one side of the tray as required. Coordinate support locations and weight per support with building structure. Provide any additional support fastenings required.
 - .4 Provide the following minimum clearances:
 - .1 300 mm vertical between top of tray and equipment or structure above.
 - .2 300 mm vertical between trays (between bottom of the upper tray to top of lower tray).
 - .3 600 mm horizontal on access side of tray.
 - .5 Ensure that sharp burrs or projections are removed to prevent damage to cables and injury to personnel.
 - .6 Install cables individually.
 - .7 Lay cables into cable tray. Use rollers where necessary, to pull cables.
 - .8 For maintained spacing, secure cables in cable tray at 3 m centers for horizontal runs with black coloured tie wraps and at 1500 mm centres for vertical runs with aluminum clamps supplied by tray manufacturer.
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- .9 Maintain power cables greater than one diameter minimum spacing unless shown otherwise.
- .10 Firestop Fire Barriers (refer to Section 26 05 01).
 - .1 Penetration of fire rated walls with cable trays is not allowed. Provide instead metallic sleeves to match cable tray capacity to allow for transitioning of cabling. Pack, seal and firestop around and inside in accordance with Section 07 84 00 Fire Stopping and Smoke Seals.

3.22 WIREWAYS

- .1 Install per manufacturer's recommendations.
- .2 Keep number of elbows, offsets and connections to a minimum.
- .3 Install barriers where required by Code.
- .4 Install gutters to full length of equipment.

3.23 SURFACE RACEWAYS

- .1 Install per manufacturer's recommendations.

3.24 FASTENINGS AND SUPPORTS

- .1 Provide supports and fastenings for the Work of this Division. Do not use supports or equipment provided by other Trades.
 - .2 Equipment fastenings and supports shall conform to manufacturers recommendations.
 - .3 Do not attach to, or suspend any electrical product or service from the roof deck, mechanical ductwork or piping.
 - .4 Do not use wire lashing or perforated strap to support or secure raceways or cable.
 - .5 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.
 - .6 For surface mounting of two or more raceways or cables use channels.
 - .7 Where there is no wall support for raceways and cables dropped vertically to equipment, provide channel properly secured to floor and structure.
 - .8 Hang supports from structural members. Where location does not permit direct support from structure provide necessary brackets, frames, channels secured to structural members.
 - .9 Fasten exposed conduit and cables to building construction or support systems using straps. Use beam clamps on exposed steelwork.
 - .10 Masonry, tile and plaster surfaces: use lead anchors.
 - .11 Poured concrete: use expandable inserts. Low velocity powder activated fastenings may be used only in poured concrete.
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- .12 Steel structures: use clips, spring loaded bolts, cable clamps, designed as accessories to basic channel members.
- .13 Do not use powder activated fasteners in, tile, precast concrete or steel structure.
- .14 Do not install conduits or cables on the bottom chord of joists or trusses.
- .15 Use beam clamps of the 2-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline. The use of "C" and "I" beam side clamps will not be allowed.
- .16 Where the roof or floor framing consists of open web or long span steel joists and/or trusses, ensure that hangers are located at or within 150 mm of the joist or truss top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist or truss spacing. Design suspension assembly such that the hanger load is transmitted only concentrically to the supporting joist or truss. The use of "C" and "I" beam clamps, brackets, etc., will not be allowed.
- .17 Locate secondary structural steel members between joists or trusses at or within 150 mm of top or bottom chord panel points. Where the secondary structural steel member cannot be located at or near a joist or truss panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member. Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted. Submit shop drawings of the suspension assembly indicating the location of suspension or support points, the maximum load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.

3.25 ACCESS DOORS

- .1 Provide an access door and arrange for its installation by the Division in whose work it occurs, whenever any electrical item equipment requiring accessibility, maintenance or adjustment is concealed.

3.26 SPLITTER BOXES

- .1 Install splitters as indicated and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement.

3.27 JUNCTION BOXES

- .1 Install junction boxes in inconspicuous but accessible locations. Secure to structure.
 - .2 Install terminal blocks on mounting rails, for termination of each wire and cable regardless of size.
 - .3 Only one voltage source is permitted in a junction box.
 - .4 Install barriers to separate different auxiliary systems.
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- .5 In areas with hard ceilings (e.g. gypsum board), install junction boxes in an accessible area. Extend conduit to junction or pull boxes.
- .6 If an accessible area is not within reasonable reach, group all junction boxes for all systems in one area of the room and advise the Design Architect/Departmental Representative of the need of an access door. Do not proceed with work until approval for access panel is received from the Design Architect.

3.28 TERMINAL BLOCKS - SURGE SUPPRESSION

- .1 Install surge suppression terminal blocks.

3.29 PULL BOXES

- .1 Install pull boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .3 Only one voltage source is permitted in a pull box.
- .4 Install barriers to separate different auxiliary systems.
- .5 In areas with hard ceilings (e.g. gypsum board), install pull boxes in an accessible area. Extend conduit to junction or pull boxes.
- .6 If an accessible area is not within reasonable reach, group all pull boxes for all systems in one area of the room and advise the Design Architect/Departmental Representative of the need of an access door. Do not proceed with work until approval for access panel is received from the Design Architect.

3.30 OUTLET AND CONDUIT BOXES

- .1 Install conduit outlet boxes for conduit up to 32 mm and pull boxes for larger conduits.
- .2 Support boxes independently of connecting conduits.
- .3 Seal boxes during construction to prevent entry of debris, dust and dirt.
- .4 For flush installations mount plaster rings to box, flush with wall surface to permit wall finish to come within 6 mm of opening.
- .5 Provide correct size of openings in boxes for conduit, armoured cable connections. Reducing washers will not be acceptable.
- .6 Install switches and other controls close to door lock or latch jambs and other openings, maintaining a minimum of 100 mm from trims of doors (except where installed in door frames of metal partitions) check door swings.
- .7 Install 100 mm square or octagonal outlet boxes for lighting fixture outlets.

3.31 METER CABINET

- .1 Install meter cabinet as close as feasible to service entrance switchboard.
 - .2 For utility meters install cabinets with all local utility requirements.
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3.32 **MASONRY BOXES**

- .1 In block walls use deep boxes to provide clear space around knockout for AC90 cable entry.

3.33 **WIRING DEVICES - SWITCHES**

- .1 In all front of house areas and public areas, all switches are to be Decora/Decorator style.
- .2 Install single throw switches with handle in UP position when switch is closed.
- .3 Install switches in gang type outlet box when more than one switch is required in a location.
- .4 Mount toggle switches at height indicated.
- .5 Install switch colours as follows:

Area	Colour
Gypsum board, plaster or paneled	White
Office	White
Service	Brown
Patient Care Areas	White
Feature wood panels	Black

3.34 **WIRING DEVICES - OCCUPANCY SENSORS**

- .1 Install each occupancy sensor at locations indicated.
- .2 Mount occupancy sensor/switches at height indicated.

3.35 **WIRING DEVICES - RECEPTACLES**

- .1 Generally, install receptacles vertically with ground pins up.
 - .2 In patient care areas, 15A/20A straight blade receptacles to be hospital grade.
 - .3 In all front of house areas and public areas, all receptacles are to be Decora/Decorator style.
 - .4 Comply with requirements of CSA Standard Z32, with regards to identifying the circuit number and supplying panelboard, permanently identified at the outlets. Identify this information in the areas on the front of each receptacle.
 - .5 Install receptacles vertically, use gang type outlet box where more than one receptacle is required in a location.
 - .6 Where split receptacle has a portion switched, mount vertically and switch upper portion.
 - .7 Coordinate with architectural and interior design drawings for final positioning and mounting heights of power and voice/data receptacles. Where there is
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disagreement between electrical and architectural drawings, take the architectural drawings as correct.

- .8 Maintain clearances between receptacle outlet boxes and millwork as stipulated on the drawings.
- .9 Align and evenly space outlet boxes that are mounted as a group.
- .10 Install receptacle colours as follows:

Area	Colour
Gypsum board, plaster or panelled	White
Office	White
Service, exterior	gray
Patient Care Areas	White
Feature wood panels	Black

3.36 WIRING DEVICES - 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 designed for flush outlet boxes on surface-mounted boxes.
- .4 Provide plaster ring where necessary.
- .5 Install cover plates as follows:

Area	Cover Plate Type
Gypsum board, plaster or panelled	stainless steel (nylon)
Offices	Nylon
Service	galvanized steel
Exterior	Lockable weather proof
Patient Care Areas	Stainless Steel
Feature wood panels	Black

3.37 WELDING RECEPTACLES

- .1 Install welding receptacles.
- .2 Ensure that phase rotation is similar for all receptacles.

3.38 CONTROL DEVICES

- .1 Install as indicated.

3.39 PLYWOOD BACKBOARDS

- .1 Install G1S plywood backboards where indicated on drawings.
 - .2 Backboards shall be installed to 8' high from floor.
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- .3 Backboards shall be painted with intumescent grey paint.

3.40 **FIELD FABRICATED METAL WORK**

- .1 Clean and prime paint field fabricated metal work.
- .2 After fabrication deburr, scrape, grind smooth, wire brush with power brush and degrease metal work.
- .3 Prime paint steel with 1 coat of CISC/CPMA 2.75 oil alkyd primer.
- .4 Prime paint aluminum as follows: wash with detergent solution and wipe down with SSPC-SP1 solvent. Apply Glidden #Y-5229 primer to 1.5 mils DFT.
- .5 For brass and bronze alloy materials, prepare as for aluminum but apply 1 coat of CAN/CGSB-1.40-M zinc chromate primer.

End of Section

1 General

1.1 SUMMARY

- .1 Section includes:
Labour, products, equipment and services necessary to complete the work of this Section.
- .2 Refer to grounding riser diagram on drawings for additional information.

1.2 RELATED SECTIONS

- .1 Section 26 05 00: Common Work Results - Electrical

2 Products

2.1 GROUND CONDUCTORS

- .1 Copper conductors, soft drawn, ASTM Class B stranded.
- .2 Insulated or bare conductors. Insulation colour green.

2.2 BURIED CONNECTIONS - EXOTHERMIC TYPE CONNECTION

- .1 Cable to rod / cable to pipe / cable to cable.
- .2 Moulds, weld metal and accessories.

2.3 CONNECTIONS TO STEEL STRUCTURES

- .1 Exothermic connection (for underground connections) or compression ground connector (for above ground connections).
- .2 Bi-metallic washers shall be used in the case of steel-copper compression connection.

2.4 MISCELLANEOUS HARDWARE

- .1 Galvanized steel ground studs, bolts, washers, nuts and accessories necessary for grounding system, including but not limited to:
 - Grounding and bonding bushings
 - Bolt type conductor connectors
 - Bonding jumpers, straps
 - Pressure type wire connectors

2.5 GROUND RODS

- .1 Copper-clad steel, minimum 19 mm diameter, 3 m long, two 1.5m sections which are connected via grounding coupling.
- .2 At manholes provide screw down lugs on ground rods.

2.6 GROUND ELECTRODE INSPECTION BOX

- .1 Inspection box, hot dip galvanized steel or hard PVC, with flush cover and ground lug, minimum 245mm dia., 300 mm deep, lockable door.

2.7 GROUND BUS

- .1 Ground bus: copper, 50 mm x 6 mm thick complete with insulated supports, fastenings, connectors, length as indicated. The ground bus shall be predrilled with holes for use with standard sized lugs.
- .2 Telecommunication Main Grounding Busbar (TMGB): copper, 100mm x 6 mm thick complete with insulated supports, fastenings, connector, and length as indicated.

The TMGB shall be predrilled with holes for use with standard sized lugs.

The TMGB shall be UL listed and meet the requirements of ANSI-J-STD-607-A

The TMGB shall be sized as above or lengthen to meet the requirements of the immediate application with consideration for future growth.

- .3 Telecommunication Grounding Busbar (TGB): copper, 50mm x 6 mm thick complete with insulated supports, fastenings, connector, and length as indicated.

The TGB shall be predrilled with holes for use with standard sized lugs.

The TGB shall be UL listed and meet the requirements of ANSI-J-STD-607-A

The TGB shall be sized as above or lengthen to meet the requirements of the immediate application with consideration for future growth.

2.8 ALUMINUM STRUCTURES AND EQUIPMENT

- .1 Use tin or silver plated connectors for grounding connections to aluminum structures and equipment.

3 Execution

3.1 GENERAL

- .1 Clean all paint, rust and dirt from all surfaces to which ground lugs are bolted.
- .2 Protect exposed grounding conductors from mechanical damage.
- .3 Ensure that moulds, for exothermic type connections, are not used for more than 50 connections.
- .4 All panels, junction and terminal boxes, shall be bonded to grounding conductors.

- .5 Primary grounding:

Install continuous grounding system including, electrodes, conductors, connectors and accessories as indicated and to requirements of ESA (Electrical Safety Authority) and Horizon Utilities.

Install connectors and cadweld in accordance with manufacturer's instructions.

Protect exposed grounding conductors during and after construction.

Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermite process.

Use mechanical connectors for grounding connections to equipment provided with lugs.

Use tinned copper conductors for aluminium structures, in all connection of two different metals, bimetallic washers shall be used.

Do not use bare copper conductors near unjacketed lead sheath cables.

.6 Secondary grounding:

Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.

Where EMT or rigid steel is used, run separate and dedicated ground wire for each circuit within.

Install connectors in accordance with manufacturer's instructions.

Protect exposed grounding conductors from mechanical injury.

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

Use mechanical connectors for grounding connections to equipment provided with lugs.

Soldered joints are not permitted.

Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

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

Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at both ends.

Make ground connections to continuously conductive underground water pipe on street side of water meter.

Install water meter shunt.

3.2 EQUIPMENT GROUNDING

- .1 Install grounding connections as indicated to typical station equipment including: metallic water main, line sky wire, neutral, gradient control mats. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cutout bases shall be bonded to ground. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers shall be grounded. Meter and relay cases, any exposed building metal, within or forming part of station enclosure shall be

bonded to ground. Sub-station fences, pothead bodies and outdoor lighting poles shall be bonded to ground.

- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.
- .3 Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station.

3.3 BURIED GROUNDING LOOP

- .1 For buried grounding connected only exothermic connection types are permitted.
- .2 Install ground rods 300 mm below finished grade.
- .3 Install ground loop around transformer foundation 300 mm below finished grade. Refer and comply with Horizon Utilities ground requirements for pad mounted transformers.

3.4 DUCT BANKS

- .1 Bond metal raceway within duct banks to system ground each 10 m distance (at least from two points).
- .2 Connect grounding conductor in duct banks to ground bus or ground rods in electrical rooms, substations, manholes, etc.

3.5 MANHOLES

- .1 Provide ground rod(s) in each manhole and connect to metalwork such as, ladder, cable racks, manhole metal frame.
- .2 Install ground rod with top projecting through floor slab and install a screw down lug for connection of portable appliances etc.
- .3 Where more than one compartment is provided, install ground rod in each compartment.

3.6 STRUCTURAL STEEL AND BUILDING GROUNDING

- .1 Ground building structural steel columns to buried perimeter grounding conductor. Ensure perimeter cable is slack to avoid stressing the connections.
- .2 Install grounding jumpers across building expansion joints.
- .3 Install ground rods close to column foundations and drive top of rod 300 mm below grade or finished floor level of slab on grade.
- .4 Install inspection boxes.

3.7 ELECTRICAL ROOMS

- .1 Install ground buses as indicated on plans.
- .2 Connect electrical panels and equipment ground buses and lugs to electrical room perimeter or ground bus bar. Make connections to bus with cable lugs,

bolted through the copper bus with shakeproof lockwashers and nuts. Use minimum No. 2/0 AWG or as shown on drawings, bared copper conductor to bond ground bus to grounding system.

3.8 LIGHTING POLES

- .1 Lighting poles shall be connected to the grounding system via the grounding conductor inside the lighting cable (fifth core in 5-core cables or third-core in 3-core cables)

3.9 PAD MOUNTED TRANSFORMERS

- .1 Main transformer (utility transformer) body shall be connected to the ground grid around it from at least two points.
- .2 Main transformer neutral point shall be connected directly to the ground grid with minimum 4/0 AWG size grounding conductor.
- .3 Also, transformer neutral points shall be interconnected via interconnection cables (Neutral core of the connecting cable).

3.10 POLE MOUNTED TRANSFORMER GROUNDING

- .1 Drive ground rods at base of each pole on which transformers are mounted and interconnect transformer, system neutral, lightning arresters and ground rods.

3.11 NEUTRAL GROUNDING

- .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.
- .2 Interconnect electrodes and neutrals at each grounding installation.
- .3 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.
- .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.

3.12 LOW VOLTAGE PANELS

- .1 All electrical panels' body shall be connected to the panel ground bus from two points. Panel ground busbar shall be connected to the grounding busbar in electrical room from two different points.

3.13 CONDUCTORS

- .1 Conductors: bare, stranded, soft annealed copper wire, size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.

- .2 Conductors: bare or PVC insulated coloured green, stranded soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
- .3 Conductors: pvc insulated coloured green, stranded soft annealed copper wire No. 10 AWG for grounding meter and relay cases.
- .4 Conductors: No. 3/0 AWG extra flexible (425 strands) copper conductor for connection of switch mechanism operating rod to gradient control mat, fence gates, vault doors.

3.14 RACEWAYS

- .1 On raceways, lock-up tight all couplers and connections to boxes and enclosures. Install bonding jumpers at expansion joints, and where necessary. Maintain ground continuity throughout run of raceway.
- .2 Install bonding jumpers on both ends of flexible conduit. Use grounding bushing, solderless lug, clamp or cup washer and screw connection. Install grounding conductor inside flexible conduit.
- .3 EMT and non-metallic raceways: install insulated grounding conductor in raceway.
- .4 Branch and feeder circuits in rigid conduit: use raceway as bonding conductor.
- .5 Cable trays: provide a bare No. 2/0 AWG ground conductor along inside of tray run bonded to tray at 15 m intervals. Where multiple cable trays are supported on a common structure bond all trays to one common grounding conductor at 15 m intervals. Keep grounding continuity when cable trays transition to conduit. Provide conduit bonding lugs as required.

3.15 TELECOMMUNICATIONS ROOMS

- .1 Bond metallic raceways to building ground
- .2 Provide telecommunications ground bus TMGB or TGB as designated on drawings, on one wall of telecommunications room (as indicated). Mounted TMGB and TGB on stand-off brackets to clear adjacent obstructions.
- .3 Provide No. 6 AWG insulated grounding conductor from TGB to ground bus to telecommunications room power distribution panel.
- .4 Maintain isolation between building ground and all components within the telecommunications room connected to the TMGB or TGB.
- .5 Provide isolated ground receptacles in telecommunications rooms. Provide a separate ground conductor from each receptacle to the ground bus in the power distribution panel.
- .6 Connection to the TMGB and TGB shall be made by exothermic welding or by listed two-hole compression lugs.

- .7 Provide No. 6 AWG insulated grounding conductor to bond TMGB to ground bus in main electrical room
- .8 All metal conduits or raceways for telecommunications cabling located within the same room or space as the TMGB or TGB shall be bonded to TMGB or TGB.
Metal conduits 27mm diameter and larger shall be bonded using electro thin plated pipe clamps.
Metal conduits 21mm diameter and smaller shall be bonded using electro thin plated conduit bonding clamps.
Metal cable trays shall be bonded using electro-tinplated cable tray bonding clamps.
Bonding surface areas shall be cleaned to bare metal removing all paint, etc. The contact area shall be protected from corrosion using antioxidant joint compound.
- .9 Where an electrical panelboard for telecommunication equipment is located in the same room or space as the TGB or TMGB, the panelboard ground bus or panelboard enclosure shall be bonded to the TMGB or TGB.
- .10 The TMGB or TGB shall be located in an area that is accessible to telecommunications personnel.
- .11 Provide individual No. 6 AWG insulated grounding conductors from each telecommunications cabinet or frame to the TGB
- .12 Provide #12AWG insulated green conductor from static dissipative tile (SDT) to TGB.

3.16 TESTING

- .1 Test the primary grounding loop resistance to ground, before bonding to others loops or devices (e.g. lightning protection loops) the connection is made to link them together.
- .2 For resistance to ground measurements use a ground resistance test set with an accuracy of 10 milliohms.
- .3 For measuring resistance to ground use the fall of potential method as outlined in IEEE Standard No. 81. After selecting the distance for the current probe take resistance measurements at a minimum of six voltage probe locations. Ensure that three of the voltage probe locations have resistance values such that the difference between any two is 0.5 ohm or less. If this is not the case repeat and retest with a larger distance for the current probe until this condition is satisfied.
- .4 Perform testing under average weather conditions; allow three days after the last rain before conducting test. Do not test resistance to ground under frozen soil conditions unless specifically approved by Consultant.
- .5 Test the integrity of the connections between the various components of the total grounding system. Test separately the continuity of the building perimeter loop (if used) and the connections between the primary grounding grid and the building grounding system.

-
- .6 For continuity measurements use a bridge or similar type test meter designed for the purpose with an accuracy of 1 milliohm.
 - .7 Where readings are not acceptable to Electrical Inspection and Consultant provide additional ground conductors, ground rods, connections, as necessary to satisfy the requirements of both.
 - .8 Prepare and submit a Test Report, signed by the Test Engineer, and where witnessed, by Departmental Representative. Include record of tests performed, methods of calculation, date and time of test, ambient conditions, and names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number. Calibration record shall include percentage error, correction factors, if any. Submit 3 copies.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section includes:

- .1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 RELATED SECTIONS

.1 Section 26 05 00: Common work results – Electrical

1.3 REFERENCES

.1 Conform to latest issues, amendments and supplements of following standards:

- .1 CSA C22.2 No.29-11, Panelboards and enclosed Panelboards.
- .2 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SYSTEM DESCRIPTION

.1 Panelboards – Power Switching Circuit Breaker Type

2 Products

2.1 PANELBOARDS - CIRCUIT BREAKER TYPE

- .1 All of Panelboards to be product of one manufacturer.
- .2 Enclosures: Steel, NEMA 2, sprinklerproof.
- .3 Bus: Copper, ground bar, isolated ground bar and full capacity neutral bar, braced for interrupting capacity as indicated on drawings or schedules.
- .4 A minimum of 10% spares.
- .5 Breakers
 - .1 Moulded-case circuit breakers, circuit breakers and ground-fault circuit-interrupters to CSA C22.2 No. 5.
 - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
 - .3 Common-trip breakers: with single handle for multi-pole applications.
 - .4 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as required in the single line diagrams.
 - .5 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

- .6 Ground Fault Interrupter Breakers – Class A:
 - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
 - .2 5mA trip sensitivity.
- .7 Ground Fault Equipment Protector Breakers – Class B:
 - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
 - .2 30 mA trip sensitivity.
- .8 Main breaker:
 - .1 Separately mounted in vertical position on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .9 Provide RED colour breakers with lock-on devices for breakers serving fire alarm devices.
- .10 Lock-on devices for all security, life safety and asset integrity circuits as identified.
- .11 Breaker Arrangement: Locate breakers at specific circuit number locations shown on panelboard schedule sheet.
- .12 Lock-on Devices: For circuits supplying continuously operating equipment. Minimum quantity 10% of 15A, 20A and 30A rated breakers.
- .6 Door: Hinged lockable door.
- .7 Keys: 2 keys per panelboard; key panelboards alike.
- .8 In addition to CSA requirements, manufacturer's nameplate to indicate panel withstand fault current.
- .9 Spaces: Fully bussed for future breakers with removable filler plates.

2.2 PANELBOARDS – POWER SWITCHING CIRCUIT BREAKER TYPE

- .1 Enclosures:
 - .1 Steel, NEMA 2, sprinklerproof.
 - .2 Interiors shall be capable of housing a control module and sized to allow easy access and replacement of the control modules.
 - .3 Interiors shall provide a Class 2 separation for the control module with an internal Class 2, 120/277 VAC power supply with secondary thermal magnetic ON/OFF protection to provide power to the panelboard control module. Power supply shall be fed from panelboard bus.
 - .4 Provide dead front cover for access to control module

- .5 Control module shall be provided with local ON/OFF switch and programming/diagnostic port.
- .2 Bus: Copper, ground bar and full capacity neutral bar, braced for interrupting capacity as indicated on drawings or schedules.
- .3 A minimum of 10% spares.
- .4 Integral programmable plug and play lighting control module that provides ON/OFF control for low voltage switchable circuit breakers.
- .5 Pre-wired and factory assembled.
- .6 Switching 'Smart' Breakers
 - .1 Low voltage controlled thermal magnetic circuit breaker in a standard panelboard enclosure.
 - .2 Branch circuit breakers shall have bolt-on type bus connectors. Plug-in type circuit breakers are not acceptable.
 - .3 Circuit breakers shall have an overcenter toggle mechanism, which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- pole circuit breakers shall have common tripping of all poles.
 - .4 Circuit breaker trip target shall be provided. In addition, the circuit breaker handle shall move to center of travel on breaker trip.
 - .5 Circuit breakers marked "Remotely Controlled" on drawings shall respond to a remote low voltage Class 2 signal for Open or Closed contact positioning. Circuit breaker power contacts shall remain Open when the breaker handle is in the OFF or tripped position, regardless of the remote close command. Remote control shall only be possible when the breaker handle is in the ON position. Circuit breakers may be manually controlled by operating the breaker handle in the event of a control module failure. Control power for circuit breakers shall be derived from the control module.
- .7 Standard Breakers
 - .1 Moulded-case circuit breakers, circuit breakers and ground-fault circuit-interrupters to CSA C22.2 No. 5.
 - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
 - .3 Common-trip breakers: with single handle for multi-pole applications.
 - .4 Circuit breakers to have symmetrical rms interrupting capacity rating as specified in the single line diagram.
 - .5 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
 - .6 Ground Fault Interrupter Breakers – Class A:

- .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
- .2 5mA trip sensitivity.
- .7 Ground Fault Equipment Protector Breakers – Class B:
 - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
 - .2 30 mA trip sensitivity.
- .8 Main breaker:
 - .1 Separately mounted in vertical position on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .9 Provide RED colour breakers with lock-on devices for breakers serving fire alarm devices.
- .10 Lock-on devices for all security, life safety and asset integrity circuits as identified.
- .11 Breaker Arrangement: Locate breakers at specific circuit number locations shown on panelboard schedule sheet.
- .12 Lock-on Devices: For circuits supplying continuously operating equipment. Minimum quantity 10% of 15A, 20A and 30A rated breakers.
- .8 Door: Hinged lockable door.
- .9 Keys: 2 keys per panelboard; key panelboards alike.
- .10 In addition to CSA requirements, manufacturer's nameplate to indicate panel withstand fault current.
- .11 Spaces: Fully bussed for future breakers with removable filler plates.

3 Execution

3.1 GENERAL

- .1 Protect equipment from dust, debris, moisture, and physical damage, with sealed envelope of plastic or other impervious material until building is enclosed and cleaned and equipment is energized.
- .2 Protect from condensation by maintaining at suitable temperature above 0°C.
- .3 Finish equipment enclosures to ANSI 49 or ANSI 61, baked grey enamel.

3.2 PANELBOARDS

- .1 Locate panelboards, secure, plumb true and square to structure.
- .2 Mounting Methods

- .1 Exterior walls and interior combustible walls: mount on continuous slotted channel strut with 75 mm clear between back of panel and wall. Where practical, group panelboards on common frame.
- .2 Interior non-combustible walls: mount against wall.
- .3 Provide plywood backboards behind all wall mounted panelboards. Plywood to G1S and painted with Intumescent grey paint.
- .3 Where panelboards are flush mounted, provide 3 – 25 mm spare empty conduits from each panelboard into ceiling space above.
- .4 Identify load circuits on panel directory complete with name and location.
- .5 Where panelboards are equipped with fused switches, install fuses immediately prior to energize. Record fuse rating on breaker or switch cover.
- .6 Training
 - .1 Provide a training session for the Departmental Representatives for normal workdays at a jobsite location determined by the Departmental Representative.
 - .2 The training session shall be conducted by a manufacturer's qualified representative. Training program shall include review of all system components and their function and operation instructions.
 - .3 Factory Testing
 - .1 The factory service shall provide adequate testing of the supplied equipment to ensure that the system performs as intended by the specification. Building engineering personnel shall be trained on all aspects of operating and maintaining the system. Care shall be taken to ensure that the system load connections are to the electrical drawing and that the control scenarios are operating properly.
 - .4 Field Quality Control
 - .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in starting-up the system for a period of working days. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the system and functions:
 - .1 Check installation of all smart panelboards, expansion cabinets and the central operator's station
 - .2 Test operation of all remote-controlled loads
 - .3 Repair or replace any defective component
 - .4 Test operation of complete lighting control system

.5 Conduct system point-by-point walk through

.5 The Contractor shall provide three (3) copies of the manufacturer's field startup.

3.3 DELIVERY, STORAGE AND HANDLING

.1 Do not ship equipment to site prior to completion of factory testing and acceptance of test results by Departmental representative.

3.4 WARRANTY

.1 Warranty requirements shall be as indicated in Division 01 except for this equipment the duration of warranty period shall be 12 months from the date the equipment is placed in service or 18 months from the date the equipment is accepted at site, whichever shall occur first.

END OF SECTION

1. General

1.1 RELATED SECTIONS

- .1 Section 26 05 00: Common Work Results - Electrical

1.2 REFERENCES

- .1 Refer to the latest in force addition of the standards.
- .2 CAN/CSA C22.2 No.144-M91, Ground Fault Circuit Interrupters.
- .3 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PB 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Division 01.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with division 01.
- .2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with division 01 and in accordance with the with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. Products

2.1 MATERIALS

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

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single or two pole ground fault circuit interrupter as indicated on plans.

2.3 GROUND FAULT PROTECTOR UNIT

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

3. Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Demonstrate simulated ground fault tests.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Division 01
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Division 01.
- .3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Labour, products, equipment and services necessary to complete the work of this Section including, but not limited to, the following:
 - .1 Lighting equipment as per the luminaire schedule and as specified herein.
 - .2 Refer to Electrical lighting plan for exact location of luminaires.
 - .3 Check latest ceiling finish schedule in areas where recessed luminaires are specified to ensure that luminaires have suitable ceiling trim for particular ceiling finish.
 - .4 Refer to Luminaire Schedule located on drawings for specific light fixture information.

1.2 RELATED SECTIONS

- .1 Section 26 05 00: Common work results – Electrical

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Division 01.
- .2 Submit certified copies of photometric test data, for each luminaire type, prepared by independent testing laboratory. Photometric data to include total input watts, candlepower summary, candlepower distribution, zonal lumen summary, luminaire efficiency, coefficient of utilization table, lamp type, ballast type and manufacturer, and lumen rating in accordance with IESNA testing procedures.
- .3 Submit samples as directed by Departmental Representative for the following luminaire types:

1.4 REFERENCES

- .1 Conform to latest issues, amendments and supplements of following standards:
 - .1 CSA C22.2 No. 9 - Luminaires
 - .2 CSA C22.2 No. 43 - Lampholders
 - .3 CSA C22.2 No. 74 - Equipment for Use with Electric Discharge Lamps
 - .4 CSA C22.2 No. 141 - Unit Equipment for Emergency Lighting

1.5 CODES AND STANDARDS

- .1 All wiring to be in accordance with the Alberta Electrical Safety Code.

- .2 Provide only equipment bearing a label acceptable to the Electrical Safety Authority (ESA) to indicate that the equipment has been tested to applicable CSA standards.

2 Products

2.1 SWITCHES

- .1 Switches
 - .1 Install lighting switches where indicated on plans.
 - .2 Switch shall be single pole single throw.
 - .3 Light switch shall be paddle style and design to fit into a standard junction box.
 - .4 Switch shall be compatible with fixtures they are controlling.
 - .5 Provide three way switching when indicated on plans.
- .2 Dimmers
 - .1 Install dimmers in locations where indicated on plans.
 - .2 Dimmers shall be compatible with the fixture they are controlling. i.e. a 0-10V dimmer will be provided to a fixture that requires 0-10V dimming control, etc.
 - .3 Dimmers shall be paddle switch style with linear slide dimmer adjacent to the paddle.
 - .4 Dimmer shall be designed to fit in a standard receptacle box.

2.2 LUMINAIRES

- .1 General
 - .1 Furnish luminaires in accordance with CSA C22.2 No. 9.
 - .2 Luminaire finishes shall resist chipping, crazing, and discolouration.
 - .3 Luminaires to contain no asbestos.
 - .4 Furnish luminaires with flanges and gaskets to eliminate light leaks.
- .2 Fluorescent Luminaires
 - .1 Fabricate steel luminaires from minimum 22-gauge mild sheet steel with joints securely fastened.
 - .2 Do not use pre-painted steel.
 - .3 Remove sharp edges.
 - .4 Phosphate dip, prime and paint luminaire body, hardware and accessories with 2 coats of baked enamel, or other finish where indicated, after fabrication.

- .5 Interior baked enamel finish to have a minimum 88% reflectance and a minimum thickness of 1.2 mils.
- .6 Where 2 level switching is indicated, furnish 2 ballasts, separately switched, with one ballast connected to the outer lamps and the other ballast connected to the inner lamp(s).
- .7 Acrylic lens, 100% virgin acrylic, 0.125" nominal thickness, extruded aluminum hinged frame.
- .3 Exit Light Luminaires
 - .1 Green running man exit sign.
 - .2 Universal ceiling, end-to-wall, surface back-to-wall mounting or recessed mounting if indicated.
 - .3 Connection for emergency 12V source where indicated.
 - .4 Refer to luminaire schedule.

2.3 BALLASTS – NON-DIMMABLE

- .1 Fluorescent
 - .1 To CSA C22.2 No. 74.
 - .2 Electronic, to operate 1 or 2 lamps, integrally mounted in luminaire unless otherwise indicated.
 - .3 Rapid start type for normal output lamps unless otherwise indicated.
 - .4 Instant start type for high output lamps.
 - .5 Programmed start type for applications with occupancy/vacancy sensors.
 - .6 Type as indicated in luminaire type appendix.
 - .7 Totally enclosed containing no polychlorinated biphenyls.
 - .8 Rated 60 Hz, voltage as indicated.
 - .9 Rated for operation over an ambient temperature range of 10°C to 40°C.
 - .10 Maximum case temperature not greater than 25°C above ambient temperature.
 - .11 Operate at in a frequency range of 25 kHz to 40 kHz.
 - .12 Produce no visible flicker.
 - .13 Minimum sound rating of Class A.
 - .14 Minimum ballast factor of 0.9.
 - .15 Minimum power factor of 0.95.
 - .16 Maximum crest factor of 1.5.
 - .17 Maximum input current total harmonic distortion of 10% measured at rated output.

- .18 To withstand line transients as defined by ANSI/IEEE C62.41, Category A.
- .19 Acceptable manufacturers:
 - .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola
- .2 LED Drivers
 - .1 Dims continuously from 100% to 1% lighting level (if applicable)
 - .2 Rated for a 50,000 hour lifetime
 - .3 Constant current reduction (CCR) or pulse width modulation (PWM) dimming for constant current drivers selection
 - .4 Works with Forward Phase controls (neutral wire required), 3-wire fluorescent controls and network lighting management controls
 - .5 Constant Current model: 200 mA to 2.1 A (in 10 mA steps), 5 W to 40 W
 - .6 Constant Voltage model: 10 Volts to 40 Volts (in 0.5 V steps), 5 W to 40 W
 - .7 Universal input voltage
 - .8 Full range of UL Class 2 products operating at low DC voltage
 - .9 Operational down to -30° C for use in outdoor and cold areas
 - .10 Integrated short circuit protection
 - .11 Acceptable manufacturers:
 - .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola
- .3 Compact Fluorescent
 - .1 Ballasts shall be CSA and/or UL listed, Class P thermally protected and meet ANSI C62.41 (IEEE 587, Category A) for surge protection.
 - .2 Light level output shall be continuous, smooth and flicker free over the entire dimming range.
 - .3 Ballast shall have:
 - .1 Power factor greater than .95 and it should be self-compensated
 - .2 Total harmonic distortion less than 10%
 - .4 Ballast shall have an ambient noise level of 27dB or less throughout the dimming range.

- .5 Ballasts must comply with FCC part 18 regulations and shall not interfere with other electrical or electronic equipment
- .6 Ballasts shall have a minimum starting temperature of 10 deg C.
- .7 Ballasts shall have protected control wire input which is not damaged by miswire.
- .8 Ballasts current inrush shall not exceed three amps at 120 volts to avoid nuisance circuit breaker trips and control contact malfunctions.
- .9 Lead length from ballast to lamp socket shall not exceed 1M (3ft.)
- .10 Acceptable manufacturers:
 - .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola
- .4 Metal halide ballast:
 - .1 Rating: voltage as indicated, for use with 1-400W metal halide lamp. Provide circuitry for quartz re-strike standby light where indicated.
 - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
 - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
 - .4 Input voltage range: plus or minus 10% of nominal.
 - .5 Minimum starting temperature: minus 30 degrees Celsius at 90% line voltage.
 - .6 Mounting: as per drawings.
 - .7 Current crest factor: 1.7 maximum current.
- .5 High pressure sodium ballast: to ANSI C82.4 design.
 - .1 Rating: 120 V, 60Hz, for use with 1-400W high pressure sodium lamp.
 - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
 - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
 - .4 Type: as recommended by manufacturer.
 - .5 Input voltage range: plus 10% to minus 10% of nominal.
 - .6 Minimum starting temperature: minus 40 degrees Celsius at 90% line voltage.
 - .7 Mounting: As per drawings..
 - .8 Current crest factor: 1.7 maximum current.
- .6 Low pressure sodium ballast:
 - .1 Rating: 120 V, 60 Hz, for use with 1-35W low pressure sodium lamp.

- .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
- .3 Power factor: minimum 95% with 95% of rated lamp lumens.
- .4 Input voltage range: plus or minus 20% of nominal.
- .5 Minimum starting temperature: minus 34 degrees Celsius at 90% line voltage.
- .6 Mounting: as per drawings.

2.4 BALLASTS – DIMMABLE

- .1 Fluorescent
 - .1 Ten-year operational life while operating with a case temperature range of 10 degrees C (50 degrees F) to 75 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
 - .2 Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment IEC 801-2.
 - .3 Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the ballast is under fully-loaded conditions and case temperature is 75 degrees C (167 degrees F).
 - .4 Programmed Rapid Start Type.
 - .5 Current crest factor (CCF) less than 1.7.
 - .6 Meet ANSI C82.11 High frequency ballast standard.
 - .7 Will not interfere with infrared devices operating at frequencies between 38 kHz and 42 kHz.
 - .8 Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
 - .9 Manufactured in a facility that employ ESD reduction practices in compliance with ANSI/ESD S20.20.
 - .10 Inaudible in a 27 dBA ambient.
 - .11 No visible change in light output with a variation of +/- 10 percent line voltage input.
 - .12 Total Harmonic Distortion less than 10 percent and meet ANSI C82.11 maximum allowable THD requirements
 - .13 Actively prevent overheating in T5-HO linear fluorescent lamp applications.
 - .14 Ballasts to track evenly across:
 - .1 Multiple lamp lengths.
 - .2 All light levels.
 - .15 Dimming range of ballast shall be from 1% to 100% illuminance level.
 - .16 Acceptable manufacturers:

- .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola
- .2 Compact Fluorescent
- .1 Continuous dimming from 100 percent to 5 percent relative light output for T4 compact and T5 twin tube lamps.
 - .2 Generate digital communication commands to distribute ballast data on the digital bus.
 - .3 Monitor and report lamp and ballast status.
 - .4 Lights automatically return to the setting prior to power interruption.
 - .5 Each ballast responds independently to:
 - .1 Up to 32 occupant sensors.
 - .2 Up to 64 personal control inputs.
 - .3 Up to 2 daylight sensors.
 - .6 Unique internal reference number visibly displayed on ballast cover.
 - .7 Averages 2 independent daylight harvesting inputs internally.
 - .8 Responds to digital load shed command.
 - .1 Sets high end trim.
 - .2 Automatically scales light output proportional to load shed command.
 - .1 Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by 3 percent to 27 percent.
 - .9 Maximum inrush current of 7 amperes for 120V ballasts and 3 amperes for 277V ballasts.
 - .10 Acceptable manufacturers:
 - .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola
- .3 Light Emitting Diodes (LEDs)
- .1 Continuous dimming from 100 percent to 1 percent relative light output.

- .2 Ability to operate with installed or specified building control system.
- .3 Lights automatically return to the setting prior to power interruption.
- .4 Each driver responds independently to:
 - .1 Up to 32 occupant sensors.
 - .2 Up to 16 daylight sensors.
- .5 Responds to digital load shed command.
- .6 Sets high end trim.
- .7 Automatically scales light output proportional to load shed command.
 - .1 Example: If light output is at 30 percent and a load shed command of 10 percent is received, the driver automatically sets the maximum light output at 90 percent (of the 30 percent light level) and lowers current light output by 3 percent to 27 percent.
- .8 Acceptable manufacturers:
 - .1 Lutron
 - .2 Philips Advance
 - .3 Osram Sylvania
 - .4 GE Motorola

2.5 LAMPS

- .1 Fluorescent Lamps are as per project luminaire schedule and lighting plan drawings.
- .2 Incandescent lamps to be - clear, A19, 100 Watt with 1000 hour lamp life, rough-service rated; or as indicated..
- .3 Tungsten halogen lamps to be - clear, T-3, 300 Watt, RSC base, 2000 hour lamp life, 5000 lumens; or as indicated.
- .4 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80; or as indicated.
- .5 Metal halide lamps to be - clear, BT37, 400 Watt, mogul base, horizontal burn, 4100 K, 15,000 hour lamp life, 36,000 initial lumens, CRI65, open or enclosed type to suit the luminaire; or as indicated.
- .6 Low pressure sodium lamps to be - clear, T21, 135 Watt, BY22d base, horizontal burn, 16,000 hour lamp life, 22,000 initial lumens; or as indicated.
- .7 High pressure sodium lamps to be - clear, ED18, 400 Watt, mogul base, 30,000 hour lamp life, 54,000 initial lumens; or as indicated.

- .8 Compact fluorescent lamps to be - 18 Watt, G24q-2 base, 12,000 hour lamp life, 12,000 initial lumens, 4100 K, CRI 80; or as indicated.
- .9 Light emitting diodes (LEDs):
 - .1 Provide the most technically proven, advanced and successfully tested LED technology at time of installation.
 - .2 Colour temperature range to be from 2800 K to 4000 K as shown on luminaire schedule
 - .3 Minimum CRI of: 80
 - .4 Rated life: at least 50,000 hours based on 70% lumen depreciation level
 - .5 Heat sinks to adequately remove heat from bottom of semiconductor

2.6 EMERGENCY BATTERY UNITS

- .1 Supply voltage 120 V AC, 1PH, 60Hz.
- .2 Output voltage 12 V DC.
- .3 Batteries: sealed lead acid calcium alloy grid type sized to operate the lamp load to 91% of initial voltage for 60 minutes.
- .4 Battery charger: solid state, multi-rate, voltage/current regulated, sized to restore battery to full charge in 12 hours.
- .5 Low voltage disconnect: solid state, modular, operates at 80% battery voltage.
- .6 EEMAC 2 code gauge steel housing.
- .7 Auxiliary equipment:
 - .1 "AC Power ON"
 - .2 "Fast charge" pilot light
 - .3 Voltmeter
 - .4 Test switch
 - .5 5 minute time delay relay
 - .6 Cord and plug
- .8 Lamp heads: mounted as indicated, 360° horizontal and 180° vertical adjustment, (12W) (20W) (55W) (micro quartz) (quartz halogen composite) lamps.
- .9 Acceptable Manufacturers:
 - .1 –Refer to Luminaire Schedule.

3 Execution

3.1 INSTALLATION - GENERAL

- .1 Provide supports for luminaires. For continuous row fluorescent type, provide support for each end plus at least one for each channel section, or additional as required. Swivel mount stems. Provide concrete inserts at points of luminaire support in unfinished areas where a concrete slab serves as ceiling. Provide support from floor and roof assemblies above ceiling as applicable.
- .2 Align luminaires in rows, maintain required heights, and install luminaires clear of other work.
- .3 Keep luminaires covered and protected from construction dust and debris until building is broom clean and free of suspended dust clouds.
- .4 Do not lamp luminaires until ready for testing and use. Obtain Departmental Representative's approval before lamping. Install lamps in lampholders.
- .5 When installation is complete, demonstrate operation to satisfaction of Departmental Representative.
- .6 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.
- .7 Attach boxes or hickies directly to poured concrete with 6 mm minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8 mm minimum bolts through precast slabs, welded to 100 mm x 100 mm minimum, 3.5 mm plate above slabs.
- .8 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidable tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan cooperatively. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown.
- .9 Provide continuous 12 mm x 38 mm channel above ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6 mm minimum diameter studs with minimum 1220 mm on centre.
- .10 Where two 1220mm surface or suspended fluorescent luminaires occur in tandem, an 2440mm body may be used. Where two single lamp luminaires occur in tandem, a common lamp ballast may be used.
- .11 Verify catalogue number of luminaires with description prior to ordering, and check for final ceiling finish in areas where recessed luminaires are called for in order to provide ceiling trim, flanges and mounting brackets to suit particular construction used where luminaires are installed.
- .12 Support luminaires in an approved manner to comply with applicable local codes and standards.
- .13 Provide steel luminaire studs, brackets and hangers. Where luminaires are hung on chain hangers, provide chain of closed link type capable of supporting ten times luminaire weight. Use U-bolts for chain ends; S-hooks are not acceptable.

3.2 INSTALLATION - EMERGENCY AND EXIT LIGHTS

- .1 Exit sign installation shall meet all requirements of the authorities having jurisdiction.
- .2 Install emergency battery units where shown. Support on brackets supplied by manufacturer.
- .3 Aim heads to properly illuminate exit path.

3.3 INSTALLATION - CEILINGS

- .1 Suspend luminaires mounted from or in a suspended ceiling directly from building structure, independent of the T-bar system, to ULC, Local Fire Marshal's Office, Alberta Building Code, Electrical Safety Authority (ESA) and Departmental Representative's approval.
- .2 In non-accessible ceilings wire with not more than 1200 mm of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the luminaire openings.
- .3 In accessible ceilings wire with not more than 1800 mm of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes, locations as shown on the Drawings.
- .4 Provide suitable trim for all luminaires installed in drywall ceilings or within lay-in or snap-in tiles.

END OF SECTION