ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Summary

.1 Work under Division 16 includes, but is not limited to the categories of the work itemized below:

.1 Electrical Testing.

.2 Grounding.

.3 Cable Tray Systems.

.4 Power and control cabling.

.5 Fastenings, conduits, fittings, junction and pull boxes.

.6 Wiring devices.

.7 Motor Control Centres.

.8 Motor Starters.

.9 Variable Frequency Drives.

.10 Low Voltage Harmonic Filtering.

.11 Uninterruptable Power Supplies.

.12 Telephone, CCTV and access control systems.

.13 Fire alarm systems.

.14 Power management control systems.

.15 Liquid filled distribution transformers.

.16 Dry type transformers.

.17 Power Metering.

.18 4160V and 12.47kV switchgear.

.19 Panelboards.

.20 Lighting equipment.

.2 Detailed requirements for electrical items are specified in other Sections but are subject to the general requirements of this Section.

.3 The Facility is considered as an industrial site. Material and installation shall be suited for heavy industrial usage, and not for commercial usage.

.4 Provide complete and functioning electrical system.

1.2 Standards

.1 Comply with appropriate requests and direction for the various Authorities Having Jurisdiction (AHJ).

.2 Comply with the following codes and standard. If a conflict is found conform, the more stringent standard shall prevail.

- .1 Manitoba Building Code (MBC).
- .2 City of Winnipeg:
  - .1 Water and Waste Department Electrical Design Guide.
  - .2 Water and Waste Department Automation Design Guide.
  - .3 The Winnipeg Electrical By-law (WEB) and associated bulletins.
  - .4 Winnipeg amendments to the National Building Code of Canada (NBC).
- .3 Canadian Standards Association (CSA):
  - .1 C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/WEB elsewhere in this document shall include reference to such amendments.
  - .2 C22.2 No. 0 - General Requirements - Canadian Electrical Code - Part 2.
  - .3 C22.3 No. 1 - Overhead Systems.
  - .4 C22.3 No.7 - Underground Systems.
  - .5 CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V.
- .4 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
- .5 National Electrical Manufacturers Association (NEMA).
- .6 Institute of the Electrical and Electronic Engineers (IEEE).
- .7 Insulated Cable Engineers Association (ICEA).
- .8 Underwriters Laboratories Canada (ULC).
- .9 American National Standards Institute (ANSI).

.10 National Fire Protection Agency (NFPA).

1.3 Definitions

.1 Schematic or Elementary Diagram: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections, and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

.2 Single-Line Diagram: A single-line diagram shows, by means of single lines and graphical symbols, the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

.3 Block Diagram: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

.4 Wiring Diagram or Connection System: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram to be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) by panel layout diagram showing the physical location of devices plus the elementary diagram.

.5 Interconnection Diagram: An interconnection diagram shows all external connections between terminals of equipment and outside points, including motors and auxiliary devices. References to be shown to all connection diagrams which interface to the interconnection diagrams.

.1 Interconnection diagrams to be continuous line type. Bundled wires to be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not permitted.

.2 Each wire identification as actually installed to be shown. The wire identification for each end of the same wire to be identical. All devices and equipment to be identified.

.3 Terminal blocks to be shown as actually installed and identified in the equipment complete with individual terminal identification. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams to be shown on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams will not be shown again on the interconnection diagram.

.4 Signal and DC circuit polarities and wire pairs to be shown on diagrams. Spare wires and cables to be shown on the diagrams.

.6 Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.4 Submittals

.1 Submit Shop Drawings and samples in accordance with Section 01300.

.2 Each submittal shall include the following information, as applicable.

.1 Project No., name and location.

.2 Equipment Tag Number.

.3 Equipment Manufacturer and model number.

.4 Manufacturer's name and description of item.

.5 Equipment capacity, duty and performance across the full operating range of the equipment including but not limited to:

.1 Voltages and voltage regulation.

.2 Currents / ampacity.

.3 Number of phases / wires.

.4 Frequency and frequency regulation.

.5 Power factor.

.6 Harmonic content.

.7 Temperature rise, thermal capacity, insulation class.

.8 Efficiency.

.9 Sound levels.

.10 Agency approval and certification.

.11 Single line, schematic, wiring and interconnection diagrams.

.12 Functional block diagrams, logic diagrams, process flow charts.

.13 HMI screenshots.

.14 Operator Work Station screenshots (if BMS system is installed).

.15 Bills of materials.

.16 Details of construction materials, enclosure types, weights and dimensions, cable entry locations, position and size of components, busbars, foundations, drilling and mounting details.

.17 Panel layouts, internal equipment layouts.

.18 Catalogue cut sheets showing pertinent physical and operation characteristics of internal components.

.19 Lighting illuminance plan of each location in pdf format referencing actual building layout and equipment locations. Plan shall include average, minimum, maximum values as well as ratios for max:min and average:min.

.20 Reports.

.21 Spare parts lists for materials to be provided by their respectful vendors or contractors.

.22 Warranty, service and support information.

2. PRODUCTS

2.1 Performance Criteria

.1 General:

.1 Ambient Temperature:

.1 Unless otherwise specified, size and de-rate equipment and materials for the ambient site conditions, but at least within the ambient temperature range of minus 40°C to plus 40°C.

.2 Altitude:

.1 Size and de-rate equipment and materials for the altitude site conditions, but not less than an elevation ranging from sea level to 1000 m without exceeding the manufacturer's stated tolerances.

.2 Corrosive Areas:

.1 Review, confirm and reclassify the exposure designations in accordance with CEC Category 1 and Category 2 environment and as set out in Section 01450 – Area Exposure Designation. Provide all equipment suitable for the exposure designation.

.3 Hazardous Locations:

.1 Provide equipment suitable for installation in designated hazardous locations as required by the Final Design.

.2 Review, confirm and re-classify, if necessary, hazardous areas per locally enforceable codes and standards including classification with NFPA 820, Canadian Electrical Code (CSA 22.1), City of Winnipeg Electrical Design Guide and the Winnipeg electrical bylaw.

.3 Provide all equipment and material in accordance with their respective hazardous area classification as specified in the Section 18 of the Canadian electrical code.

.4 Voltage Ratings:

.1 Operating voltages in accordance with the Electrical Design Guide.

.2 Power Supply Voltage.

.1 Primary distribution voltage is 12.47 kV, 3 phase, 3 wire, 60 Hz.

.3 Facility distribution voltages are:

.1 208/120 V, 3-phase, 4-wire, 60 Hz.

.2 480/277 V, 3-phase, 4-wire, 60 Hz.

.3 600/347 V, 3-phase, 4-wire, 60 Hz.

.4 4.16 kV, 3-phase, 3-wire, 60 Hz.

.5 12.47 kV, 3-phase, 3-wire, 60 Hz.

2.2 Mounting Heights and Arrangement

.1 Receptacles and Switches:

.1 Do not install recessed receptacles back-to-back in walls; allow minimum 150 mm horizontal clearance between boxes.

.2 Coordinate the positions of material and equipment and receptacles and switches. Equipment and receptacles and switches shall be easily accessible for use.

.3 Provide quantity and spacing of convenience receptacles as indicated in the Electrical Design Guide.

.4 Position light switches on latch side of doors. Position disconnect devices within ready reach and in accordance with the Canadian Electrical Code.

.5 Where several pieces of equipment are mounted near each other, the equipment shall be installed vertically and horizontally aligned.

.6 Install electrical equipment at following heights above finished floor, the following heights have been provided for guidance purposes, ensure that these heights comply with the applicable codes and standards at the time of construction:

.1 Local switches: 1400 mm.

.2 Wall receptacles:

.1 Office areas: 300 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 175 mm.

.4 In mechanical and process areas: 1400 mm.

.5 In electrical rooms: 300 mm.

.6 Outdoor: 1000 mm.

.7 In below grade valve chambers: 1800 mm.

.3 Panel boards: not less than 750 mm to bottom of tub.

.4 Data and interphone outlets: same as for receptacles.

.5 Fire alarm stations: 1500 mm.

.6 Fire alarm bells: 2100 mm.

.7 Wall mounted telephones: 1500 mm.

.8 Wall mounted speakers: 2100 mm.

.9 Wall mounted clocks: 2100 mm.

2.3 Housekeeping

.1 Protect electrical equipment from dust, water, and damage. Equipment shall be kept clean, free of dust and dirt on the inside and outside, kept dry, and to be vacuumed on the inside prior to energizing and testing.

.2 Provide concrete housekeeping pad for electrical floor stand panels to protect electrical panels from dust and water damage. At minimum housekeeping pads shall be 100 mm in height.

.3 Touch-up any scratches on equipment.

.1 Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction.

.2 Provide anti-rust zinc primer and matching spray paint to repair equipment scratches.

.4 Equipment with anti-condensation heaters shall be stored indoors at normal room temperature. Otherwise, the anti-condensation heaters shall be energized within seventy-two (72) hours of delivery and so maintained until commissioning.

2.4 Materials

.1 Equipment and materials shall be CSA or $_C$UL certified. Where there is no alternative to supplying equipment, which is not CSA or $_C$UL certified, obtain special approval from the provincial electrical inspection department.

.2 Use factory assembled control panels and component assemblies.

.3 Where specified in the individual product Specification Section, perform factory tests at the place of fabrication on completion of manufacture or assembly.

2.5 Configuration, Components and Features

.1 Conductor Terminations:

.1 Lugs, terminals, and screws used for termination of conductors shall be suitable for copper conductors.

.2 Use tin-plated lugs and terminals with nylon insulating materials.

.3 Use pan-head terminal screws.

.4 Provide terminals with integral marking strips, permanently identified with the connecting wire numbers.

.5 Minimum ratings for terminal blocks:

.1 208 and 600 V power circuits: not less than current rating of conductor and not less than 600 VAC.

.2 C-circuits (control and/or power 120 V or less) and analogue circuits: not less than 20 A and not less than 300 VAC.

.2 Equipment Base Templates:

.1 For all major electrical equipment, provide an equipment base template for location of equipment anchor bolts to be embedded in concrete.

.2 Use shop finish steel templates to Manufacturer's standards for items to be embedded in concrete.

.3 Provide access holes for the placement of grout or concrete, as applicable.

.3 Equipment Padlocking:

.1 Provide numbered padlocks and key sets for all electrical equipment including MCC and distribution panels used to energize that equipment. All equipment switches shall be padlocked in the OFF position until it is being tested and commissioned.

.2 Padlocks shall be numbered individually and supplied with two (2) keys each bearing the matching number to the padlock.

.3 Normal safety lock-off procedures shall be followed in addition to the padlocking provisions described here.

.4 Equipment padlocks shall be removed following commissioning of equipment.

2.6 Finishes

.1 Manufacturer shall paint electrical equipment and materials field finish or touch-up in accordance with Manufacturer's standard.

.2 Galvanized finishes shall comply with CAN/CSA G64.

.3 Items of fabricated metal which have not been painted as part of a mass production procedure shall be treated as follows:

.1 Shop finish metal enclosure surfaces by application of rust-resistant primer inside and outside, and at least two (2) coats of finish.

.2 Paint exterior electrical equipment with Grey #GP122 – ASA 61.

.3 Paint indoor switchgear and distribution enclosures light grey, to EEMAC 2Y-1, enamel.

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

.5 Field-clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting and finish with two coats of finish.

.6 If acceptable to the City, apply Galvacon, or approved equivalent, touch-up paint to damaged portions of galvanized surfaces and threads.

2.7 Identification

.1 Equipment Identification:

.1 Provide nameplates in accordance with the City of Winnipeg Electrical Design Guide and Identification standard.

.2 Conductor Identification:

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

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code per the Electrical Design Guide, the Automation Design Guide, and CSA C22.1.

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

.5 Use heat-shrinkable identification sleeves for conductor’s size #10 AWG and smaller. Machine-print the identifying letters and numbers, minimum 3 mm high, on sleeves with permanent black ink. Use white tubing sleeves, sized to fit the conductor insulation diameter.

.6 Make printed characters permanent, either by an infrared or heat-shrink process, depending on type of system used.

.7 Provide the required heat-shrink and printing equipment, complete with all required software.

.8 Where 'ring' type terminals are used, extend sleeve over crimp-on-base after installation of terminal and heat-shrink in place. ‘Fork’ type terminals shall not be used.

.3 Electrical Diagrams:

.1 Provide framed UV-proof plexiglass for single line electrical diagrams as follows:

.1 Electrical distribution system: install in main electrical room.

.2 Electrical power generation and distribution systems: install in power plant rooms.

.3 Switchgear or MCC: install next to equipment.

.2 Provide fire alarm riser diagram, plan, and zoning of building under framed plexiglass at fire alarm control panel and annunciator.

.3 Drawings: 600 mm x 600 mm minimum size.

.4 Plexiglass frame to be constructed such that drawings can be readily replaced.

.4 Coordination of Protective Devices.

.1 The circuit protective devices such as overcurrent trips, relays and fuses shall be installed according to the power studies values and settings.

.2 Protective relays shall be calibrated and tested in accordance with Section 16020. Initial and final settings shall be provided to match the results provided by power system studies.

.5 Conduit and Cable Identification:

.1 Conduit and cable jacket colour coding and cable markers per the Electrical Design Guide.

.2 Where cables are outdoors, installed in hazardous or corrosive areas, identify wiring at both ends with Panduit stainless steel metal embossed tags fastened with Pan-Steel stainless steel ties, or approved equivalent.

.3 Where cables are outdoors, within enclosures, non-hazardous, or non-corrosive areas, identify wiring at both ends with permanent indelible printed cable tag fastened with Tefzel wire ties. Machine print identify and numbers, minimum 3mm high, on cable tag.

.4 When factory-wired equipment has terminal numbers, and conductor numbers different than the conductor numbers shown on the control diagrams, show both numbers on the interconnection diagram, and fasten a copy of the interconnection diagram to the inside of the equipment cabinet.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

ELECTRICAL TESTING

1. GENERAL

1.1 Summary

.1 This Section specifies the testing and commissioning for all new Electrical Work, and any modifications or changes to existing components.

.2 Carry out all tests necessary to ensure that the entire electrical installation and its equipment, materials, and components are in a satisfactory physical condition electrically and shall perform the intended functions and operations. Tests shall be conducted by an independent testing agency with personnel having a minimum of five (5) years experience in the type of equipment and testing required or by Design Builder Party having equal qualifications.

.3 All employees of the testing firm shall be qualified per CSA Z462 requirements, and the Electricians License Act.

.4 The testing firm shall have at least one person on site with the following qualifications to provide technical supervision and/or guidance as required for the remainder of the testing personnel:

  .1 An employee certified by the International Electrical Testing Association (NETA).

  .2 A Professional Engineer (P.Eng.) licensed in the Province of Manitoba with specialized training and experience in the testing and inspection of electrical power distribution equipment.

  .3 A member of the certified technicians and technologists' association of Manitoba (CTTAM) with specialized training and experience in the testing and inspection of electrical power distribution equipment.

.5 All work performed by the testing firm shall be conducted by personnel who are qualified to operate, test, and commission both high and low voltage electrical equipment.

.6 The agency must have the necessary wiring, materials, equipment, tools, instruments, measuring devices and all other tools necessary to carry out the work.

.7 Testing firm name, proposed testing personnel qualifications, sample test forms and sample test reports, will be provided a minimum of eight (8) weeks prior to the scheduled site testing.

  .1 The qualifications of the proposed testing firm based on the information provided will be reviewed.

  .2 If, in the sole opinion of the City, the qualifications of the proposed testing firm and/or its personnel are deemed unacceptable, then the design builder will be required to make appropriate alterations to the testing team to the satisfaction of the City at no additional cost.

.8 Prior to the final demonstration and instructional seminars required, test and check all portions of the electrical system for satisfactory operation. All tests to be done in the presence of the City and/or his representative, suitably logged, tabulated, signed, and incorporated in project documentation.

.9 Correct all errors, omissions, and deficiencies, which are found by the tests without additional cost.

.10 DC test voltages shall be used for hi-pot tests.

.11 Meggers shall not be used on instrument signal wiring, semi-conductor devices, pulse generators, and similar equipment.

.12 Pre-Testing, and verification to include, but not be limited to the following:

Tests	Performance checked by
Normal visual	Electrical trade
Mechanical inspections	Low voltage systems installers
Megger tests	Electrical trade
Load balance tests	Electrical trade
Motor current readings	Electrical trade with Division 11/13/15 trade
Distribution voltage checks	Electrical trade
Power factor and efficiency readings	Electrical trade
Witness testing	Design builder’s representative, Electrical trade representative, City representative
Grounding	Electrical trade
Low voltage systems	Low voltage systems installer, Manufacturer, and electrical trade
Medium voltage systems	Medium voltage systems installer, Manufacturer, and electrical trade

.13 Testing and commissioning requirements apply to all electrical equipment including but not limited to:

.1 Equipment grounding.

.2 Control equipment.

.3 Motors.

.4 Motor starters.

.5 Transformers.

.6 Medium (12.47kV and 4.16kV) voltage switchgear.

.7 Low Voltage (600V) switchgear and MCC.

.8 UPS.

.9 Panels.

.10 Cable systems.

.11 VFD's.

.12 Power Factor Corrections Systems.

.13 Filters.

.14 Relay protection.

.15 Current and Voltage Transformers.

.16 Metering.

.17 Emergency Lighting.

.18 DC Battery and Chargers.

1.2 Standards

.1 Complete testing in accordance with the latest edition of the following standards and Specifications:

.1 Canadian Standards Association (CSA):

.2 CSA C22.1 – Canadian Electrical Code, Part I.

.3 CSA C22.2 No. 0 – General Requirements – Canadian Electrical Code, Part II.

.4 CSA C282 – Emergency Electrical Power Supply for Buildings.

.5 CSA Z460 – Control of Hazardous Energy – Lockout and Other Methods.

.6 CSA Z462 - Workplace Electrical Safety.

.2 W210 - Manitoba Workplace Safety and Health Act and Regulation.

.3 NETA, ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.

.4 City of Winnipeg inspection.

1.3 Submittals

.1 Submit product data in accordance with Section 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Quality control plan and testing plan with requirements listed herein and requirements listed by ANSI/ NETA ATS standard shall be provided for review per Submittal requirements for Division 16 in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements.

.3 Submit a report with the completed tests and applicable testing forms.

.4 Submit details of all test procedures and instruments, together with technician's names responsible for carrying out the test.

.5 Submit calibration records for all instruments being used in testing applications.

.6 Results of all tests shall be recorded and one set of test records, comprising a complete checklist for each item tested, shall be furnished.

.7 Submit all applicable testing forms to reflect as-built conditions.

1.4 Testing Equipment

.1 All test equipment shall be in good mechanical and electrical condition.

.2 Accuracy of metering in test equipment shall be appropriate for the test being performed.

.3 Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

.4 The test equipment shall be calibrated as specified below:

.1 The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

.2 The testing organization will have calibration certifications for test equipment, and a copy will be made available to the Contract Administrator.

.3 The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

.4 Instruments shall be calibrated in accordance with the following frequency schedule:

.1 Field instruments: Analog, 6 months maximum. Digital, 12 months maximum.

.2 Laboratory instruments: 12 months maximum.

.3 Leased specialty equipment: 12 months maximum.

.4 Dated calibration labels shall be visible on all test equipment.

.5 Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

.6 Calibrating standard shall be of higher accuracy than that of the instrument tested.

.5 Specific requirements of insulation resistance meters.

.1 Must be digital units.

.6 All test equipment to have valid calibration stickers displayed on the equipment.

.7 DC High Pot (dielectric strength) Units:

.1 Test instrument to have minimum output of 60 kV DC capacity.

.2 120 VAC powered.

.8 AC High Voltage (dielectric strength) Units:

.1 Use AC High voltage units for insulation tests and other tests as indicated, at voltage levels indicated, or required by Manufacturer’s recommendations.

.9 Low Resistance Test Units (Ductor):

.1 Low resistance test units to have 10 A output.

.2 Digital display and accuracy to 1 micro-ohm, with a range from 1 μΩ to 1000 Ω. Standard electrician multimeters will not be accepted.

.10 Insulation Resistance Tests (Megohmmeter/Megger):

.1 Use a megger with 20,000 M-ohm resolution for megger tests.

.2 Output voltages on DC megger units to be 250V, 500V, 1000V, 2500V or other as required.

.3 Record ambient temperature and adjust the measured M-ohms to 20°C ambient.

.4 Use 2.5 kV megger for 5 kV and15 kV equipment and 1000 V megger range for power equipment of 600 V and below.

.5 For 10-minute megger tests, record M-ohm values in M-ohm at 30 seconds, 60 seconds, 5 minutes and 10 minutes. Plot M-ohm against time for each connection, calculate and record the ratio of measured M-ohm as follows:

.1 60 sec M-ohm/30 sec M-ohm = dielectric absorption.

.2 10 min M-ohm/1 min M-ohm = polarization index.

.3 Report the 1-minute M-ohm as the insulation resistance value.

.6 Submit tabulated measure M-ohm figures for 10-minute insulation tests, submit a graph.

.7 Apply megohmmeter dc voltage in accordance with the equipment Manufacturer's recommendations or NETA ATS-2009 Table 100.1.

.11 VLF Test:

.1 Use a VLF tester capable of 40 kV peak that is capable of testing 1.1uF of cable load at 0.1 Hz up to 5.5 uF at 0.2 Hz.

.12 Relay Test Equipment:

.1 Relay test equipment to be designed for relay testing, secondary current injection.

.2 Current output to a minimum of 60Amps for testing of instantaneous features.

.3 Indicators to detect open signals, pick-up signals and other required signals.

.4 Timers to 1 millisecond.

.5 For equipment required on three phase systems, have a three phase voltage and relay output test unit.

.6 For equipment required on three phase differential tests, have a six phase voltage and relay output test unit.

.13 Ground Resistivity Tester:

.1 Ground resistivity tester to measure earth impedance in variable distances from the source.

.2 Unit to be capable of plotting ground resistivity from 0.1 ohms and up.

.14 Other test equipment as required in order to satisfy the requirements of this Section as detailed herein.

2. PRODUCTS

2.1 Check Tags

.1 On commencement of each portion of the electrical/instrumentation testing, the "Electrical" or "Instrumentation" checkout tag shall be attached to each piece of electrical and instrumentation equipment and completed.

2.2 Performance Criteria

.1 General Requirements:

.1 Prior to energizing of any equipment and starting tests, verify that the following has been completed:

.1 The entire assembly is clean inside and outside. The cables are not lying loosely or hanging free.

.2 The equipment is adequately bonded and grounded with the ground wires installed clear of bus work.

.3 The phasing of all bus work and of primary circuits is identified.

.4 All equipment is correctly identified front and back.

.5 Each starter is identified with correct drive number and drive title.

.6 All cables leaving electrical equipment have proper cable connectors, and are properly identified.

.7 All unused holes are properly plugged.

.8 All unused wall and floor openings are sealed water-tight, fire rated and gas tight for hazardous areas.

.9 Relay and metering sections of equipment enclosures are properly identified.

.10 Motors and connected units have been properly secured to the base and aligned.

.11 Equipment nameplate data corresponds with characteristics of power supply.

.12 Emergency or stand-by lighting system is operational.

.13 The installation is in a safe condition, there are no unguarded live parts. Conduit seals are in place if a hazardous condition could occur during the testing phase.

.14 All covers are in place and secure.

3. EXECUTION

3.1 General

.1 Coordination of Protective Devices:

.1 Provide an overall co-ordination study of the electrical distribution system certified by a Professional Engineer.

.2 Overcurrent protective devices including overcurrent trips, relays and fuses are to be set to values and settings as set out in the Final Design and verified by an independent testing firm.

.2 Conduit and Cable Testing:

.1 Control and Communication Cables:

.1 Record cable and installation data. Confirm information with Drawings and Specifications. Update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect compression-applied connectors for correct cable match and identification.

.4 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.5 Verify phasing.

.6 Perform continuity and ground check before connecting equipment.

.2 Low Voltage (up to 1000 VAC):

.1 Perform inspection and tests on cables prior to installing sealing compound in the conduit system. This applies to hazardous areas and to weatherproof penetration sealant.

.2 Record cable and installation data. Confirm information with Drawings and Specifications. Update Drawings as necessary.

.3 Inspect and record physical and mechanical condition, including grounding and cable/conduit support.

.4 For cable/wires 4/0 AWG or larger, inspect bolted electrical connections for high resistance.

.5 Inspect compression-applied connectors for correct cable match and indentation.

.6 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.7 Confirm bolt torque levels are in accordance with the Manufacturer’s recommendation.

.8 Verify phasing.

.9 Perform continuity and ground check before connection to equipment.

.10 Measure length of cable/conduit and record in meters. Record and adjust all cable lengths included in the cable schedules. Base building cabling such as lighting, fire alarm, public address, 15 A duplex receptacle circuit, etc. do not need to be recorded. For accurate lengths, record cable lengths based on conductor distance markings wherever possible.

.11 If cable/wires are terminated through window-type current transformers, inspection shall be done to verify that neutral and ground conductors are correctly placed, and the shields are correctly terminated for operation of protective devices.

.12 Perform Insulation Resistance test as described in this Section:

.1 Utilize 500 V megohmmeter for conductors less than <= 250V in accordance with NETA Standards. Investigate resistances less than 25 Mega-ohms.

.2 Utilize 1000 V megohmmeter for conductors less than <= 600V in accordance with NETA Standards. Investigate resistances less than 100 Mega-ohms.

.3 Individually test each conductor with all other conductors and shields grounded.

.4 Test duration shall be one minute.

.5 Insulation Resistance (Megger) shall be performed after pulling and before termination. All tests shall be recorded for pre-commissioning records.

.3 Medium Voltage (5 kV to 15 kV):

.1 Record cable and installation data. Confirm information with Drawings and Specifications. Update Drawings as necessary.

.2 Inspect and record physical and mechanical condition, including:

.1 Grounding.

.2 Cable Support.

.3 Visual signs of overheating, etc.

.3 Inspect bolted electrical connections for high resistance.

.4 Inspect compression-applied connectors for correct cable match and indentation.

.5 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.6 Confirm bolt torque levels are in accordance with the Manufacturer's recommendation.

.7 Verify phasing.

.8 Perform continuity and ground check before connecting to equipment.

.9 Partial discharge testing.

.10 If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.11 Perform Insulation Resistance test as described in this Section:

.1 Utilize 2,500 V megohmmeter for conductors in accordance with NETA Standards.

.2 Individually test each conductor with all other conductors and shields grounded.

.3 The test duration shall be one minute.

.4 Investigate resistances less than 5 Giga-ohms.

.12 Perform a High Voltage Very Low Frequency (VLF) AC test on cables. Adhere to all precautions and limits in the applicable NEMA / ICEA Standard for the specific cable. Perform tests in accordance with IEEE Standard 400.2. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. The test voltage shall be sinusoidal. The test voltage shall be sinusoidal with a frequency of 0.1 Hz and shall not exceed cable Manufacturer's test values or IEEE 400.2 values.

.1 If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the over-potential test, the test specimen is considered to have passed the test.

.2 Ensure that the input voltage to the test set is regulated.

.3 Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

.4 Record wet and dry-bulb temperatures or relative humidity and temperature.

.5 Test each section of cable individually.

.6 Individually test each conductor with all other conductors grounded. Ground all shields.

.7 Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.

.8 Ensure that the maximum test voltage does not exceed the limits for terminators specified in IEEE Standard 48 or Manufacturer's Specifications.

.9 Raise the conductor test voltage to the specified maximum test voltage and hold for five minutes. Record leakage current.

.10 Apply grounds for a time period adequate to drain all insulation-stored charges.

.13 Perform a Dissipation Factor (Tangent Delta; VLF-TD) test on all cables and cable segments prior to proceeding with sinusoidal waveform testing.

.1 Perform tests in accordance with IEEE Standard 400.2.

.2 Provided that the dissipation factor (VLF-TD) does not rise significantly while raising the voltage, the dissipation factor (VLF-TD) shall also be calculated for an applied voltage 2 Uo RMS. The voltage should be set at 0.5 Uo and raised to 1.5 Uo in steps of 0.5 Uo, the maximum withstand value may be used as a final step. Ensure measurement intervals of 10 seconds between each measurement at 0.1 Hz or calculated from VLF-TD measurements taken at each voltage level and at the end of the 60-minute withstand period. Acceptance shall be based on the field values/calculations against Table G.1 and Table G.2.

.3 Test 5 kV cable to 2 Uo or 10kV RMS for 5 kV cable, and 4.16 kV phase to phase distributions.

.4 Test 15 kV cable to 2 Uo or 21kV RMS for 15 kV cable, and 12.47 kV phase to phase distributions. For a sinusoidal waveform the rms is 0.707 of the peak value, assuming the Hamonic distortion is less than 5%. The test voltage applied shall be a 0.1 Hz sinusoidal waveform for a minimum of 60 minutes.

.5 The dissipation factor for acceptance shall be calculated for an applied voltage of 2 Uo RMS when referenced phase to ground:

.6 Test 5 kV cable to 2 Uo (2 Uo is defined as 2 x line to ground operating voltage, which is 10kV RMS for 5 kV cable, and 4.16 kV phase to phase distributions).

.7 Test 15 kV cable to 2 Uo or 21kV RMS for 15 kV cable, and 12.47 kV phase to phase distributions.

.14 In the event of a cable failure discovered during testing, replace the cable.

.3 Lighting:

.1 Emergency:

.1 Record the equipment nameplate data and locations. Confirm information with design and update Drawings as necessary. Inspect and record physical and mechanical condition.

.2 Inspect installation, alignment, grounding and conductor connections and supports.

.3 Verify lamp alignment.

.4 Verify each component is clean. Clean as required.

.5 Test battery.

.6 Confirm operation of all emergency lamps and exit signs during normal and emergency operating conditions.

.7 Confirm design light levels are achieved.

.2 Normal:

.1 Record the equipment nameplate data and locations. Confirm information with design and update Drawings as necessary Inspect and record physical and mechanical condition, including lens covers.

.2 Inspect installation, alignment, grounding and conductor connections and supports.

.3 Verify lamp alignment as required.

.4 Verify each component is clean. Clean as required.

.5 Confirm operation of all interior and exterior fixtures during normal and night-lighting operating conditions.

.6 Confirm operation of all switching, motion-sensor operators and photocell operators.

.7 Confirm design light levels are achieved.

.4 Transformers:

.1 Control Power:

.1 Record the equipment nameplate data. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition, including:

.1 Cracked insulation.

.2 Broken leads.

.3 Defective wiring.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.4 Verify the unit is clean. Clean as required.

.5 Verify that primary and secondary fuse ratings or circuit breakers match available Drawings. Where Drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the Drawings, where not shown.

.6 Perform Insulation Resistance tests as described in the document:

.1 Winding to winding.

.2 Each winding to ground.

.2 Liquid Filled:

.1 Compare and confirm equipment nameplate data with design and update the Drawings as necessary.

.2 Compare NGR nameplate data with Drawings and Specifications. Measure NGR resistance.

.3 Inspect physical and mechanical condition.

.4 Inspect anchorage, alignment, and grounding.

.5 Verify the unit is clean.

.6 Verify ratings of surge arrestors.

.7 Verify that control and alarm settings on temperature indicators are as specified.

.8 Inspect electrical connections for high resistance using a calibrated torque-wrench in accordance with Manufacturer's published data.

.9 Verify proper connection of grounding resistor.

.10 Check all physical clearances to ground are in accordance with Manufacturer requirements.

.11 Verify all grounds, instrument wiring, and auxiliary wiring (e.g. power supply, heaters, etc.) are secured and connected.

.12 Insulation-resistance tests winding-to-winding and each winding-to-ground Turns-ratio tests at all tap positions.

.13 Measure the resistance of each winding at each tap connection.

.14 Doble (insulation power factor) test.

.15 Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

.16 Apply voltage in accordance with Manufacturer's published data. All other connected windings shall be grounded. Calculate polarization index.

.17 Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment Manufacturer's published data.

.18 Perform power-factor or dissipation-factor tests on each bushing.

.19 Perform excitation-current tests in accordance with the test equipment Manufacturer's published data.

.20 Measure the resistance of each winding at the designated tap position.

.21 Remove the core ground strap and measure the core insulation resistance at 500 VDC.

.22 Sample the transformer inter gas blanket. Measure and record the percentage of oxygen in the transformer inert gas blanket.

.23 Remove a sample of insulating liquid in accordance with ASTM D 923. The sample shall be tested for the following:

    .1 Dielectric breakdown voltage: ASTM D 877 and/or ASTM D 1816.

    .2 Acid neutralization number: ANSI/ASTM D 974.

    .3 Specific gravity: ANSI/ASTM D 1298.

.4 Interfacial tension: ANSI/ASTM D 971.

.5 Color: ANSI/ASTM D 1500.

.6 Visual Condition: ASTM D 1524.

.7 Measure power factor or dissipation factor in accordance with ASTM D 924.

.24 Remove a sample of insulating liquid in accordance with ASTM D117, ASTM D923,7and perform dissolved-gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D3612.

.25 Inspect and clean bushings and insulators.

.26 Check oil level and temperature indicators.

.27 Check that transformer no-load tap switch is set correctly to achieve the required secondary voltage.

.28 Inspect for oil leaks and rusting.

.29 Inspect oil level.

.30 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

.3 Potential:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Verify correct connection of transformers with system requirements.

.4 Inspect installation, alignment, grounding, required area clearances between primary and secondary circuit wiring and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.5 Verify the unit is clean. Clean as required.

.6 Verify correct primary and secondary fuse sizes for voltage transformers.

.7 Inspect bolted electrical connections for high resistance.

.8 Perform Insulation Resistance test as describe in this Section:

.1 Winding to winding.

.2 Each winding to ground.

.9 Perform a polarity test on each transformer.

.10 Perform a turns ratio test on all tap positions.

.4 Current Instrument:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Verify correct connection of transformers with system requirements.

.4 Inspect installation, alignment, grounding, required area clearances between primary and secondary circuit wiring and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.5 Verify the unit is clean. Clean as required.

.6 Verify CT ratio and note ratios of multi-winding CTs.

.7 Inspect bolted electrical connections for high resistance.

.8 Perform flick test on all windings (turns) to verify polarity.

.9 Measure and record Burden for all CT's.

.10 Perform Insulation Resistance test as described in this Section.

.11 Perform a polarity test on each transformer.

.12 CT testing shall be complete prior to injection testing required for protective relays.

.5 Medium Voltage Switchgear and Circuit Breakers:

.1 Check levelling of equipment.

.2 Verify condition of paint and finish, touch-up as required.

.3 Check proper bolted or welded connections to the floor, wall and steel supports.

.4 Visually inspect completeness of equipment devices as per Manufacturer's Drawings.

.5 Verify removal of packing braces and shipping supports.

.6 Check connections to the ground grid.

.7 Check cleanliness of the enclosure; clean all equipment by vacuum machine.

.8 Check the tightness of field made connections and terminations of the bus bars and feeders and tighten by torquing as per Manufacturer's recommendations.

.9 All bolted electrical bus connections shall be tested for high resistance using both a calibrated torque wrench and the Manufacturers recommended data and a low resistance ohmmeter.

.10 Compare equipment nameplate data with Drawings and Specifications.

.11 Inspect physical and mechanical condition.

.12 Inspect anchorage and alignment.

.13 Inspect installation alignment and connections of complete arc-chutes and vents.

.14 Perform point-to-point checks of control wiring.

.15 Operate the circuit breaker to ensure smooth operation.

.16 Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute in accordance with Table 100.1 in NETA ATS-(latest edition).

.17 Perform insulation-resistance tests on each breaker pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.18 Perform insulation-resistance tests on each disconnect pole, phase-to-phase and phase-to-ground with the disconnect switch closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.19 Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with Manufacturer's published data. If Manufacturer has no recommendation for this test, it shall be in accordance with Table 100.2 in NETA ATS (latest edition).

.20 The test voltage shall be applied for one minute.

.21 Perform a dielectric withstand test on each breaker pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.22 Verify correct operation of any auxiliary features such as trip and pickup indicators, electrical close and trip operation, trip-free, and anti-pump function.

.23 Test and commission the switchgear and associated interlocks and transfer switching where applicable.

.24 Test all physical operations of the switchgear including all racking and testing of any maintenance positions.

.25 Verify phasing.

.6 Battery Systems:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.4 Verify the unit is clean. Clean as required.

.5 Measure:

.1 Bank charging voltage.

.2 Individual cell voltage.

.3 Measured test values to be in accordance with Manufacturer's published data.

.6 Verify during Recharge Mode:

.1 Charging rates from charger.

.2 Individual cell acceptance of charge.

.7 Load tests for integrity and capacity, test values in accordance with IEEE 450.

.7 Circuit Breakers (all voltages):

.1 Air:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition, including:

.1 Proper cell fit and element alignment; and

.2 Proper operation of cubicle shutters and racking mechanism.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports.

.4 Bolt torque level in accordance with Manufacturer's recommendations and NETA ATS-2017. Where conical washers (Belleville or other) are used, coordinate with the applicable design engineer prior to tightening or applying pressure to connections.

.5 Verify the unit is clean. Clean as required.

.6 Proper contact condition.

.7 Perform mechanical operator and contact alignment tests on breaker and its operating mechanism in accordance with Manufacturer's instructions.

.8 Verify that primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operations are correct.

.9 Ensure that maintenance devices are available for servicing and operating breaker.

.10 Check for adequate lubrication on contact, moving, and sliding parts.

.11 Check condition of brushes and limit switches on charging and lifting motors.

.12 With Breaker in TEST Position:

.1 Trip and close breaker with control switch; and

.2 Trip breaker by manually operating each protective relay.

.13 Perform breaker travel and velocity analysis in accordance with Manufacturer's instructions; values shall be in accordance with Manufacturer's acceptable limits.

.14 Perform Insulation Resistance tests as described in this Section:

.1 Pole-to-pole and pole-to-ground with breaker contacts opened for one (1) minute.

.2 Pole-to-pole and pole-to-ground with breaker contacts closed for one (1) minute.

.3 Test values to comply with NETA ATS-(latest edition).

.15 Contact Resistance Tests:

.1 Contact resistance in microohms across each pole.

.2 Correct deviation of 50 percent or more from adjacent poles and similar breakers.

.16 Dielectric Withstand Tests:

.1 Maximum applied voltage for equipment in accordance with NETA ATS-(latest edition).

.2 Each pole-to-ground with other poles grounded and contacts closed.

.3 Test results evaluated on pass/fail basis.

.17 Minimum pickup voltage tests on trip and close coils.

.2 Molded Case:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.4 Verify the unit is clean. Clean as required.

.5 Operate the circuit breaker to insure smooth operation.

.6 Test all breakers utilizing the 'Push-to-Trip' button, if equipped.

.7 Move operating handle to the off and on positions.

.8 Inspect electrical connections for cables 4/0 and larger for high resistance.

.9 Perform an Insulation Resistance test for breakers with a frame size greater or equal to 250A, or as specified elsewhere in the Specification.

.10 Perform a contact/pole-resistance test.

.3 Vacuum:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition, including:

.1 Proper cell fit and element alignment.

.2 Proper operation of cubicle shutters and racking mechanism.

.3 Pull rod adjustment.

.4 Trip latch clearance.

.5 Overtravel stops.

.6 Wipe and gap setting.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports.

.4 Bolt torque level in accordance with Manufacturer's recommendations and NETA ATS (Latest edition). Where conical washers (Belleville or other) are used, coordinate with the applicable design engineer prior to tightening or applying pressure to connections.

.5 Verify the unit is clean. Clean as required.

.6 Perform breaker travel and velocity analysis in accordance with Manufacturer's instructions; values shall be in accordance with Manufacturer's acceptable limits.

.7 Check contact erosion indicators in accordance with Manufacturer's instructions.

.8 With Breaker in TEST Position:

.1 Trip and close breaker with control switch.

.2 Trip breaker by manually operating each protective relay.

.9 Perform breaker travel and velocity analysis in accordance with Manufacturer’s instructions; values shall be in accordance with Manufacturer’s acceptable limits.

.10 Perform Insulation Resistance tests as described in this Section:

.1 Pole-to-pole and pole-to-ground with breaker contacts opened for one (1) minute.

.2 Pole-to-pole and pole-to-ground with breaker contacts closed for one (1) minute.

.3 Test values to comply with NETA ATS (latest edition) Table 100.1.

.11 Contact Resistance Tests:

.1 Between the line and load stab of closed contact resistance in microohms across each pole.

.2 Correct deviation of 50 percent or more from adjacent poles and similar breakers.

.12 Dielectric Withstand Tests:

.1 Maximum applied voltage for equipment in accordance with NETA ATS- (latest edition).

.2 Each pole-to-ground with other poles grounded and contacts closed.

.3 Test results evaluated on pass/fail basis.

.13 Minimum pickup voltage tests on trip and close coils.

.8 Load Break Switches and Disconnects (all voltages):

.1 Check levelling of equipment.

.2 Verify condition of paint and finish, touch-up as required.

.3 Visually inspect completeness of equipment devices as per Manufacturer's Drawings.

.4 Verify removal of packing braces, shipping supports.

.5 Check connections to the ground grid.

.6 Check the tightness of field-made connections and terminations of the bus bars and feeders and tighten by torqueing as per Manufacturer's recommendations.

.7 Compare equipment nameplate data with Drawings and Specifications.

.8 Inspect physical and mechanical condition.

.9 Inspect anchorage and alignment.

.10 Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with the disconnect closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.11 Perform a dielectric withstand test on each breaker pole, phase-to-phase and phase-to-ground with the disconnect closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.12 Verify correct operation of any auxiliary features such as trip and pickup indicators, electrical close and trip operation, trip-free, and anti-pump function.

.13 Verify phasing.

.9 Automatic Transfer Switch:

.1 Record the equipment nameplate data and settings. Confirm information with Drawings and Specifications. Update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer’s and code requirements.

.4 Verify the unit is clean. Clean as required.

.5 Inspect electrical connections for high resistance.

.6 Check doors and panels for proper interlocking.

.7 Visually inspect and exercise transfer switch.

.8 Check positive mechanical and electrical interlock between normal and alternate sources.

.9 Check for proper operation of manual transfer function switch.

.10 Verify settings and operation of control devices.

.11 Perform Insulation Resistance tests as described in this Section:

.1 Test voltage shall be in accordance with Manufacturer’s published data.

.2 Pole-to-pole and pole-to-ground with switch closed in both source positions for 1 minute.

.3 Test values to comply with Manufacturer's published data or NETA ATS-(latest edition) Table 100.1.

.12 Contact Resistance Tests:

.1 Contact resistance in microohms across each contact for both source positions.

.2 Investigate values exceeding 100 microohms.

.3 Correct deviation of 50 percent or more from adjacent poles and similar switches.

.13 Set and Calibrate in accordance with Manufacturer's Specifications.

.14 Perform Automatic Transfer Tests by:

.1 Simulating loss of normal power.

.2 Return to normal power.

.3 Simulating loss of alternate power.

.15 Simulating single-phase conditions for normal and alternate sources.

.16 Monitor and Verify Operation and Timing of:

.1 Normal and alternate voltage sensing relays.

.2 Timing delay upon transfer and retransfer.

.3 Interlocks and limit switch functions.

.17 If power and/or control fuses are present, record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.

.10 Protective Relays:

.1 Record the equipment nameplate data and settings.

.2 Verify equipment and CT phasing and polarity is in accordance with design.

.3 Verify protective relay settings are according to setting sheets.

.4 Verify protective relay logic and I/O mapping are programmed according to design.

.5 Inspect and record physical and mechanical condition.

.6 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.7 Verify the unit is clean. Clean as required.

.8 Perform point-to-point checks of CT wiring from switchgears to protective relaying.

.9 Perform point-to-point checks of control wiring between protective relaying, auxiliary relays, switchgear, control panels and PLC.

.10 Verify functionality of trip, transfer and breaker fail functions.

.11 Perform primary current injection tests on all current transformers to verify operation of protective relaying.

.11 Metering:

.1 Current and potential injection to verify correct scales and accuracies.

.2 Perform tests and results on testing forms.

.12 Power supply and distribution circuits:

.1 Phasing of all primary circuits prior to energizing.

.13 CT circuits:

.1 Circuit continuity.

.2 Ensure that CT shorting bars are removed or installed as required.

.3 Circuit insulation (with grounds lifted).

.14 PT circuits:

.1 Circuit insulation (with grounds lifted).

.15 Surge Arrestors:

.1 Record the equipment nameplate data and settings. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer’s instructions and code requirements.

.4 Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

.5 Verify the unit is clean. Clean as required.

.6 Inspect bolted electrical connections for high resistance.

.7 Verify that arrestors are electrically connected in their specified configuration.

.8 Verify that stroke counter, if present, is correctly mounted and electrically connected.

.9 Perform Insulation Resistance tests as described in this Section:

.1 From each phase terminal to the case.

.10 Test the grounding connection. Resistance between the arrestor ground terminal and the ground system should be less than 0.5 ohms.

.16 Motor Starter Circuits:

.1 Record the equipment nameplate data, adjustable settings, size of overload, etc. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.4 Verify the unit is clean. Clean as required.

.5 Inspect contactors for evidence of overheating or stress.

.6 Visually inspect and exercise circuit breaker.

.7 If power fuses are present record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.

.8 Perform Insulation Resistance test.

.9 Perform Contact/Pole resistance test.

.17 Harmonics:

.1 Connect to existing CTs and PTs if provided. If not provided, supply appropriate CTs and PTs as required.

.2 Test duration at each location is to be one hour.

.3 Coordinate with Operations Personnel to ensure the loads run during the test are representative of normal and maximum plant operation.

.4 Monitor the following for all three phases:

.1 Voltage, current and power factor.

.2 Harmonic voltage for 1st (base) through 15th harmonics.

.3 Harmonic current for 1st (base) through 15th harmonics, expressed in percent of current.

.4 Total harmonic distortion (THD).

.5 Record sample at one (1) minute intervals.

.6 Provide MS Excel files of the test results.

.7 Provide a summary Page in the report indicating the THD and maximum, average and minimum for each voltage and current harmonic.

.18 Low voltage switchgear and circuit breakers:

.1 Check levelling of equipment.

.2 Verify condition of paint and finish, touch-up as required.

.3 Check proper bolted or welded connections to the floor, wall and steel supports.

.4 Visually inspect completeness of equipment devices as per Manufacturer's Drawings.

.5 Verify removal of packing braces and shipping supports.

.6 Check connections to the ground grid.

.7 Check cleanliness of the enclosure; clean all equipment by vacuum machine.

.8 Check the tightness of field made connections and terminations of the bus bars and feeders and tighten by torquing as per Manufacturer's recommendations.

.9 Compare equipment nameplate data with Drawings and Specifications.

.10 Inspect physical and mechanical condition.

.11 Inspect anchorage and alignment.

.12 Perform point-to-point checks of control wiring.

.13 Operate the circuit breaker to ensure smooth operation.

.14 Perform insulation-resistance tests on each breaker pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.15 Perform insulation-resistance tests on each disconnect pole, phase-to-phase and phase-to-ground with the disconnect switch closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.16 Perform a dielectric withstand test on each breaker pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole for one minute. Test voltage shall be in accordance with Manufacturer's published data.

.17 Verify correct operation of any auxiliary features such as trip and pickup indicators, electrical close and trip operation, trip-free, and anti-pump function.

.18 Test and commission the switchgear and associated interlocks.

.19 Use switchgear testing and programming device to ensure its functionality.

.20 Test all physical operations of the switchgear including all racking and testing of any maintenance positions.

.21 Verify phasing.

.19 Panel boards:

.1 Record the equipment nameplate data. Record breaker data on Test and Inspection Form. Confirm information with design and update Drawings as necessary.

.2 Inspect and record physical and mechanical condition.

.3 Inspect installation, alignment, grounding, required area clearances and conductor connections and supports. Torque all connections as per Manufacturer's instructions and code requirements.

.4 Verify the unit is clean, free of all dirt filings and other debris. Clean as required.

.5 Verify that circuit breaker sizes and types correspond to Drawings. Test according to Molded Case Circuit Breakers.

.6 Confirm correct operation and sequencing of mechanical interlock systems.

.7 Inspect insulators for evidence of physical damage or contaminated surfaces.

.8 Exercise all active components.

.9 Verify proper phasing.

.10 Perform Insulation Resistance Tests on each bus phase with all other phases grounded:

.1 The main breaker, if present, is to be open for the test.

.2 If no main breaker is present, disconnect the supply conductors.

.3 Open all load breakers.

.20 Variable Frequency Drives (VFD):

.1 Complete factory data in testing forms with all VFD setting parameters.

.2 Conduct tests and record information listed in testing forms and provide certification from the VFD Manufacturer that the VFD equipment has been properly installed and tested.

.1 Verify continuity of wiring.

.2 Verify correctness of operation of all controls, interlocks.

.3 Adjust all set points, minimum frequency, maximum frequency, acceleration time, deceleration time, output current, constant speed, for each VFD based on the process requirements.

.4 Confirm that moving and working parts are lubricated.

.5 Functional testing of each VFD system to applicable CSA and IEEE standards, with the motor connected.

.3 Operate the AC drive and motor (not coupled) in manual mode. Confirm satisfactory operation in accordance with the Manufacturer's instructions.

.4 Operate the AC drive and motor (coupled) in automatic mode. Confirm satisfactory operation and control.

.5 Confirm installation conforms to the requirements of the testing forms.

.6 Check for proper phase rotation.

.7 Check for correctness and continuity of all external control wiring, vendor package equipment connections, field connections and motor heater connections.

.8 Check for continuity of RTD circuits inside motor by measuring at the motor terminal box the resistance of each RTD. Resistance should be approximately 100 ohms.

.21 AC Motors:

.1 Record and conduct tests listed in the testing forms.

.2 Check for proper lubrication.

.3 Checks for proper direction of rotation, verify correct rotation, and correct if needed.

.4 Check for vibration and excessive noise.

.5 Measure the insulation resistance of all motors before they are connected. Motors 37 kW and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistances less than 10 megohms shall not be permitted.

.6 With the incoming feeder cable disconnected, with all feeder switches and motor starters racked in, or connected, with all feeder switches and motor starter contactors open and with ground detector and voltmeter fuses removed, Megger between phases and each phase to ground. Megger readings to be 10 megohms or higher.

.7 With the load end of each cable connected to the motor and with the contactor or switch open, Megger the outgoing feeder cables and motor windings to ground by connecting the Megger to the load side terminals. Test/record one phase on motor starters, all three phases on fused switch feeder units. Megger readings to be 5 megohms or higher.

.22 Grounding System:

.1 Conduct tests and record information listed testing forms and:

.1 Inspect thoroughly to ensure that ground connections are clean and properly secured to equipment and building steel.

.2 Inspect ground conductors to ensure that they have not been damaged due to construction work.

.3 Inspect physical and mechanical condition.

.4 Inspect bolted electrical condition for high resistance.

.5 Perform resistance tests between the main grounding electrode and grounded points in the electrical system, including, but not limited to switchgear, transformers, and MCCs. Investigate connections with a resistance greater than 0.5 milliohms.

.6 Perform resistance tests between the lightning protection terminals (at roof level) and the grounding electrode. Investigate and correct connections with a resistance greater than 0.5 milliohms.

.23 Manufacturer Calibration and Verification:

.1 Description:

.1 Calibrate and verify the following equipment:

.1 Primary switchgear.

.2 Medium voltage distribution.

.3 600 V switchgears, MCCs, and panel boards.

.2 The calibration and verification to be carried out in the field after installation and connection of equipment, but prior to energizing.

.2 Calibration and Verification:

.1 The calibration and verification to be carried out in the following stages:

.1 Primary switchgear.

.2 Power distribution transformers.

.3 Secondary switchgear.

.4 MCCs.

.5 Power factor correction equipment.

.6 VFDs.

.2 Verify:

.1 That all equipment is installed, connected and cleaned inside and out.

.2 That the specified tests have been carried out.

.3 The electrical rooms are cleaned and are adequately illuminated and heated.

.3 Provide:

.1 120 V power for test purposes.

.2 A qualified professional to assist in the calibration and verification.

.3 All other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.4 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and overall coordination scheme. Field set each relay according to the recommended settings.

.5 Verify all transformer ratios, insulation resistance values, fuse sizes, current transformer (CT) and potential transformer (PT) ratios and certify that the installation is in accordance with the requirements of the Manufacturer and the power study model.

.6 Carry out the tests required for calibration and verification as specified in the related Sections.

.7 All bus and cable connections shall be tightened to Manufacturer's Specifications.

.8 Clean all relays with dry, dust-free compressed air.

3.2 Equipment Checkout

.1 Pre-Installation:

.1 Perform all Factory Acceptance Testing as indicated in the Design and Construction Specifications.

.2 Submit copies of all shop and factory tests data and interpreted results.

.3 Conduct additional pre-installation testing as recommended by the equipment Manufacturer.

.2 Pre-Energizing:

.1 Coordinate, demonstrate, complete and verify satisfaction of the pre-operational checkout requirements in Design Builder’s Design.

.2 Conduct pre-operational testing as recommended by the equipment supplier and Manufacturer.

.3 Perform the following additional pre-operational checks and tests:

.1 Inspect all installed equipment prior to energization.

.2 Inspect all equipment for damaged parts.

.3 Complete installation of the equipment in accordance with Manufacturer's requirements.

.4 Verify all settings, adjustments of the system are correct.

.5 Verify all control devices are correctly installed.

.6 Verify all materials, tools, instruments, and other components required for testing are readily available.

.7 Verify all equipment certifications and factory test reports have been gathered.

.4 Pre-functional checkout.

.1 Prior to Functional Testing, adjust and make operational all protective devices. Prior to energizing equipment, perform all Equipment Checkout activities of the control circuit consisting of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Submit a description of the proposed test procedures prior to the performance of all Equipment Checkout activities.

.2 Verify that motors are connected to rotate in the correct direction by momentarily energizing the motor. Verify that both the motor and the driven equipment will not be damaged by reverse operation. Co-ordinate motor rotation check prior to Equipment Checkout Completion.

.3 Checkout Tags

.1 Upon receipt of equipment, attach a "Check-Out Tag" to each piece of equipment that has a designated Tag or equipment number assigned.

.2 On completion of each phase of the installation, enter the appropriate information on the tag, including the test results or make cross-reference to appropriate test forms.

.3 Provide electrical checkout tags and instrument checkout per City standard.

3.3 Functional Testing

.1 Prior to Functional Testing, all electrical checkout testing, adjustment and calibration requirements shall be complete and all appropriate data shall be completed.

.2 During functional testing, confirm that all electrical checkout testing data forms are re-verified with equipment under normal operating conditions (equipment is not running).

.3 Perform the Functional Testing activities as defined below:

.1 Update and verify the Power Study Model of the Facility with normal process loads. Re-verify and update all overcurrent device settings based on the latest Power Study Model.

.2 Program, verify and test all sequences of operations of the load-shedding system by the PCS.

.3 Program, verify and test all modes of operation of the Power Distribution (PFC 80).

.4 Program, verify and test the load transfer equipment switching between sources (utility to generator) in all sequences of operation including black plant, cold generator start-up, ride through, maintenance conditions with open and closed transitioning.

.5 Provide the arc flash study and provide all equipment labelling requirements.

.4 Power Factor Testing (equipment is not running):

.1 Record power factor readings at fifteen (15) minute intervals for full twenty-four (24) hour period during normal operation of the facility.

.2 Take reading at following locations on distribution system:

.1 Main Service.

.2 Area Switchgears.

.3 MCCs.

3.4 Operational Testing

.1 Prior to Operational Testing, ensure that all electrical testing, adjustment and calibration requirements for Functional Testing are complete.

.2 Perform the operational testing activities as defined below:

.1 Re-verify all normal operating power loads and overcurrent device settings are correct.

.2 Provide adjustments to any circuit breakers and relay trip units if required during operational testing phase.

.3 Re-verify and complete the Power Study Model for the electrical system based on normal operating conditions.

END OF SECTION

ELECTRICAL FIRESTOPPING

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of firestop systems for conduit, cable and cable tray at floor, wall, and ceiling penetrations.

.2 A firestop system (fire stop) refers to a specific construction consisting of:

- .1 Any device intended to close off an opening or penetration during a fire.
- .2 Material(s) that fill an opening in a wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes along with their means of support through the wall or floor opening.
- .3 Material(s) that fill an opening in a wall assembly where penetration is by electrical and non-electrical outlet boxes along with their means of support in the wall assembly.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .2 ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- .3 ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
- .4 ASTM E1399, Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
- .5 ASTM E1966, Standard Test Method for Fire-Resistive Joint Systems.
- .6 ASTM E2174, Standard Practice for On-Site Inspection of Installed Firestop Systems.
- .7 ASTM E2307, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus.
- .8 ASTM E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- .9 ASTM E2750, Standard Guide for Extension of Data from Penetration Firestop System Tests Conducted in Accordance with ASTM E814.
- .10 ASTM E2837, Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- .11 ASTM E3038, Standard Practice for Assessing and Qualifying Candidates as Inspectors of Firestop Systems and Fire-Resistive Joint Systems.

.12 ASTM C1241, Standard Test Method for Volume Shrinkage of Latex Sealants During Cure.

.13 ASTM D3960, Standard Practice for Determining Volatile Organic Compound (VOC) Contents of Paints and Related Coatings.

.14 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.2 Canadian Standards Association (CSA):

.1 C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

.3 Underwriters Laboratories Canada (cUL):

.1 CAN/ULC-S101, Standard Method of Fire Endurance Tests of Building Construction and Materials.

.2 CAN/ULC-S102, Standard Test Method for Surface Burning Characteristics of Building Materials and assemblies.

.3 CAN/ULC-S115, Standard Method of Fire Tests of Firestop Systems.

.4 263, Fire Tests of Building Construction and Materials.

.5 723, Test for Surface Burning Characteristics of Building Materials.

.6 1479, Fire Tests of Penetration Firestops.

.7 2079, Tests for Fire Resistance of Building Joint Systems.

.4 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.5 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals, 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature including material safety data sheets for each material supplied. Firestop materials shall be compatible with the cable jackets, conduit and/or cable tray material, and other electrical hardware. Chemical incompatibility, galvanic action, or other corrosive by-product is not acceptable.

.2 Includes reference and literature outlining the “F” flame occurrence for flame passage restriction. Includes reference and literature outlining the penetration firestop, fire resistive joint system and perimeter containment system within or at the perimeter of smoke barriers with the appropriate “L” or air leakage rating. Includes reference and literature outlining the resistance to growth of organic material.

.3 The Manufacturer provided “Engineering Judgement” specific to the wall/ceiling/floor penetration and associated cabling system with material ratings specific to the Canadian Market (i.e.. CSA certificate or cUL listing). In Hazardous locations the firestop methods and materials shall include Classified ratings for use in Canada.

.4 Includes the contractor(s) qualifications for installation of firestop systems, the “ULc Qualified Firestop Contractor”, with experience inspecting completely installed systems to ASTM E2174, ASTM E2393, and CAN/ULC S115.a

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide firestop materials from a single Manufacturer.

.2 Acceptable Manufacturers

.1 Fire Stop Systems Inc. – Thermalastic 83.

.2 Thomas & Betts – Flamesafe coating.

.3 Vimasco – No. 1A coating.

.4 Hilti.

.5 Or approved equal.

2.2 Materials

.1 Catalogue numbers provided to specify features and grade of quality of the cable tray system.

.2 Acceptable Products for penetrations include:

.1 Hilti FS 657 Fire Block.

.2 Hilti CP 620 Fire Foam.

.3 Hilti CP 675-T Firestop Board.

.4 Hilti FS-ONE Intumescent Firestop Sealant.

.5 Or approved equal.

2.3 Identification

.1 Provide firestopping labelling at each penetration with applicable Manufacturers label.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Preparation:

 .1 Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.

  .1 Verify penetrations are properly sized and in suitable condition for application of materials.

  .2 Surfaces to which firestop materials is to be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

  .3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

  .4 Comply with Manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

.3 Manufacturer's instructions: Comply with Manufacturer's instructions for installation of through-penetration materials.

.4 Installation of fire blocks:

 .1 Install wire mesh on one side of the penetration to support the fire block installation.

 .2 Build up the fire blocks within the penetration firmly seated. Cut the fire blocks with a knife to suit the places penetrations.

 .3 Finish building up the fire blocks until the entire until the entire opening is filled.

 .4 Completely fill cable spaces and gaps between blocks and joints with firestop sealant.

.5 All installed firestop systems shall be inspected in compliance with ASTM E2174, ASTM E2393 and requirements by other divisions. The completed report shall be provided to the Contract Administrator for their review and records.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Provide the Facility ground system in accordance with Appendix 18K – Studies and Models, the requirements of all related sections in the latest Manitoba Electrical Protection Act, and the local Electrical Inspection Branch.

.2 The system to consist of cables, ground rods, supports, ground plates, ground-enhancing material, and all other necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 Ground/bond switchgear, panel boards, transformers, UPS, and other equipment to the Facility ground system.

.4 Ground/bond all cable tray systems to the Facility ground system.

.5 Establish a continuous ground plane of all metallic components to a common point on each skid package (or identify the equipment i.e., VFD) to facilitate bonding to ground.

.6 The work shall be completed in accordance with Electrical General Requirements spec Section 16010.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

  .1 B3, Standard Specification for Soft or Annealed Copper Wire.

  .2 B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

  .3 B33, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

.2 Canadian Standards Association (CSA):

  .1 C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

  .2 C22.3 No. 3, Electrical Coordination.

  .3 C22.2 No. 27, Busways (Tri-national standard with UL-857 and NMX-J-148-ANCE).

  .4 C22.2 No. 41, Grounding and Bonding Equipment (Trinational standard with NMX-J-590-ANCE and UL 467).

  .5 B72, Installation Code for Lightning Protection Systems.

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 P81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

.2 80, Guide for Safety in AC Substation Grounding.

.3 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.

.4 3002.3, Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems.

.5 3003.1, Recommended Practice for System Grounding of Industrial and Commercial Power Systems.

.6 3003.2, Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems.

.4 National Fire Protection Association (NFPA):

.1 780, Lightning Protection Code.

.5 Underwriter Laboratories Canada (cUL).

.6 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Operating and Maintenance Data: Provide with the related item of process equipment for incorporation in operation and maintenance manual.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Burndy.

.2 Slacan.

.3 Hydel.

.4 Erico.

.5 Thomas & Betts (Eaton).

.6 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Coordinate the design for the grounding system with Section 16293 – Lightning Protection for Structures.

.2 Ground Electrodes:

.1 Ground rod electrodes: copper clad steel, 19 mm dia. by 3 m long.

.2 Ground plate electrode: copper surface area minimum 0.2 m^2, 1.5 mm thick.

.3 Provide polymer ground inspection well with each electrode.

.4 Make grounding connections to ground grid, ground plates and the plant wide grounding system.

.5 Install ground connection to the structure foundation (ufer ground) and connect to rebar in two perpendicular locations. Install ufer grounding in at least two locations of the building (minimum 20 m of #2/0 Cu wire) in the bottom 50 mm of the structure (slab or foundation footing).

.6 Install ground rod at each set of manholes (instrumentation and power) for U/G duct systems. Make grounding connections to pull box covers and cable racks and the plant wide grounding system.

.7 Make special provision for installing electrodes that will give recommended resistance to ground value, where rock terrain prevails (less than 5 ohms).

.8 Acceptable Products:

.1 Slacan cat. #22109, for non-vehicular locations,

.2 Dobney MR-8-12 and MR-8L for vehicular locations, or

.3 A.E. Concrete cat. #3-RT, for vehicular locations,

.4 Or approved equivalent.

.3 Ground Conductor:

.1 Stranded, soft annealed copper wire, size 4/0 AWG shall be bare wire for electrode interconnections, underground site ground wire, and PVC-insulated coloured green for transformers, MCCs, cable tray, metal structures, and switchgear.

.2 PVC insulated coloured green, CSA FT4 rated for indoors, CSA FT1 rated for outdoors, stranded untinned soft annealed copper conductor for grounding motor frames where specified. Size of ground conductor shall be as specified.

.3 Conductors: 4/0 AWG and 2/0 AWG extra flexible (425 strands) copper conductor for connection of fence gates and building doors.

.4 PVC insulated coloured green, stranded untinned soft annealed copper wire 10 AWG for grounding meter and relay cases.

.5 Ground conductor shall be bare where installed inside equipment enclosures.

.6 Where installed outside of enclosures, ground conductors shall be 600 V rating, PVC-insulated coloured green, for corrosion protection. Ground cable insulation to be RW-90 type with CSA class FT4 flame test rating.

.7 For Skid mounted equipment, all ground conductors to be stranded copper TWH complete with a green jacket unless otherwise required by the Final Design.

.8 CAD welded connections.

.4 Ground Connections:

.1 Provide Burndy Hyground (or approved equivalent) compression connections, conductor to conductor, conductor to rods.

.2 Bolted removable test links to permit isolation from electrodes and grounding bus.

.3 Use approved mechanical connector, conductor to rebar and conductor to equipment.

.4 Non-corroding accessories necessary for complete grounding system, type, size material including:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Compression type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

.5 Grounding connection to building structure, metal columns or beams, compressed to metal; BURNDY TMHG or YGIBW (or approved equivalent), sized to the metal structure available.

.6 Grounding connection to building structure, metal columns or beams welded to metal structure; BURNDY GSTUD-HY or approved equivalent.

.5 Ground Conductor – Conduits and Ducts:

.1 Provide appropriately sized stranded copper ground conductor in all conduits and ducts except primary service ducts, and telephone service duct.

.6 Ground Bus:

.1 Provide ground bus, copper, size as indicated in the Final Design, complete with insulated supports, fastenings and connectors.

.2 Wall mounted main ground bus bars on insulated stand-offs for grounding lighting and control distribution transformers, miscellaneous and future electrical equipment in Electrical Room.

.3 Wall mounted telecommunications main ground bus bars on insulated stand-offs for grounding telephone board, communications equipment cabinets and racks, marshalling panels and main control panel, miscellaneous and future installed equipment in control room.

.4 Provide a solid copper ground bus, complete with insulated supports, fastenings and connectors on each skid package (or identify the equipment i.e., VFD) to ground all skid mounted equipment (or identify the equipment i.e., VFD).

.5 Install dedicated ground system for instrumentation and isolate from the plant wide grounding system and building metal. Make grounding connections to wall mounted ground bus bars on insulated stand-offs with a #6 green Cu cable.

.6 Provide dedicated ground bus for Facility automation system. Provide a dedicated ground bar placard labelled with “FOR PLANT CONTROLS ONLY”.

.1 Located ground bar for automation system by automation system equipment.

.2 Dedicated ground bar shall have a direct electrical connection the Facility ground grid and will not share connection bond with electrical equipment.

.3 Copper equipment ground bars Acceptable Product:

.1 Erico Eritech EGBA sized.

.2 Or approved equivalent.

.4 Equipment ground plates to be two-hole copper flush mounted ground plate. Acceptable Product:

.1 Erico Cadweld YGF series.

.2 Or approved equivalent.

.7 Air Terminals:

.1 Copper solid rod with blunt tip.

.2 28 strand, 0.0865” strands, copper conductor.

.3 Fastenings and attachment straps: copper.

.4 Electrodes: same as grounding system.

.5 Connections: bronze copper connections formed by compression connectors to ANSI/IEEE 837 with provision for inspection at polymer ground inspection well.

.6 Connections: Where possible, all connections are to be formed by exothermic weld process. For copper connections, exothermic weld connections are required. For Aluminum connections, use compression connections, as exothermic welds are not readily available.

2.3 Identification

.1 Provide cable tags to all above grade ground cabling.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Coordinate the installation for the grounding system with Section 16293 – Lightning Protection for Structures.

.3 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.4 Provide all ground connections to AC grounding systems including, conductors, connectors, and accessories in accordance with references noted above and requirements of the Governing Authority.

.5 Protect exposed grounding conductors from mechanical injury and corrosion.

.6 Make buried connections using cad weld, and connections to electrodes and structural steel work using copper compression, and compression connectors to ANSI/ IEEE 837 Connections to electrodes, fencing and structural steel work using compression type connectors.

.7 Use mechanical connectors for grounding connections to equipment provided with lugs. Cadweld connections shall not be permitted.

.8 Use 4/0 AWG bare copper cable main ground grid and for taps on risers from main ground grid to building structure and equipment.

.9 Use tinned copper connectors for aluminum structures.

.10 The ground systems shall consist of #4/0 copper conductor loops surrounding the buildings, ground rods, connections to the building rebar and steel.

.11 Install a 4/0 AWG copper conductor with underground duct bank.

.12 Install cable tags on ground conductors, except for ground conductors in cable trays. Ground conductors exiting cable trays will require cable tags.

.13 Metallic conduit systems shall be bonded to ground.

3.2 Connections

.1 Use Penetrox "E" joint compound (or approved equivalent) on all connections.

.2 Make connections with Burndy Hyground compression fittings or approved equivalent.

.3 Bond all non-current carrying metal parts of electrical equipment.

3.3 Branch Circuit Grounding Conductor

.1 Install ground conductors in all conduit and wire systems.

.2 Where Teck cable is used, its ground conductor shall be properly terminated at each end.

3.4 Equipment

.1 Install grounding connections to equipment included in, but not necessarily limited to the following list:

  .1 Service equipment.

  .2 Frames of motors.

  .3 MCCs.

  .4 Transformers.

  .5 Control panels.

  .6 Cable trays.

  .7 Distribution panels.

  .8 All metallic equipment and piping in hazardous locations.

  .9 All metallic equipment, metallic stairways, and hand railing for tanks in process areas.

.2 Provide 2/0 AWG copper grounding jumpers and bonding connectors where tray runs are not continuous. Bond tray to continuous ground conductor at each end of the tray run, at each side of bends, and at maximum 15 m intervals and at each intervening tray joint(s). Bond on either side of a connection plate.

.3 Protect exposed grounding conductors from mechanical damage.

3.5 Neutral Grounding

.1 Provide neutral-ground connections where required for solidly grounded systems and make connections to neutral grounding resistors for resistance grounded systems.

3.6 Field Quality Control

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

.3 Ensure that final resistance of interconnected ground system is 5 ohms, or less.

  .1 Ground resistance and counterpoise tests must be made during dry weather and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.

  .2 Complete grounding testing and validations prior to backfill. Provide additional ground electrodes and conductor as required to meet the grounding requirements.

.4 Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

.5 Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

.6 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Engineer and local authority having jurisdiction over installation.

.7 Temporary disconnect the two grounding conductors between the facility ground busbar and the facilities underground grounding system. Reconnect when testing is complete.

.8 Mark on the drawings clarifying ground rod(s) where the testing took place (i.e., Gridline X and Gridline X).

.9 Optional Method 1 – The 4-pole Earth Resistance Test:

  .1 On the markup drawing, include the Testing instrument electrode names and distance between them.

  .2 Place auxiliary grounding electrodes in accordance with instrument Manufacturer's recommendations but not less than 50 feet (15 m) apart, in accordance with IEEE Standard 81.

.10 Optional Method 2 – The Induced Frequency Method (Radio method):

  .1 If proceeding with this method, ensure a minimum of 4 ground rods are checked (i.e., at each corner of the grid or facility).

.2 Measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.

.11 Perform tests before energizing electrical system.

.12 Disconnect ground fault indicator during tests.

.13 Submit all ground continuity and resistance test results and markup sheets within three (3) days of field tests, and prior to commissioning activities to Contract Administrator for review.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies conduits for electrical conductors including fittings and supports, collectively called raceways. The material of the conduit must meet the requirements of the area classification.

.2 Provide a complete system of raceways for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems.

.3 Design equipment anchorage and support system for vertical and lateral loading in accordance with the MBC.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 B137.1 Polyethylene (PE) Pipe, Tubing, and Fittings for Cold Water Pressure Services.

.2 C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

.3 C22.2 No. 18.1, Metallic Outlet Boxes.

.4 C22.2 No. 18.2, Non-metallic Outlet Boxes.

.5 C22.2 No. 18.3, Conduit, Tubing, and Cable Fittings.

.6 C22.2 No. 18.4, Hardware for the Support of Conduit, Tubing, and Cable.

.7 C22.2 No. 18.5, Positioning Devices.

.8 C22.2 No. 25, Enclosures for use in Class II, Division 1, Group E, F, and G Hazardous Locations.

.9 C22.2 No. 30, Explosion-proof Equipment.

.10 C22.2 No. 45.1, Electrical Rigid Metal Conduit – Steel.

.11 C22.2 No. 45.2, Electrical Rigid Metal Conduit — Aluminum, Red Brass, and Stainless Steel.

.12 C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.13 C22.2 No. 83, Electrical Metallic Tubing (EMT).

.14 C22.2 No. 83.1, Electrical Metallic Tubing – Steel (Tri-national Standard, with NMX-J-536-ANCE and UL 797).

.15 C22.2 No. 85, Rigid PVC Boxes and Fittings.

.16 C22.2 No. 211.1, Rigid Types EB1 and DB2/ES2 PVC Conduit.

.17 C22.2 No. 211.2, Rigid PVC (unplasticized) Conduit.

.18 C22.2 No. 211.3, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National standard with UL-1684).

.19 C22.2 No. 227.1, Electrical Nonmetallic Tubing (Binational Standard with UL 1653).

.20 C22.2 No. 227.2.1, Liquid-tight Flexible Nonmetallic Conduit (Trinational Standard with NMX-J-ANCE and UL 1660).

.21 C22.2 No. 227.3, Mechanical Protection Tubing (MPT) and Fittings (Tri-national standard with NMX-J-855-ANCE and UL-1696).

.22 C22.2 No. 327, HDPE Conduit, Conductors-in-conduit, and Fittings.

.23 C22.2 No. 2515, Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Binational Standard with UL 2515).

.2 Underwriter Laboratories Canada (cUL):

.1 514B, Standard for Conduit, Tubing, and Cable Fittings.

.3 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.4 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit written certification from a Professional Engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment are structurally sound and have been designed according to requirements of the WBB.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Catalogue numbers specified are for illustrating features and to establish the grade of quality of the materials specified in this Section and are taken from one Manufacturer's product line.

2.2 Configuration, Components and Features

.1 Conduit Systems:

.1 Select conduit type in accordance with *WWD Electrical Design Guide*.

<table>
<tr><th>Location</th><th>Application/Condition</th><th>Race spec</th></tr>
<tr><td rowspan="6">Indoor Dry
(Non-process Areas, Architecturally Finished and Office Areas)</td><td>Concealed (framed walls and ceiling spaces –lighting and receptacle circuits only)</td><td>EMT</td></tr>
<tr><td>Concealed (concrete, concrete block, masonry)</td><td>RPVC</td></tr>
<tr><td>Exposed</td><td>RA</td></tr>
<tr><td>Specialized Instrumentation</td><td>RA*</td></tr>
<tr><td>Final connection to equipment and light fixtures</td><td>FLMC</td></tr>
<tr><td>Final connection to suspended fluorescent fixtures only</td><td>FLMC</td></tr>
<tr><td rowspan="2">Dry and wet Indoor and outdoor areas
(General Process)</td><td>Exposed</td><td>RA</td></tr>
<tr><td>Final connection to equipment</td><td>FLMC</td></tr>
<tr><td rowspan="2">Buried All non-hazardous areas</td><td>Embedder in concrete structure or beneath slab on grade, direct buried duct bank</td><td>RPVC</td></tr>
<tr><td>Concrete encased duct bank</td><td>DB2</td></tr>
<tr><td rowspan="2">Process Corrosive, head space and chemical corrosive</td><td>Exposed</td><td>PRA</td></tr>
<tr><td>Final connection to equipment</td><td>FLMC*</td></tr>
<tr><td rowspan="2">Hazardous, non-corrosive areas
(Process corrosive head space, chemical corrosive)</td><td>Exposed</td><td>RA</td></tr>
<tr><td>Final connection to equipment</td><td>FXp*</td></tr>
<tr><td rowspan="2">Hazardous and corrosive areas
(Process corrosive, head space, chemical corrosive)</td><td>Exposed</td><td>PRA</td></tr>
<tr><td>Final connection to equipment</td><td>FXP*</td></tr>
</table>

.2 Conduit Fastening and Supports:

.1 Support groups of conduits with framing channel with end caps and straps for three or more conduits.

.2 Suspended raceway supports shall consist of concrete inserts, steel rod hangers, and jamb nuts supporting framing channel or lay-in pipe hangers. Suspended raceway supports and racks to be seismically designed and braced as specified herein.

.3 Beam clamps to secure conduits to exposed steel work.

.4 Acceptable Manufacturers:

.1 Atkore.

.2 Emerson Industrial Automation.

.3 Calpipe Industries Inc.

.4 ABB Thomas & Betts.

.5 Or approved equivalent.

.3 Pull Cords:

.1 Pulling rope shall be a minimum 6 mm polypropylene type, mildew and rot resistant with minimum tensile strength of 5kN. Install in all raceways identified as future or spare.

.4 Fire Barriers:

.1 To be compatible with coating or jacketing of raceways and cables.

.2 To be re-enterable, for installation of additional raceways or cables.

.3 Fire rating of barrier to match that of the required separation.

.4 Products which are affected by water are not permitted.

.5 Refer to Section 16055 Electrical Firestopping, and Section 07800 Fire and Smoke Protection for further requirements.

.5 Hazardous Locations Conduit Seals:

.1 Material to match installed conduit, rigid aluminum or PVC coated rigid aluminum.

.2 Select and size fittings for conduit fill and alignment, EYS or EZS type.

.3 Sealing compound shall be installed after the conductors are installed, tested, and reviewed by the Engineer of Record.

.4 Acceptable Manufacturers:

.1 Eaton Crouse-Hinds.

.2 Emerson Industrial Automation, Appleton, O-Z Gedney.

.3 Or approved equivalent.

.6 Conduit Cable Seals:

.1 Provide conduit cable sealing bushings with double grommets for cable in below grade conduit penetrations into basements and galleries or other below grade dry locations for

53 mm and larger conduits. Install blank unit fittings in all spares including other unused conduits at these locations.

.1 Acceptable Products:

.1 Emerson Industrial Automation O-Z Gedney Type CSM.

.2 Or approved equivalent.

.2 Provide foam type sealant for non-metal-clad cable in any conduit size and for metal-clad cable in conduit less than 53 mm in below-grade conduit penetrations into basements and galleries, including other below grade dry locations.

.1 Acceptable Products:

.1 Dura-line Hydra-Seal S-60.

.2 PRC-DeSoto/Semco PR-821 sealant.

.3 Or approved equivalent.

.3 Provide heat shrink watertight cable breaks out seals for outdoor exposed cable entries from conduits.

.1 Acceptable Manufacturers:

.1 Tyco Electronics Raychem.

.2 3M.

.3 ABB Thomas & Betts.

.4 Or approved equivalent.

.7 Conduit Penetration Seal:

.1 Provide a watertight seal wherever conduits penetrate outdoor concrete walls, penetrate ceilings, or penetrate through a cast-in-place concrete below grade.

.1 Acceptable Products:

.1 Emerson Industrial Automation O-Z/Gedney Co., Type FSK.

.2 Or approved equivalent.

2.3 Raceway Specification

.1 Raceway Identification: COM D.

Description:	Communication duct.
Compliance:	Manitoba Telephone System requirements.
Construction:	PVC duct.
Minimum Size:	25 mm
Fittings and Accessories:	Same as RPVC for 25 mm duct.
	Same as DB2 for 50 mm and larger ducts.

.2 Raceway Identification: DB2.

Description:	PVC conduit, Type 2.
Compliance:	CSA C22.2 No. 211.1
Application:	Concrete encased.
Construction:	Rigid non-metallic conduit made of polyvinylchloride (PVC).
Minimum Size:	50 mm
Acceptable Manufacturers:	Royal, Ipex
	Or approved equivalent.
Fittings, Boxes, and Accessories:	PVC solvent weld-type.
	Manufactured spacers where used in an encased conduit bank.
	Manufactured adapters for connection to other types of raceways.

.3 Raceway Identification: EMT.

Description:	Electrical metallic tubing
Compliance:	CSA C22.2 - No. 83.1
Finish:	Electro-galvanized steel, inside coating for ease of conductor pulling.
Minimum Size:	25 mm
Acceptable Manufacturers:	JMC Wheatland Tube, Atkore Columbia-MBF.
	Or approved equivalent.
Fittings, Boxes, and Accessories:	Steel compression connectors. Straps 1-hole steel. Electro-galvanized pressed sheet steel utility boxes.
	Acceptable Manufacturers: Thomas & Betts
	Or approved equivalent.

.4 Raceway Identification: LFMC.

Description:	Liquid tight flexible steel conduit.
Compliance:	CSA C22.2 - No. 56
Application:	Final connection to equipment subject to vibration or equipment/instrument adjustments, use with rigid conduit.
Construction:	Spirally wound galvanized flat steel strip with successive convolutions securely interlocked and jacketed with liquid tight polyethylene cover.
Acceptable Manufacturers:	Electri-flex Liquatite, Atkore AFC Cable Systems.
	Or approved equivalent.
Fittings:	Steel or malleable iron body and gland nut with Dura-Plate finish, with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat.
	Use 45- and 90-degree insulated fittings.
	Acceptable Manufacturers: Thomas & Betts, Appleton.
	Or approved equivalent.
Installation:	Except as otherwise specified, the length of flexible liquid tight conduit shall not exceed 20 times the trade diameter of the conduit, to a maximum of 600 mm.

.5 Raceway Identification: FMC.

Description:	Flexible aluminum conduit
Compliance:	CSA C22.2 - No. 56
Application:	Final connection to suspended fluorescent fixtures in indoor office areas for use with EMT.
Construction:	Spirally wound aluminum strip with successive convolutions securely interlocked.
Acceptable Manufacturers:	Electri-flex Liquatite, Atkore AFC Cable Systems.
	Or approved equivalent.
Fittings:	Insulated-throat type.

.6 Raceway Identification: FXP.

Description:	Flexible metal conduit, explosion-proof.
Compliance:	Suitable for use in Class I, Zone 0, Zone 1 and Zone 2 hazardous locations.
	CSA C22.2 - No. 25
	CSA C22.2 - No. 30
Application:	Used for final connections to motors and other equipment subject to vibration or adjustment in Class I, Zone 0, Zone 1 and Zone 2 hazardous locations.
Construction	Materials shall be chosen for the environment for which they are installed, the gases that may be present, and for the prevention of corrosive action. Outer bronze or stainless steel braid, inner brass or stainless steel core with insulating liner.
Acceptable Manufacturers:	Emerson Industrial Automation Appleton, Eaton Crouse-Hinds
	Or approved equivalent.
Installation:	Provide the length of flexible, explosion-proof conduit no less than 300 mm and no more than 600 mm.

.7 Raceway Identification: FLNC.

Description:	Flexible liquid tight nonmetallic conduit.
Compliance:	CSA C22.2 - No. 227.2.1
Application:	Final connection to equipment subject to vibration or equipment/instrument adjustments, use with RPVC, ERS, and PRS conduits in sizes 1/2 inch up to 1-1/2 inch.
Construction:	Spirally cast tubing, smooth interior, PVC. Resistant to oil, acid, ozone, alkaline, and sunlight resistant.
Acceptable Manufacturers:	Electri-flex Liquatite, Atkore AFC Cable Systems.
	Or approved equivalent.
Fittings:	High-strength, chemical-resistant, glass-filled thermoplastic. Resistant to oil, acid, ozone, and alkaline. PVC locknut. Neoprene "O" ring for liquid tight termination.
	Use 90-degree fittings.
	Acceptable Manufacturers: Thomas & Betts, Series 6300.
	Or approved equivalent.

Installation:	The length of flexible liquid tight conduit shall not exceed 20 times the trade diameter of the conduit, and no more than 600 mm.

.8 Raceway Identification: PRA.

Description:	Rigid aluminum conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.
Compliance:	Same as RA. For a CSA C22.2 No. 30 environment, with CSA C22.2 No. 45 or cUL 1203.
Finish:	Rigid aluminum (RA) conduit, to which a minimum 40-mil thick PVC coating has been bonded to the outside of the conduit. Pinhole-free, red urethane inside coating. Bond strength to exceed the tensile strength of the PVC coat to allow conduit bending without cracking of coating. Elbows factory made and coated.
Fittings, Boxes & Accessories:	Same as for RA, and: Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings coated by the same company.
Acceptable Manufacturers:	Plastibond by Robroy Industries. Or approved equivalent.
Installation:	Support PVC coated conduit away from the structure using PVC coated conduit hardware. Install plastic coated conduit tight with strap wrenches. Make sure that all conduit threads are covered by a manufactured plastic pressure sealing sleeve. Do not use pipe wrenches and channel locks for tightening plastic coated conduits. Patch damaged areas using Manufacturer's recommended material. Build up the area to be patched to the full thickness of the coating. Painted fittings are not permitted.

.9 Raceway Identification: RA

Description:	Rigid aluminum conduit.
Compliance:	CSA C22.2 - No. 45 and CSA C22.2 No. 18
Construction:	Copper-free aluminum alloy 6063-T5.
Minimum Size:	19 mm
Fittings, Boxes and Accessories:	Same as for RS, except copper-free aluminum in lieu of ferrous materials.
Straps:	1-hole cast aluminum.

Description:	Rigid aluminum conduit.

.10 Raceway Identification: RPVC

Description:	Rigid PVC conduit.
Compliance:	CSA C22.2 - No. 211.2 and CSA C22.2 No. 85.
Application:	Direct burial or concrete encased.
Construction:	High-impact, polyvinylchloride (PVC).
Minimum Size:	19 mm
Fittings and Accessories:	PVC solvent weld-type.
	O-ring expansion couplings and joints.
	Straps 2-hole PVC up to 53-mm size, 2-hole PVC covered steel above 2-mm size, nylon clamp with spacer where clearance from mounting surface is required.
	Manufactured adapters for connection to other types of raceways.
Boxes:	
Indoor, Dry:	Moulded PVC, F-style.
Indoor Wet, Outdoor and Corrosive:	NEMA Type 4X reinforced polyester with threaded hubs or moulded PVC.
Installation:	Secure PVC conduit entering fibreglass boxes or cabinets by threaded bushings on the interior of the box and terminate with a threaded male terminal adapter having a neoprene O-ring. Make joints with standard PVC couplings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Conduit runs between boxes.

.1 Limit the number of directional changes of conduit to total not more than 270 degrees in any run between pull boxes. Limit conduit runs between boxes to 40 m, less 5 m for every 90 degrees of change in direction. Avoid bends and offsets. Use manufactured elbows and offsets when required or field bend conduit without flattening and without kinking conduit.

.2 Make turns with manufactured fittings and conduit bends. Welding, brazing or otherwise heating metal conduit is not permitted.

.3 Cap all conduits immediately after installation until cables are pulled in. Cap all unused conduits.

.4 Install pull cords in empty conduits and spare conduits.

.5 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.

.6 Dry out conduits before installing wire.

.7 All conduit installed exposed in finished areas shall be free of visible labels and trademarks.

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

.9 Surface-mounted conduits:

.1 Use explosion-proof flexible connection for connection to explosion-proof motors.

.2 Install conduit sealing fittings in hazardous locations. After completion of all cable tests fill with compound.

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

.4 Make rigid PVC conduit joints by solvent-welding using an approved conduit cement.

.5 Field threads on rigid conduit to be of sufficient length to draw conduits up tight.

.6 Underground metallic or non-metallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC-coated rigid steel conduit before emergence above ground.

.10 Surface Conduits:

.1 Run parallel or perpendicular to building lines.

.2 Two (2) or more conduits in the same general routing shall be parallel with symmetrical bends.

.3 Install conduits behind electric heaters with 1.5 m clearance.

.4 Run conduits in flanged portion of structural steel.

.5 Group conduits on suspended channels.

.6 Do not pass conduits through structural members except as specified.

.7 Do not place conduits within 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

.11 Concealed Conduits:

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo and/or concrete toppings.

.12 Conduits in Cast-In-Place Concrete:

.1 Locate to suit reinforcing steel. Install in centre one-third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

.5 Install conduits between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, place conduits under the reinforcement.

.6 Do not install aluminum conduit in concrete without added corrosion protection including heat-shrink sleeves or bitumastic coating.

.7 Locate to suit reinforcing steel. Install in centre one-third of slab. Organize conduits to minimize cross-overs.

.8 Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit.

.9 Do not place conduit in concrete slabs where slab thickness is less than 4 x conduit diameter. Encase conduits completely in minimum 25 mm concrete. Maintain clearances equal to the nominal conduit diameter, but not less than 40 mm between conduits encased in slabs. Clearances of less than 40 mm at conduit crossing and terminating locations are permitted.

.10 Provide bonded, weathertight expansion fittings wherever embedded conduit crosses building expansion joints and between two (2) adjacent structures.

.11 Where the drawings indicate future duplication of equipment wired hereunder, provide concealed portions of conduits for future equipment.

.13 Junction and Pull Boxes:

.1 Provide junction or pull boxes as set out in the Final Design.

.14 Conduit Terminations:

.1 Secure conduit entering sheet metal boxes or cabinets by locknuts on both the interior and exterior of the box or cabinet and install insulating grounding and/or bonding bushing over ends of metal conduit. Terminate conduit entering other boxes with a hub. Provide cast boxes and non-metallic enclosures with threaded or solvent weld hubs. Fittings for all conduits that enter enclosures will confirm that the NEMA rating of the enclosure is not affected or changed. Make joints with standard couplings or threaded unions. Bond metal parts of non-metallic boxes and plastic-coated boxes to the conduit system. Do not use running threads instead of unions or excessive thread on conduit. Cut the ends of conduit square, and ream.

.2 Arrange conduit so that motors and field equipment enclosures in process areas are entered from the bottom to minimize the possibility of moisture entry. Only when approved by the Contract Administrator, for the conduit above, run it down beside the enclosure and install a tee condulet and drip leg.

.3 Provide sufficient length of "free" flexible conduit for motors mounted on slide rails to permit the motor to travel the full length of the rails. Provide a minimum three metre loop of flex on sump pump motors to allow motor drive coupling to be disconnected without disturbing flex connection.

.15 Conduit Support:

.1 Support systems as specified in Section 16191 – Fastenings and Supports.

.2 Route conduit parallel and/or perpendicular to walls, structural members, or intersections of vertical planes and ceiling.

.3 Provide spacers for surface-mounted aluminum conduit to avoid direct contact with concrete.

.4 Install no conduit closer than 150 mm to objects operating above 30°C.

.5 Space out from the wall using framing channels where three or more conduits are located in a parallel run.

.6 Secure conduit rack supports to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.

.7 Run conduits in flanged portion of structural steel.

.8 Comply with the seismic requirements specified in Section 16010 – Electrical General Requirements for support systems.

.16 Conduit Penetrations:

.1 Pass conduit routed perpendicular through floors, walls, and other concrete structures through cast-in-place openings. In cases where cast-in-place openings are not possible, bore appropriately sized holes through the concrete to accommodate the conduit passage. Prior to boring locate and avoid structural steel through non-destructive means. The size and location of the holes shall be such as to not impair the structure's integrity. After completion, grout cast-in-place penetrations and caulk penetrations through building structures around the conduit and finish to match existing surroundings. Protect conduits that rise vertically through the floor by a 90 mm high concrete pad with a sloping top.

.2 Do not pass conduits through structural members unless set out in the Final Design.

.3 Wherever conduits penetrate outdoor concrete walls and/or outdoor ceilings through a cored hole below grade, provide a watertight seal via conduit sealing bushing.

.4 Wherever conduits pass through fire walls, provide a fire barrier applied in strict accordance with Manufacturer's instructions. Clean off spillage of sealant.

.5 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roofs, metal walls, or watertight membranes.

.6 Before coring, cutting, and breaking of concrete, examine the structure closely for support cables. Utilize detection systems including X-ray or thermograph to locate concealed conduits, cables, and reinforcing steel. Repair all damage caused from the penetrations.

.7 Provide a watertight conduit seal via thru wall and floor seal where conduits penetrate outdoor concrete walls and/or ceilings through a cast-in-place penetration below grade.

.8 When using RA conduit to penetrate from a non-hazardous location to a hazardous location, coat the conduit with bituminous paint to prevent galvanic corrosion of the conduit. After conduit has been installed, seal core entry around conduit with non-shrink grout (e.g., “Cement All”) to prevent transmission of vapours from the hazardous location.

.17 Conduit Separation:

.1 Separate analogue and communication conduits from AC power and control conduits by a minimum of 300 mm for metallic conduits and 600 mm for non-metallic conduits.

.18 Cable Installation in Conduits:

.1 Install cables in conduits.

.2 Do not pull spliced cables into conduits. Do not pull cables into incomplete conduit systems.

.3 Install multiple cables in conduits simultaneously.

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

.5 To facilitate matching of colour-coded multi-conductor control cables reel off in same direction during installation.

.6 Before pulling cable into conduits and until cables are properly terminated, seal ends of cables with moisture seal tape.

.7 After installation of cables, seal void around cables with duct seal compound at point of entry into below-grade structures.

.8 Allow 1 m of extra length of cable in loop form at splice boxes, pullpits, and manholes.

.19 Fibre Optic Installation:

.1 Conduit bends for fibre optic cable to be in accordance with Manufacturer recommendations and a minimum of 610 mm.

.20 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of cable trays.

.2 Cable tray size and type are specified on the Drawings as required for cable routing. The Drawings show main cable tray routes only – they do not show all required cable trays and channel to individual pieces of equipment. Provide cable tray installation as required for complete cable routing installation.

.3 The Drawings indicate general concepts and may not show all details required for mounting or installation. Supply and install any additional items required for a complete and working installation.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 CAN/CSA C22.2 No. 126 – Metal Cable Tray Systems.

.2 National Electrical Manufacturer Association (NEMA):

- .1 NEMA VE 1, Metal Cable Tray Systems.
- .2 NEMA VE 2, Cable Tray Installation Guidelines.

.3 City of Winnipeg WWD Electrical Design Guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Prior to construction, submit design drawings and calculations indicating all tray loading has been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.
- .3 Design drawings shall include but not limited to:
  - .1 Indicate the various types of cable trays used.
  - .2 Show actual cable tray installation details and suspension system.
  - .3 Arrangement and dimensions of mounting fittings and accessories.
  - .4 Layouts showing all cable channel and cable tray locations.

.4 Indicate cable tray structural support system, dimensions, materials, fittings, anchor and connection details and load rating of the support.

2. PRODUCTS

2.1 Manufacturers

.1 Provide cable trays from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Cooper B-Line.

.2 Thomas and Betts.

.3 Or approved equivalent.

2.2 Cable Tray

.1 Cable trays shall be aluminum ladder type, Class C for indoor tray, class D for outdoor tray, to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as required, but not less than 150 mm.

.1 Fiberglass and stainless steel tray shall be used in environments where it will outperform aluminum tray.

.2 Elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from Manufacturer.

.3 Provide rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.

.4 Provide barriers where different voltage systems and/or different electrical systems are in the same cable tray. Provide separate cable tray for medium voltage (4.16 kV and 12.47 kV) power cables.

.5 Cable tray rungs shall include cable tie slots for horizontally mounted tray, to secure cables at regular intervals with cable ties.

.6 Cable tray rungs shall include open slot channel for vertically mounted tray, to secure cables at regular intervals with cable clamps.

.7 Provide cable tray cover where mechanical protection of cables is required and for all outdoor installation. Cable tray covers shall be solid aluminum covers with a flange and c/w raised cover clips.

.8 Cable tray bonds shall be a minimum #2/0 AWG, stranded, copper conductor connected to each tray section with a Manufacturer approved grounding/bonding lug, in accordance with CEC requirements. Upsize bond conductor to account for cable ampacity in accordance with CEC table 16.

.9 Fibre cables and trays:

.1 Install cables individually.

.2 Lay cables into cable tray. Use rollers when necessary to pull cables.

.3 Secure cables in tray at 2 m centers, with nylon ties.

.4 Identify cables with nameplates in accordance with City of Winnipeg Identification Standards.

.5 The air space between cables shall be 100% of the largest cable diameter unless otherwise specified. Main fibre cable shall be installed on the opposite side of the tray as the redundant fibre. Where the quantity of cables results in main and fibre cables within two diameters of one another, provide metallic barrier.

2.3 Cable Channel

.1 Provide aluminum for process and office areas, except for:

.1 Use 316 stainless steel within the chemical building and for any exterior cable tray runs. Provide the required width and depth of channel to accommodate the required cabling.

.2 Channels shall be ventilated through type.

2.4 Supports:

.1 Rod hangers, nuts, fittings and hanger clamps: stainless steel type 316.

.2 Wall mounted support brackets: aluminum.

.3 Horizontal supports shall be installed in strict accordance with the Manufacturer recommendations for the loading class.

2.5 Accessories

.1 Use 316 stainless steel washers, bolts and fixing hardware.

.2 Provide supports, clamps and accessories as required.

.3 Supply and install tray manufacturer approved conduit to cable tray adapters for transitions from a conduit system onto the tray.

.4 Supply and install tray manufacturer approved ground wire clamps for ground wire connection onto tray members.

.5 Supply and install all other tray manufacturer approved accessories, including cantruss guide clamps, support brackets, etc.

2.6 Floor/Wall Seal Systems

.1 Floor/wall sealing systems shall be fire rated to suit the fire rating of the penetrations, with an approved fire barrier system.

.2 Systems to be CSA or cUL certified.

.3 Provide system to allow for cable re-entry to allow for future work.

2.7 Fire Barriers:

.1 In accordance with Section 16055 – Electrical Firestopping.

2.8 Cable Spacers:

.1 Recommend suitable space in accordance with Manufacturers requirements , codes and standards, and the design Drawings.

.2 Diameter of opening to be suitable for cable size.

.3 Mounting hardware to be compatible with tray system.

.4 Multi conductor cable feeders to be tied down with adequate tie raps.

2.9 Identification

.1 Warning Notices:

.1 Provide yellow plates with black lettering.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Provide a cable tray system for three (3) or more cables when cable lengths exceed 3 m.

.3 Install cable tray support at every 3.0 m, and at all cable tray bends.

.4 Run cable tray continuously to establish rigidity using factory fittings. Corners, tees, elevation changes shall be made using factory fittings. Cable tray shall be discontinuous where installed at different elevations.

.5 Where tray runs change elevation, trays shall overlay each other. Further, tray sections shall be coupled together to provide rigidity. This coupling shall be made by using a short length of tray and adjustable elbows or shall be coupled by means of common support rods at the tray overlap.

.6 Use expansion-joint splice plates to allow 50 mm free movement between adjacent trays when crossing a building expansion joint.

.7 Install covers on trays crossing under open stairways and grating, on outdoor trays and for 2 m above floor penetrations.

.8 Provide a green PVC-insulated bonding conductor of 4/0 AWG copper on tray throughout the entire length of each tray run. Bond each isolated segment of tray, which is less than 15 m, to a tray run. Solidly connect each tray run to the electrical room ground bus. Attach bonding conductor to tray every 15 m with approved ground wire connector and anti-oxidizing compound. Bonding conductor insulation to be FT4 rated for indoors and FT1 rated for outdoors. For trays stacked vertically above each other (maximum of three trays in stack), provide a bonding conductor throughout the entire length of one tray with bonding jumpers provided every 15 m from that tray to the other tray(s) in the tray stack. Upsize bond conductor to account for cable ampacity in accordance with CEC Table 16.

.9 Cable trays are only to support cables. Do not attach pipes, fixtures, and the like to cable tray or cable tray supports.

.10 Cables in Cable Tray:

  .1 Install cables individually.

  .2 Lay cables into cable tray to provide a minimum of cable crossovers.

  .3 Space cables as indicated in Design Builder’s Design.

  .4 Secure cables in cable tray at 6 m centres with nylon ties.

  .5 The air space between cables shall be 100% of the largest conductor diameter or unless otherwise specified. Provide a minimum of 40% spare capacity for installation of future cabling without requiring derating of cables installed under this DBA.

.11 Install warning notices every 10 m on all cable trays in accordance with CSA C22.1.

.12 Provide Firestop sealing systems for cable tray penetrations through fire rated walls according to Section 16055.

END OF SECTION

HVTECK CABLES 5 KV TO 15 KV

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of HVTECK Cables 5 kV to 15 kV.

1.2 Standards

.1 Association of Edison Illuminating Companies (AEIC):

.1 CS8-00, Specification for Extruded Dielectric Shielded Power Cables rated 5 through 46 kV.

.2 Institute of Electrical and Electronics Engineers (IEEE):

.1 48, Standard for Test Procedures and Requirements for AC Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.

.2 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5kV through 35 kV.

.3 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.

.3 American Society for Testing and Materials (ASTM):

.1 B3, Standard Specification for Soft or Annealed Copper Wire.

.2 B8, Standard Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium Hard, or Soft.

.4 Canadian Standards Association (CSA):

.1 C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

.2 C22.2 No. 131 Type TECK 90 Cable.

.3 C22.2 No. 174 Cables and Cable Glands for Use in Hazardous Locations.

.4 C68.3, Shielded and Concentric Neutral Power Cables Rated 5-46 KV.

.5 C68.10, Shielded Power Cable for Commercial and Industrial Applications, 5-46KV.

.5 Institute of Electrical and Electronics Engineers (IEEE):

.1 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

.2 592, Standard for Exposed Semi conducting Shields on High Voltage Cable Joints and Separable Insulated Connectors.

.3 400.2, Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF).

.6 Insulated Cable Engineers Association (ICEA):

.1 S-93-639/NEMA WC74, 5-46KV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

.2 S-97-682, Utility Shielded Power Cable rated 5-46 kV.

.3 T-25-425, Guide for Establishing Stability of Volume Resistivity for Conducting Polymeric Components of Power Cables.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Include insulation material, conductor material, voltage rating, cable termination kits, cable splice/ terminator qualifications, and other data pertinent to the specific cable, and applicable standards.

2. PRODUCTS

2.1 HV Teck Cable 5 kV and 15 kV

.1 Voltage: 5kV and 15kV as required.

.2 Conductor: Three conductor cables with Class B compressed stranded copper per ASTM. Sized as required.

.3 Conductor Shield: Extruded thermosetting semiconducting shield which is free stripping from the conductor and bonded to the insulation.

.4 Insulation: Natural high dielectric strength tree-retardant cross linked polyethylene (TR-XLPE) insulation, exhibiting an optimum balance of mechanical and electrical properties, ensuring resistance to treeing. Rated for 133% insulation level.

.5 Insulation Shield: Extruded thermosetting semiconducting shield with controlled adhesion to the insulation providing the required balance between electrical integrity and ease of stripping.

.6 Metallic Shield: Helically applied non-magnetic uncoated copper tape over the insulation shield. The copper tape shield shall be overlapping.

.7 Assembly: Three conductors are twisted together with fillers and soft drawn, bare copper bonding conductor and covered with binder tape.

.8 Bonding Conductor: Class B compressed stranded bare copper per ASTM. Sized as required.

.9 Inner jacket: Sunlight resistant polyvinyl chloride (PVC) jacket tightly applied over the binder tape.

.10 Armour: Flexible Aluminum Interlocking Armour (AIA) applied over the inner jacket for mechanical protection.

.11 Outer jacket: Sunlight resistant polyvinyl chloride (PVC) jacket applied over the armour. CSA FT-4 flame test rated.

.12 Suitable for -40ºC installation.

.13 Approved products:

.1 CSA HVTECK 5 kV and 15 kV shielded.

.2 Or approved equal.

2.2 HV Teck Cable 5 kV and 15 kV Connectors

.1 Weatherproof strain relief (cable gland) style connectors, to accommodate cable shield, shall be compatible with the cable type and manufacture.

.2 Acceptable Cable Connectors:

.1 ABB (Thomas and Betts) type Star TECK sized for the applicable cable complete with locknut and grounding bushing.

.2 Or approved equal.

2.3 Cable 5 kV and 1 5kV Termination

.1 Heat shrink type cable terminations shall be used for shielded Cable Conductor Terminations, proper sized to the conductor and insulation dimensions.

.1 Inside applications, perform IEEE Class 2 indoor terminations. Indoor terminations shall be the Elastimold type, complete with housing and stress tube.

.1 Acceptable Terminations:

.1 ABB (Thomas and Betts) Ranger 2 Series (R2IT) indoor sized for the applicable cable/conductor. Include appropriate shield kits to match the cable type and application, heat-shrinkable cable breakout boots, and all materials and misc. consumables required for a complete installation.

.2 TE Raychem type HVT-Z indoor sized for the applicable cable/conductor, c/w type CBR-6 breakout boots and type HVOT re-jacketing tubing or approved equal. Include appropriate shield kits to match the cable type and application, and all materials and misc. consumables required for a complete installation.

.2 Outside applications, perform IEEE Class 1/1A outdoor terminations. Terminations shall include weather protected precautions and materials, complete with housing and stress tube.

.1 Acceptable Terminations:

.1 ABB (Thomas and Betts) Ranger 2 Series (R2T) for outdoor sized for the applicable cable/conductor. Include appropriate shield kits to match the cable type and application, heat-shrinkable cable breakout boots, and all materials and misc. consumables required for a complete installation.

.2 TE Raychem type HVT-Z outdoor sized for the applicable cable/conductor, c/w type CBR-6 breakout boots and type HVOT re-jacketing tubing or approved equal. Include appropriate shield kits to match the cable type and application, and all materials and misc. consumables required for a complete installation.

.3 Multi-conductor cables shall include conductor “breakout boots” and “rejacketing tubing”. Conductor breakout boots shall be utilized to seal the individual insulated phase conductors to the internal cable jacket to prevent water ingress to the cable.

3. EXECUTION

3.1 General

.1 Install shielded power cables in concrete encased duct bank and in underground concrete encased conduit in accordance with the Technical Requirements.

.2 Install 15 kV and 5 kV cable on cable tray for runs entirely within the facility.

.3 Install power cables with large radius cable bends, not exceeding Manufacturer’s recommendations.

.4 Support cables with U-channel struts or frame to provide additional support where transition from cable tray or equipment leaves cables inadequately supported.

.5 Supply and install shield connectors, cable grounding kits, lugs, stress relief tubes, tapes and any other materials required for correct installation and termination in accordance with Manufacturer instructions. All termination kits and accessories shall be the proper equipment for the intended cable as indicated by the cable Manufacturer.

.6 Permanent “DANGER – HIGH VOLTAGE” warning labels are to be fixed to all high voltage cable conduits, trays containing high voltage cable, points of access to high voltage cables and conductors and the high voltage cable itself where not run in tray or conduit. Spacing of warning labels is not to exceed 10 m.

.7 Colour code all power distribution conductors at both ends throughout Facility.

  .1 Same colour for same phase throughout, by insulation colour markers.

  .2 Conductor colour coding to be in accordance with CEC and as follows:

    .1 3 Phase - red (A), black (B), blue (C)

.8 Perform tests in accordance with Section 16020 – Electrical Testing.

.9 Complete Test forms and submit to the Contract Administrator for review prior to energizing.

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

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of wires and cables.

.2 All conductors including grounds and bonds shall be high conductivity copper.

.3 Materials to be manufactured to CSA standards, approved and suitable for -40°C to +90°C operation. Wires and cables shall meet their applicable CSA standard for construction and for testing.

.4 Increase conductor sizes to account for loading, cable and conductor spacing with the associated de-rating factors, voltage drop, ambient temperature, equipment termination temperature ratings, and all other requirements in accordance with CEC requirements.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 CSA C22.1, Canadian Electrical Code (CEC), Part 1), Safety Standard for Electrical Installations.
- .2 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- .3 CSA C22.2 No. 18.3, Conduit, Tubing, and Cable fittings.
- .4 CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables.
- .5 CSA C22.2 No. 49, Flexible Cords and Cables.
- .6 CSA C22.2 No. 51, Armoured Cables.
- .7 CSA C22.2 No. 65, Wire Connectors.
- .8 CSA C22.2 No. 123, Metal Sheathed Cables.
- .9 CSA C22.2 No. 131, Type TECK 90 Cable.
- .10 CSA C22.2 No. 174, Cable and Cable Glands for Use in Hazardous Locations.
- .11 CSA C22.2 No. 188, Splicing Wire Connectors.
- .12 CSA C22.2 No. 197, PVC Insulating Tape.
- .13 CSA C22.2 No. 208, Fire Alarm and Signal Control.
- .14 CSA C22.2 No. 230, Tray Cables.
- .15 CSA C22.2 No. 239, Control and Instrumentation Cables.

.2 Insulated Cable Engineers Association (ICEA).

.3 Institute of Electrical and Electronics Engineers (IEEE).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Catalogue numbers specified are for establishing the grade of quality of the materials specified in this Section and are taken from one Manufacturer's product line.

.2 Acceptable Manufacturers:

.1 Cabling: As specified for the type and application within this Section.

.2 Cable Connectors:

.1 Appleton.

.2 Thomas & Betts.

.3 Or approved equivalent.

.3 Wire Connectors:

.1 Burndy.

.2 Thomas & Betts.

.3 3M.

.4 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Wire Insulation Voltage

.1 Wiring at less than 600 V to be 600 V insulated.

.2 Wiring at 600 V to be 1000 V insulated.

.3 Composite 600 V power and 120 V control cables shall not be permitted.

.2 Building Wires:

.1 Comply with CSA C22.2 No. 38 – Thermoset-insulated wires and cables.

.2 Conductors:

.1 Stranded copper.

.2 Minimum size 12 AWG, except 14 AWG for control circuits.

.3 Insulation chemically cross-linked, thermosetting polyethylene, and rated RW90, 1000 V. Use RWU 90 insulation as set out by the Final Design.

.4 Colour coding to Section 16010 – Electrical General Requirements; wires sized 2 AWG and smaller to be factory-coded, taping is not permitted.

.3 Armoured Cable (< 1000 VAC):

.1 Conductors and insulation same as for building wires, except that Manufacturer's standard insulation colour coding is permitted.

.2 Multi-conductor, composite or single-conductor construction as set out in the Final Design, plus bare ground conductor.

.3 Interlocking aluminum armour.

.4 Teck Cable (Power and Control):

.1 Comply with CSA C22.2 - No. 0.3, CSA C22.2 No. 131, and CSA C22.2 No. 174.

.2 HL rating for hazardous location Zone 1.

.3 Inner jacket thermosetting PVC compound.

.4 Outer jacket of PVC material rated -40ºC and meeting low gas emission and FT4 flame test requirements set forth in CSA C22.2 No. 0.3 and IEEE 1202.

.4 VFD Cable:

.1 Three copper-conductors cables with three symmetrically positioned bonding conductors.

.2 Minimum 1000 V rated cross-linked polyethylene insulation which guarantees high dielectric strength to withstand high voltage spikes of two to three times' normal voltage. Final rating shall be based on Final Design.

.3 The continuously corrugated, corrosion-resistant aluminum sheath with 100% coverage and low resistance path to ground.

.4 A PVC jacket rated FT4 and AG14 to confirm that the cable is grounded at the terminations only, preventing the pick-up of stray currents. The black PVC jacket to be UV resistant, suitable for outdoor use.

.5 Suitable for cable tray installation, indoor and outdoor.

.6 The VFD cable shall:

.1 Comply to CSA C22.2 No. 123 and CSA C22.2 No. 174

.2 CSA FT4 Flame Test.

.7 The Acceptable Manufacturers:

.1 Nexans Drive Rx VFD Cable.

.2 or approved equivalent.

.8 Provide only connectors approved for use by the Manufacturer.

.5 Flexible Cables:

.1 Designations and Compliance:

.1 Flexible Cords; Type S0W, to CSA C22.2 No. 49, Type ST, to CSA C22.2 No. 49.

.2 Portable Cables up to 2 AWG, Type SGOW, to CSA C22.2 No. 96.

.3 Portable Power Cables up to 500 kcmil, Type G, to CSA C22.2 No. 96, IEEE 1018 or IEEE 1017.2.

.2 Conductors and Insulation:

.1 Stranded copper.

.6 Connectors for Armoured Cables (< 1000 VAC):

.1 Comply to CSA C22.2 No. 18 and CSA C22.2 No. 174.

.2 Teck cable connector: Connectors to be watertight. Dry-type not permitted. Material compatible with connecting body including junction, outlet or splice box to which connection is made. Grounding ring or "fingers" and neoprene bushing.

.3 Type AC cable connector: two-screw, clamp-type, nylon insulated, dry-type.

.4 Acceptable Products:

.1 Hazardous Locations, Thomas& Betts STAR TECK XP.

.2 Hazardous and corrosive locations, Thomas & Betts STAR TECK XP all with heat-shrink sleeve applied.

.3 Corrosive locations, Thomas & Betts STAR TECK, all with PVC coating.

.4 All other locations, for jacketed armoured cable, Thomas & Betts STAR TECK.

.5 Or approved equivalents for above.

.5 Teck Cable connectors to use materials similar to the connected equipment to prevent corrosion caused by contact of dissimilar metals. The locknut of the connector shall be of the same material used as the Hub of the connector.

.7 Connectors for Portable/Flexible Type Cables:

.1 Watertight type for use with flexible cables.

.2 Material compatible with connecting body including applications with junction, outlet, and splice boxes to which connection is made.

.3 Stainless steel wire mesh cord grip where connector is used with free-hanging cable.

.4 Acceptable Products:

.1 General Locations: ABB (Thomas & Betts) Type RANGER.

.2 Or approved equivalent.

.8 Wire Connectors:

.1 The following listings specify products for copper conductors only.

.2 Comply to CSA C22.2 No. 65 and CSA C22.2 No. 188.

.3 Twist-On Connectors:

.1 Insulated serrated.

.2 Wing-type cap.

.3 Internal spiral spring: set-screw and crimp-type are not permitted.

.4 Minimum rating 600 V.

.5 Limited for use up to 10 AWG wire.

.4 Terminal Connectors:

.1 Ring-type, crimp-on terminal with nylon insulating sleeve over brazed seam shank.

.2 Minimum rating 600 V, 105°C.

.3 Conductive member made from electro tin-plated copper.

.4 Use limited for conductors up to 10 AWG.

.5 Compression Lugs:

.1 Made from one-piece pure electrolytic copper tubing, tin plated.

.2 Colour coded.

.3 Long barrel for minimum two (2) crimps.

.4 For use with conductors 8 AWG and larger.

.5 For 1/0 AWG and larger conductors, use two-hole long barrel compression lugs.

.6 Install ferrules with nylon insulating sleeves on all No. 14 and smaller stranded wires being terminated on terminal strips. Individual ferrule is required for each conductor.

.6 Compression splices: similar to compression lugs, suitable for in-line, C-tap and similar configurations.

.9 Joint Compound:

.1 Conductive compound, suitable for application to threaded and compression connections.

.2 Compatible with cable and conductor insulation and material.

.3 Capable of being brushed on at temperatures from minus 25°C to 110°C.

.4 Acceptable Products:

.1 Aluma-Shield.

.2 Burndy Penetrox.

.3 ABB (Thomas & Betts) Kopr-Shield.

.4 Or approved equivalent.

.10 Electrical Tape:

.1 To be compatible with conductor and cable insulation or jacketing.

.2 For general purpose: vinyl plastic, premium grade, minimum 0.18 mm (7 mil) thickness, colour coded. Acceptable Product: 3M Super 33+ or 35 (or approved equivalent).

.3 Self-vulcanizing linerless rubber tape, minimum 0.76 mm (30 mil) thickness. Acceptable Product: 3M Type 130 C (or approved equivalent).

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 Establish exact location of equipment and their connection points before wiring installation is commenced.

.4 Protect wiring against damage from construction activity by suitable means.

.5 Protect metallic cable connectors in process areas with heat-shrinkage sleeves. Sleeve length to extend 75 mm past the connector and to provide a tight fit around connector and cable.

.6 Arrange wiring in process area such that motor connection boxes and other field mounted devices are entered at the side or bottom of the connection box or enclosure.

.7 Provide sufficient length of "free" cable for motors mounted on slide rails to permit the motor to travel the full length of the rails.

.8 Install reducing bushings where threaded entry in a motor connection box is larger than the hub size of the cable connector.

.9 In-line splices are not permitted.

.10 Repairing damage to a cable jacket is not permitted. Replace the entire length of a damaged cable.

.11 Arrange cable supports such that maintenance work and removal of the equipment served by the cable, will not cause any damage to the cable.

.12 Jacketed Armoured Cable:

  .1 Install on surface. Surface mounted cables to be strapped using one hole aluminum straps with clamp back (T&B 1275AL series or approved equivalent). Fastening, strapping and support materials to be compatible with the area conditions and materials selected for the application. Strap at every 1 m intervals. Cables shall not be strapped to handrails and piping.

  .2 A group of three (3) or more cables running parallel to each other to be installed in a cable tray.

  .3 Install cable connectors at both ends of each armoured cable.

  .4 Provide protection for cables where subject to mechanical damage, notably where cable passes through a floor slab.

.5 Tighten and mark Teck connector gland nuts following tightening. Connect markings to be made with felt pen as a line between gland nut surface and surface of connector body to show relative position of gland nut after final tightening has been done.

.6 Where hazardous locations rated Teck connectors are used, installer shall follow Manufacturer's assembly procedures for all stages of the installation. Allow cable sealing compound to harden in connector bodies before inserting connector and wires into connector hub.

.13 Flexible Cables:

.1 Provide cables to be installed with strain relief-type connectors to take the tension from the cable termination.

.2 Provide wire mesh grip where cable is free hanging or subject to frequent flexing.

.3 Where excess cabling is to be provided, neatly coil and tie excess length and attach to structure using hooks or supports as set out in the Final Design.

.4 Acceptable Products:

.1 Hubbell Kellems Series,

.2 Eaton Arrow Hart Series,

.3 Or approved equivalent.

.14 Connector Sizing:

.1 Strictly adhere to Manufacturer's listing for matching connector and terminal sizes to cable and conductor sizes.

.2 Similarly, the proper compression tools and dies to be selected for each compression fitting to obtain the correct compression strength and as not to damage insulation sleeves and finishes.

.3 Select cable connectors with correctly sized grommets, bushings, glanding devices and threads. The application of tape or using reducers is not an acceptable alternative to selecting the correct size connector.

.15 Terminations and Splices:

.1 Twist-on connectors shall be limited to use on lighting circuits, control wiring in outlet boxes, luminaires, and with factory-supplied leads and pig-tails in field devices. Pre-twist the conductors tightly prior to installation of twist-on connectors.

.2 Do not use twist-on connectors inside panels and apparatus which are equipped with terminal blocks.

.3 Use locking fork-type connectors on flat screw-type terminals.

.4 Use ring-type connectors for 10 AWG and smaller on stud and post-type terminals and any termination subject to vibration.

.5 Use compression-type lugs for 8 AWG and larger unless equipment is provided with proper lugs designed for conductor terminations.

.6 Unless motor connection boxes are equipped with terminals, use compression-type motor connection lugs and machine bolts with belville washers at motors for conductors up to 1 AWG. For 1/0 AWG and larger conductors use two-hole long barrel compression lugs and apply self-vulcanizing tape or heat-shrink end cap over termination.

.7 In moist or corrosive areas, apply joint compound to conductor prior to installation of compression fitting.

.8 Follow Manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

.16 Fire Barriers:

.1 Provide openings in fire rated walls, and floors, where cables run through.

.2 In accordance with Section 16055 – Electrical Firestopping.

.17 Hazardous Location Penetrations:

.1 Provide openings between hazardous locations, walls or floors, where cables are to run through.

.2 Maintain a temporary vapour tight seal during cable installation work and finish off with mortar type fire stop sealant after all cables are installed and tested.

.3 Install approved fire and gas stop seal.

.4 Install cables to one side of penetration opening to allow space for coring of fire stop seal materials for addition of future cables.

.18 Complete the Test forms and submit to the Contract Administrator for review prior to energizing.

.19 Remove and replace entire length of cable if cable fails to meet any of the test criterions.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of communication cables.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 C22.2 No. 239, Control and instrumentation cables.

.2 Japanese Industrial Standards (JIS):

.1 JIS C 5961 – Test Methods for Connectors for Optical Fiber Cord.

.2 JIS C 5962 – General Rules for Connectors for Optical Fiber Cord.

.3 JIS C 5970 – FO1 Type Connectors for Optical Fiber Cables.

.4 JIS C 6820 – General Rules of Optical Fibers.

.3 Telecommunications Industry Association (TIA):

.1 TIA/EIA-455-Series – Fiber Optic Cable Tensile Loading and Bending Test.

.2 TIA/EIA-455-25 - Compressive Loading Resistance of Fiber Optic Cables.

.3 TIA/EIA-455-33 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.

.4 TIA/EIA-455-41 - FOTP-86 Fiber Optic Cable Jacket Shrinkage.

.5 TIA/EIA-455-81 - Fiber Optic Cable Cyclic Flexing Test.

.6 TIA/EIA-455-86 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.

.7 TIA/EIA-455-104 - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class IA Graded-Index Multimode Optical Fibers.

.8 TIA/EIA-455-181 - Standard Test Procedures for Optical Fibers, Cables, Connecting and Terminating Devices, and other Fiber Optic Components (FOTPs).

.9 TIA/EIA-455-492AAAA-A - Repeated Impact testing of Fiber Optic Cables and Cable Assemblies.

.10 TIA/EIA-598-A - Optical Fiber Cable Color Coding.

.11 TIA/EIA-568-C - Optical Fiber Cable Testing Standard.

.4 Underwriters Laboratories (UL):

.1 UL 1277 – Electrical Power and Control Tray Cables with Optional Optical Fiber Members.

.2 UL 1666 – Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.

.3 UL 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical Fiber Cables.

.5 City of Winnipeg Electrical Design Guide.

.6 City of Winnipeg Automation Design Guide.

.7 Standards in Specification 16010 – Electrical General Guidelines.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Catalogue and technical data.

.3 Installation data including allowable pulling tension, pulling radius, and bending radius.

2. PRODUCTS

2.1 Configuration, Components and Features

.1 Serial Binary Data Interchange Cables (RS232D):

.1 Conform to the following:

.1 Shielded, including terminators.

.2 Moulded terminations.

.2 Balanced Digital Interface Circuits (RS422/RS485):

.1 Conform to the following:

.1 CSA Certified for trays and risers.

.2 Conductor: 16 AWG bare solid copper.

.3 Dielectric: Cellular polyethylene.

.4 Shield: Aluminum Mylar and 90% tinned copper braid.

.5 Jacket: Black polyvinyl chloride (PVC).

.6 Electrical characteristics @ 20°C:

.1 Capacitance: 35.8 plus or minus 3.0 pf/m,

.2 Impedance: 24 plus or minus 2 A.

.3 Propagation velocity: 78 percent.

.4 Inner conductor resistance: 1.4 A/100 m.

.5 Shield resistance: 0.43 A/100 m.

.6 Attenuation @ 1 MHz: 0.59 dB/100 m.

.2 Where armoured trunk cable is specified, conform to the above plus the following:

.1 Armour: 15 mm corrugated chrome plated steel armour applied longitudinally.

.2 Moisture barrier: 0.05 mm heat sealable bonded to outer jacket.

.3 Outer Jacket: 1.27 mm polyethylene.

.3 CCTV Cable:

.1 CCTV Cameras shall be IP based. Provide Ethernet or fibre optic cabling with Ethernet to fibre converters. For cabling requirements, refer to the items below.

.4 Ethernet CAT 6A Cable:

.1 CAT 6A Cable shall be CSA approved and shall be constructed as follows:

.1 Complies with ANSI/TIA-568-C.2 CAT 6A standards.

.2 Twenty-four (24) gauge solid copper conductors.

.3 Four (4) twisted pairs.

.4 Bandwidth 500 MHz.

.5 Jacket: PVC.

.6 FT4 rating.

.2 ANSI/ISA S50.02 – Fieldbus Standard for Use in Industrial Control Systems.

.5 Ethernet Armored CAT 6A Cable:

.1 CAT 6A Cable shall be constructed as per item 2.1.4 including the following:

.1 FT4 rating with FT6 outer jacket.

.2 Type – Plenum Rated Cable.

.3 Armored and outer jacket rated 600V for installation in tray.

.2 ANSI/ISA S50.02 – Fieldbus Standard for Use in Industrial Control Systems.

.3 Multi-Ethernet cables in a single Teck armour jacket are permitted.

.6 Profibus DP Cables:

.1 Profibus DP Cable shall comply with the requirements of EN50170-2-2:1996.

.2 Requirements:

.1 Two-wire shielded with circular cross section.

.2 Loop resistance: < 150 W/km.

.3 Operating temperature: minus 40°C to 60°C.

.4 Flame-retardant to IEC-60322-3-24.

.5 Colour Code: red and green, 22 AWG stranded bare copper conductors.

.6 Isolation: 300 V.

.7 Jacket colour: Purple.

.8 Cables in Hazardous Locations: Aluminum Armored.

.9 Cables outdoor installation rated for -40C° to 75C°

.10 Spur cables: Not Armored.

.11 UV-resistant.

.12 Belden 3079E and/or123079A Profibus DP cable, Turck 4515 and/or 4510A.

.7 Profibus PA Cables:

.1 Profibus PA Cable shall comply with the requirements of EN50170-2-2:1996.

.2 Requirements:

.1 Two-wire shielded with circular cross section. 1 twisted pair.

.2 Loop resistance: < 150 W/km.

.3 Operating temperature: minus 40°C to 75°C.

.4 Copper Conductor, Solid, 0.8 mm2 corresponding to 18 AWG.

.5 Colour Code: brown and blue, 22 AWG stranded bare copper conductors.

.6 Voltage rating: 300 V.

.7 Flame test as per CSA FT4.

.8 Hazardous location HL-BCD CSA certified or equivalent.

.9 Approvals, ACIC, CMG CSA or equivalent.

.8 Fibre-Optic Single-mode Cable:

.1 Cable to conform to the following:

.1 ANSI/TIA/EIA-492-CAAA.

.2 Single-mode (SM) OS2, 1310 / 1550 nm.

.3 Graded-index glass.

.4 Gel-filled, loose-buffer construction.

.5 Attenuation: 0.5/0.5 dB/km @ 1,310 / 1,550 nm.

.6 Numerical aperture: 0.275.

.7 Strength member: Kevlar.

.8 Pulling tension: 2000 N.

.9 Jacket: PVC.

.10 FT6 rating outer jacket.

.11 Type: Plenum Rated Cable.

.2 Break-out cables and jumpers shall be tight-buffer construction. Jumper cables shall be supplied as factory assembled units.

.3 Fibre Optic connectors shall be ceramic LC type. Terminations shall be completed with pre-terminated crimp ends or fusion spliced pigtails.

.9 Fibre-Optic Multi-Mode Cable:

.1 Cable to conform with the following:

.1 ANSI X3.166.

.2 Minimum ANSI/TIA/EIA-492-AAAC designation. ANSI/TIA/EIA-492-AAAD designation may be used only when required for distance and bandwidth.

.3 50/125 Tm core/cladding.

.4 Dual-mode OM3, 850/1300 nm.

.5 Graded-index glass.

.6 Gel-filled, loose-buffer construction.

.7 Spiral interlocked armour.

.8 Bandwidth: 1500/500 MHz-km @ 850/1,300 nm.

.9 Attenuation: 3.25/1.0 dB/km @ 850/1,300 nm.

.10 Numerical aperture: 0.275.

.11 Strength member: Kevlar.

.12 Pulling tension: 2,000 N.

.13 Jacket: Polyethylene

.2 Break-out cables and jumpers shall be tight-buffer construction. Jumper cables shall be supplied as factory assembled units.

.3 Fibre Optic connectors shall be oven-cure aluminum/ceramic LC type.

.4 All fibre terminations are to include buffer tube fan out kits, connectors, termination/distribution panels, and wall mount enclosures.

.5 All cables shall be indoor/outdoor direct burial rated and rodent protected.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Do not make splices in any of the data cable runs. Where splices are required due to available delivery lengths, obtain the approval of the designer prior to installing the cable.

.3 Where splices are made to coaxial or twin-axial cables, use standard coaxial cable connectors. Splices in fibre-optic cables shall be fusion type.

.4 Ground cable shields at one end only. Ground the shields at the marshalling panel.

.5 Protect all cables against moisture during and after installation.

.6 Install Ethernet cable in accordance with ANSI/TIA-568-C.2. Install cabling in conduit.

.7 Install armored Ethernet cable in accordance with ANSI/TIA-568-C.2. Attach cabling to walls and ceilings with PVC clamps with clamp backs at 1.2 m intervals or in cable tray.

.8 Install fibre-optic cable in conduit or cable tray raceways in compliance with the Manufacturer instructions. For conduit installations, provide pull boxes at 50 m maximum spacing. Coil sufficient cable for loop to reach floor at box location, but not less than 6 m. Pull box shall be not less than 600 by 600 by 200 mm size. Conduits shall enter sides of pull box at approximately 100 mm from top of box. Identify cables in accordance with Section 16010 – Electrical General Requirements at entrance and exit to box.

.9 Conductor Terminations:

.1 Terminate shields of any cable operating at over 20 kHz with radial connector; pigtails not permitted.

.2 Provide tool-crimp N-connectors at coaxial cable terminations except trunk runs.

.3 Provide tool-crimp TRN connectors at twin-axial cable terminations.

.4 Terminate fibres of fibre-optic cables with break-out kit and ST-type connectors in cross-connect panels. Provide sufficient jumpers to cross connect all cores at each cross-connect panel.

.10 Service Conditions:

.1 Except for installation solely within air-conditioned control rooms, cables shall be suitable for the following:

.1 Installation in raceways, trays, or attached directly to structural surfaces.

.2 Exposure to direct sunlight.

.3 Continuous submersion in water.

3.1 Testing

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable Manufacturer.

.3 All fiber optic cable sample test sheets and all test results. Test forms shall clearly label the test type, the test location, test date, wavelength, index of refraction, cable identification, fiber type, fiber number, fiber colour, and the result or the value of the tested parameter. Along with the test forms, the following documents shall be submitted:

.1 Manufacturer’s data on testing equipment used on this project.

.2 Details (such as Manufacturer, model number, serial number and calibration expiration date) of test equipment being used. Must be current within six (6) months of test date.

.3 All OTDR traces and end-to-end attenuation testing (attenuation and length) results shall be supplied on printed hard copy and submitted electronically.

.4 A completed warranty registration.

.5 Testing shall be in accordance with TIA -526-14-C. TIA -568, TIA-455-78-B for Multimode 50/125 μm.

.6 Test cable for continuity to include cable, connectors, splices (if applicable) and adapters on each strand.

.7 Cable links must be tested for 100% of the installed cable. Any failing links must be diagnosed and corrected, followed with a new test to verify that the corrected link meets the Manufacturer and standards performance requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of junction boxes, splitters, and pull boxes.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 C22.2 No. 0, General Requirements – Canadian Electrical Code, Part II.

.2 C22.2 No. 0.4, Bonding of Electrical Equipment.

.3 C22.2 No. 14, Industrial Control Equipment.

.4 C22.2 No.76, Splitters.

.5 C22.2 No. 30, Explosion-proof Equipment.

.6 C22.2 No. 40, Junction and Pull Boxes.

.7 C22.2 No. 94, Special Purpose Enclosures.

.8 C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-environmental Considerations (Tri-national standard with NMX-J-235/1-ANCE and UL-50).

.9 C22.2 No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations (Tri-national standard with NMX-J-235/2-ANCE and UL-50E).

.10 C22.2 No. 286, Industrial Control Panels and Assemblies.

.2 Electrical Equipment Manufacturers Association of Canada (EEMAC), now known as Electro-Federation Canada.

.3 Manitoba Building Code (MBC):

.1 The Buildings and Mobile Home Act amendments to the National Building Code of Canada (NBC).

.4 Manitoba Electrical Code (MEC):

.1 Manitoba amendments to the Canadian Electrical Code (CEC).

.5 National Electrical Manufacturers Association (NEMA):

.1 NEMA ICS 6, Industrial Control and Systems: Enclosures.

.6 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.7 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

.8 Underwriters Laboratories Canada (cUL):

.1 508A, Industrial Control Panels.

.2 698A, Industrial Control Panels Relating to Hazardous (Classified) Locations.

.3 1203, Explosion Proof and Dust-Ignition Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.3 Definitions

.1 Junction Box: A box where conductors are spliced without terminal blocks, boxes are not scheduled on drawings or tagged in field.

.2 Terminal Box: A box containing terminal blocks to connect conductors, boxes are scheduled on drawings and tagged per *WWD Identification Standard* for instrumentation and electrical circuits respectively.

.3 Pull Box: A box used to ease the pulling of conductors to be a through-pull or a T or X conduit connection, but no splicing of conductors is being done. Generally, not scheduled on drawings or tagged in field.

.4 Cabinet: An enclosure containing electrical control components including relays, controllers and the like or an enclosure with a large number of terminal blocks for the purpose of serving as a marshalling point for a number of branch circuits. Scheduled on Drawings and tagged in field.

.5 Splitter: An enclosure containing a splitter block or bus bars for the connection of a main circuit.

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Terminal block and component layout.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Catalogue numbers specified are for illustrating features and to establish the grade of quality of the products specified in this Section and are taken from one Manufacturer's product line. Products from other listed Manufacturers which have identical features and characteristics are permitted.

.2 Acceptable Manufacturers:

- .1 Appleton.
- .2 BEL Products.
- .3 Crouse-Hinds.
- .4 Hammond.
- .5 Hoffman.
- .6 Killark.
- .7 Eurobex.
- .8 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Low Voltage Splitters:

- .1 Comply to CSA C22.2 – No. 76.
- .2 Stainless steel enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .3 Main and branch lugs or connection bars to match required size and number of connecting conductors.
- .4 At least three spare terminals on each set of lugs in splitters.
- .5 Use electrical splitters in controlled environments only (non-process areas).

.2 Junction Boxes:

- .1 For outlet and conduit boxes refer to Section 16141 – Outlet Boxes, Receptacles and Switches.
- .2 For below-grade and cast-in-concrete application, NEMA Type 4X, cast iron alloy body and cover with neoprene gasket.

.1 Flanged with bolted cover.

.2 Acceptable Manufacturer:

.1 Crouse-Hinds Type WJB.

.2 Or approved equivalent.

.3 Flanged with bolted, checkered, flush sidewalk cover.

.4 Acceptable Manufacturer:

.1 Crouse-Hinds Type WJBF.

.2 Or approved equivalent.

.3 Terminal and Pull Boxes:

.1 Intended for surface mounting, except as otherwise shown or specified in final design.

.2 Weatherproof, Style WP1:

.1 Copper-free cast aluminum, NEMA Type 4.

.2 Hinged door if any one dimension exceeds 300 mm.

.3 Manufactured breather designed to maintain weatherproof classification of enclosure.

.4 When used as terminal box, equipped with mounting pan and terminal strip, to Section 16141.

.5 Acceptable Product:

.1 Killark, Series DB.

.2 Or approved equivalent.

.3 Weatherproof, Style WP2:

.1 Same features as for Style WP1, except made of sheet aluminum, minimum 2.3 mm thick.

.2 Dripshield.

.3 Acceptable Product:

.1 Hammond Series 1418 N4 AL.

.2 Or approved equivalent.

.4 Weather- and corrosion-proof, Style WP3:

.1 Same features as for Style WP1, except NEMA Type 4X enclosure, made of Type 316 stainless steel.

.2 Acceptable Product:

.1 Hoffman Series A*SS6LP.

.2 Or approved equivalent.

.5 Weather- and corrosion-proof, Style WP4:

.1 Same features as for Style WP1, except non-metallic, NEMA Type 4X fibreglass enclosure.

.2 Quick-release latches.

.3 Acceptable Product:

.1 Hammond Series PJ.

.2 Or approved equivalent.

.6 Indoor Dry Location, Style GP5:

.1 Welded steel or aluminum NEMA Type 12 enclosure.

.2 Hinged cover with quick-release latch, automotive handle and lockable for enclosures which exceed 300 mm in width or height per location requirements.

.3 Acceptable Product:

.1 Hammond Series 1414PH/1418.

.2 Or approved equivalent.

.7 Watertight, Style WT:

.1 Same as weatherproof styles WP1 to WP 4, except without breather.

.8 Explosion-proof, Style XP:

.1 Same features as for Style WP1, except, in addition to being weatherproof, also suitable for the hazardous location shown or specified.

.2 Acceptable Manufacturer:

.1 Crouse-Hinds Type EJB.

.2 Or approved equivalent.

.4 Cabinets:

.1 Intended for surface mounting, except as otherwise shown or specified in final design.

.2 Single- or double-door construction with stainless steel full-length hinge.

.3 Minimum standard: formed and welded NEMA Type 12 construction, of minimum 1.8 mm thick sheet steel, with automotive door handle.

.4 For process and outdoor areas and below grade valve chambers: formed and welded NEMA Type 4 construction of minimum 2 mm thick sheet aluminum, with stainless steel door clamps.

.5 Full size equipment mounting pan of formed sheet metal.

.6 Acceptable Manufacturers:

.1 Hammond Series 1418 and 1418 N4 AL, for Type 12 and Type 4 respectively.

.2 Or approved equivalent.

.5 Equipment Mounting Hardware:

.1 Mounting straps, brackets and fastening hardware designed for the installation of terminal blocks.

.2 Welded studs in sheet metal enclosures to avoid penetration of enclosure walls.

.3 Raised cast bosses in cast metal enclosures, drilled and tapped, for hardware installation.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 Splitter Installation:

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise in final design.

.4 Junction, Pull Boxes and Cabinet Installation:

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor, coordinated with other equipment and items including masonry, panel boards, and fire hose cabinets.

.3 Install terminal blocks using mounting straps and hardware designed for this purpose.

.4 Install pull boxes so as not to exceed length of conduit runs as specified in Section 16132.

.5 Minimum standard in Process Areas and below grade locations is NEMA Type 4.

.6 Install a breather in locations of high humidity and changing temperature conditions when enclosures are installed outdoors and do not contain environmental temperature control, or in Category 1 or Category 2 areas that share exterior doors (for personal or overhead) that can be opened for a period for time.

.7 Where boxes terminate conduits at interior walls below grade elevation, provide a drain hole in the bottom of the box suitable for accumulated moisture drainage.

.5 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of outlet boxes, receptacles and switches.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

.2 C22.2 No. 14, Industrial control equipment.

.3 C22.2 No. 18.1, Metallic outlet boxes (Tri-national standard with ANCE NMX-J-023/1 and UL514A).

.4 C22.2 No. 18.2, Nonmetallic outlet boxes.

.5 C22.2 No. 18.3, Conduit, tubing, and cable fittings (Tri-national standard with ANCE NMX-J-017 and UL514B).

.6 C22.2 No. 18.4, Hardware for support of conduit, tubing, and cable (Bi-national standard with UL-2239).

.7 C22.2 No. 18.5, Positioning devices (Bi-national standard with UL-1565).

.8 C22.2 No. 25, Enclosures for use in Class II, Division 1, Groups E, F, and G hazardous locations.

.9 C22.2 No. 30, Explosion-proof equipment.

.10 CSA C22.2 No. 213, Non-incendive electrical equipment for use in Class I and II, Division 2 and Class III, Division 1 and 2 hazardous (classified) locations (Bi-national standard with ISA 12.12.01).

.2 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.3 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

.4 Underwriters Laboratories Canada (cUL):

.1 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

.2 1203, Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Location

.5 City of Winnipeg electrical design guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Catalogue numbers specified are for illustrating features and to establish the grade of quality of the products of this Section. Products from other listed Manufacturers which have identical features and characteristics are permitted.

.2 Acceptable Manufacturers:

.1 Outlet and conduit boxes:

.1 Appleton.

.2 Crouse-Hinds.

.3 Killark.

.4 Or approved equivalent.

.2 Receptacles and switches:

.1 Bryant, Hubbell.

.2 Pass and Seymour.

.3 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Colours:

.1 Colouring shall follow the WWD electrical design guide.

2.3 Configuration, Components and Features

.1 Outlet and Conduit Boxes – General:

.1 Boxes suitable for area classification shown or specified and except as further noted, made of same material or to have same finish as connecting conduit where available.

.2 Size boxes in accordance with CSA C22.1.

.3 102 mm square or larger outlet boxes as required for special devices.

.4 Pre-Gang, single-gang boxes where wiring devices are grouped.

.5 Sectional boxes are not permitted.

.6 Blank cover plates for boxes without wiring devices.

.7 Combination boxes with barriers where outlets for more than one system are grouped.

.8 In areas where conduit and cable is surface run provide copper-free aluminum type FD boxes.

.9 In areas where EMT conduit is permitted, provide electro-galvanized pressed sheet steel boxes.

.10 All outlets and switchboxes on drywall surfaces shall be flush mounted.

.2 Sheet Steel Outlet Boxes:

.1 Electro-galvanized steel multi gang flush devices boxes for flush installation, minimum size 102 mm x 54 mm x 48 mm. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings.

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

.3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

.3 Outlet Boxes for Metal conduit:

.1 Materials:

.1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.

.2 Surface mounting exposed: FS type, cast aluminum for threaded conduit, with attached lugs, corrosion resistant two coats finish.

.2 Components:

.1 Ceiling outlets, surface mounting, concealed:

.1 102 mm square, depth 54 mm, Iberville 52171 series.

.2 119 mm square, depth 54 mm, Iberville 72171 series.

.4 Outlets, concealed mounting in concrete:

.1 102 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series or approved equivalent.

.2 Wall boxes, concealed in concrete or masonry: for one and two gang applications: 102 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.

.3 Wall outlets, dry general location only, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required, or approved equivalent. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or approved equivalent).

.4 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series (or approved equivalent), condulet.

.5 Floor outlets shall be concealed type: Of a type adjustable after box secured, permanently watertight concrete type, sheet steel, T & B #1963, or approved equivalent.

.6 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

.5 Outlet Boxes for Rigid PVC Conduit:

.1 Materials:

.1 Rigid PVC boxes and fittings: Un-plasticized PVC.

.2 Components:

.1 Floor boxes: Round with threaded hubs for threaded female connectors.

.6 Masonry Boxes:

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

.7 Concrete Boxes:

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

.8 Conduit Boxes:

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

.2 Fibreglass or RPVC boxes with factory-threaded hubs and mounting feet for locations exposed to the elements, in corrosive non-hazardous areas, and in below grade pipe chambers.

.3 Cast metal boxes with suitable classification in hazardous locations.

.1 Crouse-Hinds Type GRFX.

.2 Or approved equivalent.

.9 Fittings – General:

.1 Suitable for area classification shown or specified in final design and except as further noted made of same material and finish as connecting conduit where available.

.2 Bushing and connectors with nylon insulated throats.

.3 Knock-out fillers to prevent entry of foreign materials.

.4 Use conduit outlet bodies for conduit up to 1¼ inch and pull boxes for larger conduits.

.5 Use double locknuts and insulated bushings on sheet metal boxes.

.10 Switches:

.1 15 A or 20 A, single- and double-pole, three- and four-way, and other variations including key-operated switches and pilot lights.

.2 Use 20 A, 120/277 V press-switch type for wet and corrosive locations:

.1 Hubbell Series HBL1281.

.2 Or approved equivalent.

.3 For single-pole 120/277 V double-throw applications use:

.1 Hubbell Series HBL1381 for maintained contact and HBL1556 for momentary contact.

.2 Or approved equivalent.

.11 U-Ground, Straight Blade Receptacles 15 A, 125 V:

.1 Use CSA type 5-15R, premium specification grade.

.2 For general use:

.1 Hubbell No. 5261 single or 5262 duplex receptacles with one-piece grounding system, triple-wipe contacts, and break-off links for use as split receptacles.

.2 Or approved equivalent.

.3 For wet and corrosive locations:

.1 Hubbell 52CM61 single or 52CM62 duplex receptacles.

.2 Or approved equivalent.

.4 For isolated ground applications:

.1 Hubbell IG-5261 for single receptacles or Hubbell IG-5262 for duplex receptacles.

.2 Or approved equivalent.

.5 For ground fault circuit interrupter duplex receptacles, use:

.1 Hubbell GF5252-GRY.

.2 Or approved equivalent.

.12 U-Ground Straight Blade Receptacles Above 15 A:

.1 Same properties as for 15 A, 125 V type.

.2 Configuration as listed in CSA C22.1, Diagram 1.

.3 Limit straight blade receptacles to 30 A, 250 V.

.4 Adhere to colour-coding as specified.

.5 For general process areas and sump pump receptacles, use:

.1 20A T-slot (5-20R), corrosion-resistant, yellow Hubbell HBL53CM61.

.2 Or approved equivalent.

.13 Locking Type Receptacles Up To 250 V:

.1 Heavy duty, grounding-type, specification grade.

.2 Configuration as listed in CSA C22.1, Diagram 2.

.3 Limit this type of receptacle to 30 A, 250 V.

.4 Adhere to colour-coding as specified.

.14 Pilot Lights:

.1 For use in conjunction with a lighting switch.

.2 LED pilot lights with red jewel lens.

.3 Push to test.

.15 Power outlets:

.1 Heavy duty, water-tight, circuit breaking pin and sleeve type with dedicated grounding pin.

.2 Provide the appropriate power outlets per CEC Diagram 1 or Diagram 2 to match each application and operational requirement.

.3 Amperage and voltage as set out in the Final Design.

.4 Copper-free cast aluminum back boxes, angle-style or with angle adaptors, as applicable.

.5 Spring-loaded door with locking ring.

.6 Materials: non-metallic body, locking ring and door, brass pins and sleeves. Stainless steel springs and hardware.

.7 Acceptable Products:

.1 Crouse-Hinds watertight pin and sleeve.

.2 Or approved equivalent.

.16 Safety Interlock Receptacles:

.1 With integral heavy-duty, horsepower-rated mechanical disconnect switch, interlocked with receptacle in a manner as to prevent the insertion and removal of plug when switch is not in the OFF position.

.2 Amperage and voltage per final design.

.3 Enclosure high-impact thermoplastic, rated NEMA 4X.

.4 Receptacle pin and sleeve-type features as specified for Power Receptacles.

.5 Acceptable Product:

.1 Crouse-Hinds CW430M15W, 30 A, 600 VAC, 3 PH, 20 HP.

.2 Or approved equivalent.

.17 Quick Connectors and Receptacles:

.1 Connectors, straight-type, moulded to heavy duty cable, 1.8 m long.

.2 Receptacles, straight-type to match connector.

.3 3-pole and 5-pole models.

.4 Acceptable Product:

.1 Brad-Harrison/Woodhead.

.2 Or approved equivalent.

.18 Wiring Devices for Hazardous Locations:

.1 Devices shall be certified for the hazardous location.

.2 Switches use:

.1 Crouse-Hinds Type EFS and EFD.

.2 Or approved equivalent.

.3 Receptacles, up to 30 A, 250 V use:

.1 Crouse-Hinds Arktite Type CPS.

.2 Or approved equivalent.

.19 Plugs and Connectors:

.1 Use U-Ground, straight blade-type, corrosion-resistant nylon/polycarbonate body, premium specification grade, with cord grip provision acceptable products.

.1 Hubbell Series 5*CM66.

.2 Or approved equivalent.

.2 Locking-type, as above, acceptable product:

.1 Hubbell Series CM-C.

.2 Or approved equivalent.

.3 Power plugs to match respective receptacles in material and pin configuration.

.1 Hubbell pin and sleeve series.

.2 Or approved equivalent.

.20 Cover Plates:

.1 Brushed stainless steel, min. 1 mm thickness, for flush-mounted devices.

.2 Sheet steel utility box cover plates with rounded edges for surface mounted utility boxes.

.3 Copper-free, cast aluminum covers with neoprene gasket for FS-style boxes.

.4 For weatherproof and corrosion-resistant switches:

.1 Hubbell No. 17CM50.

.2 Or approved equivalent.

.5 For weatherproof switches where switch position is critical:

.1 lever-type cover, Scepter VSC.

.2 Or approved equivalent.

.6 For corrosion-resistant receptacles:

.1 Hubbell Series 52CM2.

.2 Or approved equivalent.

.7 For weatherproof receptacles:

.1 Cast aluminum with double lids, "cover self-closing" type, Hubbell Series 520*WO.

.2 Or approved equivalent.

.8 Provide multi-gang cover plates on multi-gang boxes.

.9 Plates for special ampere receptacles shall be stainless steel to suit the receptacles.

.10 Receptacles noted on the final design drawings with a ‘WP’ designation shall be provided with:

.1 Hubbell No. 5222 flip-cap style cover plate suitable for wet locations.

.2 Or approved equivalent.

2.4 Identification

.1 For receptacles up to 250 V provide a Type 3 nameplate identifying the locational feed including information from the associated panel board and its circuit number.

.2 For receptacles above 250 V up to 600 V provide a Type 1A nameplate indicating the device fed from MCC equipment number, and descriptor.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Ensure that there is insulation and vapour barrier behind boxes mounted in exterior walls, to prevent condensation through boxes.

.4 Mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials. Where several devices are mounted in the same area, the devices shall be vertically and horizontally aligned.

.5 For receptacles, colour of nameplate to match colour of receptacle except that for receptacles with a dual function. Provide receptacle colour-coded with the prime function and the nameplate colour-coded with the secondary function per WWD electrical design guide.

.6 Test wiring devices for correct connections.

.7 Outlet and Conduit Boxes:

  .1 Support boxes independently of connecting conduits.

  .2 Provide temporary mechanical protection to fill boxes for the prevention of debris from entering the box(es). Remove temporary protection upon completion of Project, replace covers, perform seals etc. for a finished and complete installation.

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

  .4 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

  .5 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

  .6 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building in finished areas. Maintain wall insulation.

  .7 Outlets installed in party walls shall be offset by a minimum of one (1) stud space.

  .8 Install neoprene gaskets on all cast boxes and fittings.

  .9 Provide correct size of openings in boxes for conduit and cable connections. Reducing washers are not allowed.

  .10 Where boxes terminate conduits at interior walls below grade elevation, provide a drain hole in the bottom of the box suitable for accumulated moisture drainage.

.8 Switches:

  .1 Install single throw switches with handle in "UP" position when switch closed (ON).

  .2 Install switches in gang type outlet box when more than one switch is required in same location.

.3 Mount toggle switches at height required, and when not shown as specified in Section 16010.

.4 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise required by the Final Design.

.9 Outlets:

.1 Install receptacles in gang type outlet box when more than one (1) receptacle is required in one (1) location.

.2 Mount receptacles vertically at height specified in Section 16010 – Electrical General Requirements. Mount with ground slot at bottom.

.3 Where split receptacle has one (1) portion switched, mount vertically and switch upper portion.

.10 Cover Plates:

.1 Provide cover plates for all wiring devices.

.2 Protect stainless steel cover plate finish with paper or plastic film until painting and other Work is finished.

.3 Install suitable common cover plates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.4 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.11 Quick Connectors and Outlets:

.1 Use to connect 120 VAC power supply to instruments and to connect solenoid valves, pressure switches, temperature switches and other instrument components.

.2 Select 3-pole and 5-pole type as set out in the Final Design.

.3 The supply side shall be the outlet connector, the receiving side shall be the inlet connector.

.12 Mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.13 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of fastening and support systems for cables, cable trays, raceways, and electrical equipment.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .2 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .4 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .5 E119, Standard Method for Fire Tests of Building Construction and Materials.
- .6 E814, Standard Test Method of Fire Tests of Through Penetration Firestops.

.2 FM Global (FM):

- .1 Approval Guide, A Guide to Equipment, Materials & Services Approved by Factory Mutual Research For Property Conservation.

.3 Canada Standards Association (CSA):

- .1 CSA C22.1, Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

.4 Underwriters Laboratories Canada (cUL):

- .1 FRD, Fire Resistance Directory.
- .2 263, Fire Tests of Building Construction and Materials.
- .3 723, Test for Surface Burning Characteristics of Building Materials.
- .4 1479, Fire Tests of Through-Penetration Firestops.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Catalogue numbers specified are for the purpose of illustrating features and to establish the grade of quality of support systems. Products from other Manufacturers listed that have identical features and characteristics are permitted.

.2 Acceptable Manufacturers

.1 B-Line Systems Inc.

.2 CANSTRUT Products Ltd.

.3 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Support and Framing Channels:

.1 Channel shall be U-shape with rolled edges for attachment of fastening nuts and clamps.

.2 Single and factory-welded, multi-channel configuration.

.3 Extruded copper-free aluminum in Category 1 areas, Type 316 stainless steel in hazardous Category 2 areas, or fibreglass in corrosive non-hazardous Category 2 areas. Use like materials for supporting materials. Aluminium or stainless steel shall be 41 x 41 mm, 2 mm thick. Coordinate material selection with Section 16114 - Cable Tray systems, and Section 16106 - Conduit systems.

.2 Framing Fittings and Hardware:

.1 Factory-made and finished, material shall match the support channels to form a complete system and shall be selected for the prevention of galvanic corrosion.

.3 Ceiling Hangers:

.1 ANSI Type 316 stainless steel, threaded rod hangers minimum 12 mm diameter.

.2 Straps or hangers of plumber's perforated banding are not permitted.

.4 Beam Clamps:

.1 Factory-made and finished, designed for the live load to be supported.

.2 ANSI Type 316 stainless steel.

.5 Concrete and Masonry Anchors:

.1 Anchor bolts as specified in Section 05501 – Anchor Bolts.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Secure equipment to masonry, tile, and plaster surfaces with nylon shields.

.3 Secure equipment to poured concrete with expandable inserts of the same material type to prevent corrosion. At minimum the insert material shall be stainless steel, or approved material with composition and coatings suitable for the application.

.4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts. At minimum the insert material shall be stainless steel, or approved material with composition and coatings suitable for the application.

.5 Secure surface-mounted equipment with twist clip fasteners to inverted T-bar ceilings. T-bars shall be adequately supported to carry the weight of the equipment specified before installation.

.6 Unless approved, wooden plugs, plastic inserts, or gunpowder-driven inserts are not permitted as a base to secure conduit supports.

.7 Match support and framing channels to conduit and equipment it is used with; that is, materials shall be selected for the prevention of galvanic corrosion.

.8 Support equipment, conduit, and cables using clips, spring-loaded bolts, or cable clamps designed as accessories to basic channel members. Materials shall be selected for the prevention of galvanic corrosion and suitable for area classification.

.9 Fasten exposed conduit and cables to building construction or support system using straps as specified in Section 16106 – Conduit Systems.

.10 Use beam clamps to secure conduit to exposed steel work. Materials shall be selected for the prevention of galvanic corrosion and suitable for area classification.

.11 Cables to be supported by cable channels or cable trays. Provide a cable tray system for three (3) or more cables when cable lengths exceed 3 m.

.12 For surface mounting of two or more conduits use channels at spacing as specified in the CEC.

.13 Provide metal brackets, frames, hangers, clamps, and related types of support structures where indicated or as required to support conduit and cable runs. Materials shall be selected for the prevention of galvanic corrosion.

.14 Raceways and cables dropped vertically to equipment where there is no wall support shall be supported by other approved methods.

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

.16 Aluminum supports shall not come into direct contact with concrete in process areas and in all Category 1 and Category 2 wet/moist areas unless it is wrapped or coated. Materials shall be selected for the prevention of galvanic corrosion.

.17 Conduit and cable shall not be supported by other trades, or equipment added to these same supports by other trades except with permission from the installer with approval of the Engineer of Record.

.18 Install fastenings and supports as required for each type of equipment cables and conduits, and as specified in the Manufacturer's installation recommendations.

.19 Do not weld supports to structural members and do not cut or drill beams, joists, or structural steel. Where welding has been permitted, treat welded area with rust-resistant primer and finish paint.

.20 Supports shall be securely fastened, and free from vibration and excessive deflection or rotation. Deflections shall not exceed 4 mm over a 1 m span and 8 mm over a 2 m span.

.21 Use round or pan head screws for fastening straps and boxes. Materials shall be selected for the prevention of galvanic corrosion.

.22 Perform tests in accordance with Section 16020 – Electrical Testing.

   .1 Load applied to any fastener shall not exceed 25 percent of proof test load. Use vibration and shock resistant fasteners for attachments to concrete slabs.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of alternating current induction motors, 0.125 kW (1/3 HP) and smaller. Motors larger than 1/3 HP are specified in 16223 – Electric Motors up to 250 kW.

.2 Unless specified otherwise, electric motors shall be provided by the Manufacturer of the driven equipment, as an integral component of the driven equipment, as specified in Division 11 and Division 15. Conform to the requirements of Division 11.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 CSA C22.2 No. 100 - Motors and Generators.
- .2 CSA C22.2 No. 145 - Electric Motors and Generators for Use in Hazardous Locations.
- .3 CSA C747 - Energy Efficiency Test Methods for Small Motors.

.2 National Electrical Manufacturer Association (NEMA):

- .1 NEMA Std. MG1 - Motors and Generators.

.3 Institute of Electrical and Electronics Engineers (IEEE):

- .1 IEEE Std. 114 - IEEE Standard Test Procedure for Single-Phase Induction Motors.

.4 Canadian Electrical Code (CEC) as adopted by the Province of Manitoba.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Nameplate data in accordance with NEMA MG 1
- .3 Motor Data for each typical size or type of motor-driven equipment shall be provided on approved forms for the project.
- .4 Overall dimensions of motor.
- .5 Enclosure type and mounting (e.g., horizontal, vertical).
- .6 Shaft centreline to base dimension.

.7 Shaft extension diameter and keyway, coupling dimensions and details.

.8 Fixing support dimensions.

.9 Terminal box location and size of terminals.

.10 Arrangement and dimensions of accessories.

.11 Connection diagrams for power and control.

.12 Speed/torque characteristic.

.2 The submittals for this Section and the submittal for the equipment that is driven by the motor shall be combined into one submittal.

1.4 Quality Assurance

.1 Build motors as specified in CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers: Acceptable Manufacturers and Acceptable Products are listed below. The Manufacturer’s standard product may require modification to conform to specified requirements.

.2 Acceptable Manufacturers:

.1 Baldor.

.2 Bodine.

.3 US Motors.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Exposure Classification:

.1 The motor shall be suitable for the area classification.

2.3 Configuration, Components and Features

.1 General:

.1 Motors shall have Class F insulation.

.2 Provide copper rotor material and copper windings.

.3 Motor nameplate shall be engraved or stamped Type 316 stainless steel, and shall include information enumerated in NEMA Standard MG1, as applicable. Nameplates shall be permanently fastened to the motor frame in a readily visible place.

.4 Materials shall be selected for the prevention of galvanic corrosion. Motors shall include integral overload and overheating protection per CSA C22.1 Section 28 and shall include branch circuit protection with motor starter and overload for overheating protection.

.5 Motors shall include anti-condensation heater in unheated spaces and outdoor applications, to minimize condensation within the motor enclosure.

.6 Provide motors with totally-enclosed fan-cooled TEFC or totally-enclosed non-ventilated TENV enclosures.

.7 Provide explosion-proof motors marked or labeled for Class I, Zone 1, Group IIA hazardous.

.8 Connection Boxes:

.1 In hazardous areas, provide explosion-proof conduit box(es).

.2 Provide a grounding lug within the box for a cable or raceway ground connection.

.3 Boxes shall be designed to permit installation in any of four positions 90 degrees apart.

.4 Provide oversized boxes, a minimum of one size larger than standard box size.

.5 Connection box shall be copper-free aluminum when installed in process areas.

.2 Rating:

.1 Motors shall be rated for operation at 115 VAC,1 phase 60 Hz, and continuous-time rated in conformance with NEMA Standard MG1.

.2 For valve actuators not available at 115 VAC or 208 VAC, motors shall be rated for operation at 600 VAC/3 ph/60 Hz.

2.4 Finishes

.1 Corrosion-resistant epoxy finishes shall be applied to enclosure.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.1 Perform insulation testing and coordinate between trades to perform motor checks for proper direction of rotation, verify correct rotation, and correct if needed.

.2 Measure running current and evaluate related to load conditions and nameplate full-load amperage.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and install of alternating current induction motors, 250 kW or below, to be provided with the driven equipment.

.2 This Section does not apply to medium voltage (2300 V and greater), specialty motors including valve operator motors, and torque rated motors.

.3 Unless specified otherwise, electric motors shall be provided by the Manufacturer of the driven equipment, as an integral component of the driven equipment, as specified in Division 11 and Division 15.

.4 Motors shall be suitable for rotating equipment.

1.2 Standards

.1 Canadian Standards Association (CSA):

  .1 CSA C22.2 No. 100 - Motors and Generators.

  .2 CSA C22.2 No. 145 - Electric Motors and Generators for Use in Hazardous Locations.

  .3 CSA C390 - Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors.

.2 National Electrical Manufacturer Association (NEMA):

  .1 NEMA Std. MG1 - Motors and Generators.

.3 Institute of Electrical and Electronics Engineers (IEEE):

  .1 IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.

  .2 IEEE 114 – Test Procedure for Single Phase Induction Motors.

.4 The City of Winnipeg Water and Waste Department (WWD):

  .1 WWD – Electrical Design Guideline.

.5 Manitoba Hydro Power Smart Program.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

  .1 Manufacturer's descriptive literature for materials.

.2 Motor Data for each typical size or type of motor-driven equipment shall be provided on approved forms for the project.

.3 Overall dimensions of motor.

.4 Shaft centreline to base dimension.

.5 Shaft extension diameter and keyway, coupling dimensions and details.

.6 Fixing support dimensions.

.7 Terminal box location and size of terminals.

.8 Arrangement and dimensions of accessories.

.9 Connection diagrams for power and control.

.10 Speed/torque characteristic.

.2 The submittals for this Section and the submittal for the equipment that is driven by the motor shall be combined into one submittal.

1.4 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

.2 Motors shall meet or exceed the efficiencies per CSA C390.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Baldor.

.2 General Electric.

.3 Toshiba.

.4 TECO Westinghouse (Canada).

.5 Siemens.

.6 U.S. Electric.

.7 ABB.

.8 Flygt (for submersible pump motors only).

.9 Or approved equivalent.

2.2 Performance Criteria

.1 Exposure Classification:

.1 The motor shall be suitable for the area classification.

2.3 Materials

.1 Unless specified otherwise, provide all motors with:

.1 Frame: Cast iron.

.2 Fan blades and shrouds: Cast metal.

.3 Hardware: Stainless steel.

.4 Windings: Non-hygroscopic.

2.4 Configuration, Components and Features

.1 Bearings:

.1 Provide sealed ball bearing type on motors less than 37.5 kW.

.2 Bearings on 37.5 kW motors or larger to be greaseable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

.3 Provide oversized, diagonally-split, gasketed, NEMA 4 terminal boxes complete with threaded hub for cable entry for ODP and TEFC motors.

.4 Provide oversized, diagonally -split, gasketed NEMA 7 terminal boxes complete with threaded hub for cable entry for explosion-proof motors.

.5 Conductors in terminal boxes shall be connected to R90 compression connectors.

.6 Provide a ground connection and lifting eyes or lugs.

.7 Motors shall be aligned and balanced with the related equipment in the shop to minimize vibration and undue stresses.

.8 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 V 1 phase 60 Hz.

.9 Current Imbalance:

.1 Do not exceed the current imbalance listed below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.1 Smaller than 3.75 kW: 25 percent.

.2 3.75 kW and larger: 10 percent.

.2 Base imbalance criteria upon the lowest value measured.

.10 Winding Over Temperature Protection:

.1 Provide stator winding over-temperature protection on all motors rated 45 kW and larger. Motors rated less than 45 kW shall have stator winding over-temperature protection when required by the specific equipment Specification Section or if recommended by the driven-equipment Manufacturer.

.2 Over-temperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over-temperature protection. One detector per phase shall be provided. Detectors shall be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4X enclosure in Type 2 motors and a NEMA 7C or 9 enclosures for Type 3 motors.

.3 In frequent and continuous applications (distribution pumping, conveyors, HVAC, chillers) where the drawings or other Specifications call for additional motor monitoring, provide a thermistor relay monitor as part of the motor protection and controls.

.4 For submersible motors refer to clause 2.4.7.

.2 High Efficiency Motors:

.1 Motors shall be rated Premium Efficiency as defined in NEMA MG-1.

.2 Design high efficiency horizontal motors to meet or exceed the minimum Manitoba Hydro Power Smart Program qualifying efficiency (not base efficiency) applicable.

.3 Motors 0.375 kW to 150 kW:

.1 General:

.1 Motors shall be 3-phase, squirrel-cage, full-voltage start, high efficiency induction type.

.2 Rating:

.1 Motors intended for continuous service shall be heavy-duty, high-efficiency, TEFC unless specified otherwise required by the Final Design.

.2 Provide squirrel cage induction type, with a service factor of 1.15 at 40^{o}C ambient, Class F insulation and non-hygroscopic windings unless otherwise required by the Final Design, Class B temperature rise.

.3 Motors shall be suitable for full-voltage starting. Voltage tolerance shall meet the American National Standards Institute (ANSI) C84.1-1982[2] or to be +10% to -10% of nameplate voltage.

.4 Motor voltage rating per WWD electrical design guide unless otherwise required by the Final Design.

.5 Provide motors of sufficient capacity to operate the driven load and associated devices under all specified operating conditions without overloading.

.1 Motors shall not deliver more than 85 percent of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

.3 Enclosure and Insulation:

.1 Classify motors as:

.1 Type 1 (General Duty).

.2 Type 2 (Process).

.3 Type 3 (Explosion-proof).

.2 Enclosures and insulation systems are specified in this Section. Temperature rise for all motor types shall not exceed that permitted by Note II, paragraph 12.42, NEMA MG1.

.3 Insulation to be non-hygroscopic.

.1 Type 1: Unless specified otherwise in final design, TEFC enclosures with Class F insulation.

.2 Type 2: TEFC with Class F insulation, suitable for moist and corrosive environment. Motors rated 7.5 kW and larger shall have Class F insulation with Class B temperature rise. All internal surfaces shall be coated with an epoxy paint. Aluminum frame motors shall not be permitted. Steel frame motors shall be permitted for motors with frames 184 and smaller.

.3 Type 3: rated for operation in a Class 1, Zone 1, Group IIA hazardous location in accordance with CSA C22.1 and Section 16010 – Electrical General Requirements. The motor shall have a Class F insulation. Steel frame motors shall not be permitted. A CSA approved breather-drain device shall be provided in the motor drain hole.

.4 Motors for VFDs:

.1 The motor shall be inverter duty rated for VFD applications and shall comply with NEMA MG-1 Part 31 for insulation.

.1 The motor shall have a service factor rating of 1.15 for sinusoidal 60Hz; service factor of 1.0 when operated from a VFD.

.2 Motors shall be capable of withstanding pulse-width modulated (PWM) wave shapes from VFD with peak phase-to-phase motor stator overvoltage.

.2 Motors shall be inverter duty and shall be compatible with the characteristics of the intended VFDs.

.3 Provide NEMA design B type motors with fans, blowers, and pumps.

.4 The motors design shall include self-ventilation capable of producing adequate cooling capacity throughout the motors range of operation.

.5 For constant torque applications provide inverter duty motors with winding over-temperature protection.

.6 Motors larger than 150 kW shall have an insulated bearing on the non-driven end (NDE).

.7 In frequent and continuous applications (distribution pumping, conveyors, HVAC, chillers) where the drawings or other Specifications call for additional motor monitoring, provide a thermistor relay monitor as part of the motor protection and controls.

.5 Vertical Motors:

.1 Provide full-voltage vertical motors with a Type P base specifically designed for vertical installation.

.2 Universal position motors shall not be permitted.

.3 Provide vertical motors with solid shafts.

.4 Provide thrust bearing rating compatible with the loads imposed by the equipment.

.6 Two-speed Motors:

.1 Provide two-speed motors with separate windings.

.2 Single-winding two-speed motors shall not be permitted.

.7 Submersible Pump Motors:

.1 Provide induction type motor with a squirrel cage rotor, shell type design, NEMA B type, rated for 575 V, 3 phase, 60 Hz and 115 V, 1 phase, 60 Hz for 0.75 kW and smaller.

.2 Housed in an air-filled watertight chamber.

.3 Winding insulation shall be moisture resistant Class F rated for 155°C.

.4 Design the motor for continuous duty handling pumped media of 40°C.

.5 Motor shall be capable of up to fifteen (15) evenly spaced starts per hour.

.6 Provide thermal switches embedded in the stator coils to monitor the temperature of each phase winding. Thermal switches shall be set to open at 125°C. Switches shall reset automatically after motor cools.

.7 Use the thermal switches in conjunction with and supplemental to external thermal motor overload protection.

.8 Provide NEMA design B type motors with fans, blowers, and pumps.

.9 Provide the combined service factor (combined effect of voltage, frequency).

.10 Design the motor for 40ºC ambient temperature with a temperature rise not to exceed 80ºC.

.11 Provide motor with power and monitoring cables with oil-resistant chloroprene rubber of sufficient length to reach the wall-mounted disconnect switch and control station, when required.

.12 Provide shielded monitoring cables for variable frequency driven motors.

.13 The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 20 m.

.14 Motor shall be sufficiently cooled by the surrounding environment and pumped media.

.15 The motor power shall be adequate so that the pump does not overload the motor throughout the entire pump performance curve from shut-off to run-out.

2.5 Finishes

.1 Provide motor finishes in accordance with Section 16010 – Electrical General Requirements.

2.6 Identification

.1 Nameplates:

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information specified in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Additionally, indicate:

.1 The ABMA L-10 rated life for the motor bearings for motors 50 HP and larger.

.2 The nominal efficiency for all motors.

.3 Class, zone, group, and UL frame temperature limit code for explosion-proof motors.

.4 Motor application (e.g., Inverter-duty).

.5 Speed range over which the machine is designed to operate.

.6 Type of torque application for which the machine is designed e.g., VT (variable torque), CT (constant torque), CHp (constant horsepower) or equivalent.

.7 Type of inverter it is designed for e.g., PWM (pulse width modulated).

.3 Permanently fasten nameplates in a readily visible position on the motor frame.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Motor Installation:

  .1 Dry out motor if dampness present, in accordance with Manufacturer's recommendations.

  .2 Provide connections as indicated in the design builder final design. Use liquid-tight PVC jacketed flexible conduit between rigid conduit and motor.

  .3 Provide flexible conduit long enough to permit movement of motor over entire length of slide rails, when applicable.

  .4 Perform tests in accordance with Section 16020 – Electrical Testing.

  .5 Perform insulation testing and coordinate between trades to perform motor checks for proper direction of rotation, verify correct rotation with motor uncoupled from driven equipment, and correct if needed.

  .6 Align and couple motor to driven machinery to Manufacturer's instructions, using only correct parts including couplings, belts, sheaves, as provided by Manufacturer.

END OF SECTION

MOTOR CONTROL CENTRES

1. GENERAL

1.1 Summary

.1 This Section covers work related to Section 16010 – Electrical General Requirements for the provision of motor control centres.

1.2 Standards

.1 WWD Electrical Design Guide in Appendix 18D – City Standards.

.2 Canadian Standards Association (CSA):

- .1 CSA C22.1, Canadian Electrical Code Part I (CEC), as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.
- .2 C22.2 No. 0, General Requirements – Canadian Electrical Code, part II.
- .3 C22.2 No. 0.4, Bonding of Electrical Equipment.
- .4 C22.2 No. 0.19, Requirements for Service Entrance Equipment.
- .5 C22.2 No. 4, Enclosed Switches.
- .6 C22.2 No. 5, Circuit Breakers.
- .7 C22.2 No.14, Industrial Control Equipment.
- .8 C22.2 No. 40, Junction and Pull Boxes.
- .9 C22.2 No. 94, Enclosures for Electrical Equipment, Non-environmental Considerations (Tri-national standard with NMX-J-235, and UL-50).
- .10 C22.2 No. 178.1, Transfer Switch Equipment (Tri-national standard with NMX-J-672 ANCE, and UL-1008).
- .11 C22.2 No. 178.2, Requirements for Manually Operated Generator Transfer Panels.
- .12 C22.2 No. 178.3, Transfer Switch Equipment, over 1000 Volts (Binational standard with UL-1008A).
- .13 C22.2 NO. 254, Motor Control Centres (Trinational standard with NMX-J-353-ANCE and UL-845).
- .14 C22.2 No. 286, Industrial Control Panels and Assemblies.
- .15 C22.2 No. 94-M91, Special Purpose Enclosures.
- .16 CSA-C22.3 No. 1, Overhead Systems.

.17 CSA C22.3 No.7, Underground Systems.

.18 CSA CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.19 CSA C282, Emergency Electrical Power Supply for Buildings.

.20 CSA Z462 Workplace Electrical Safety.

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms.

.4 Manitoba Hydro:

.1 Customer Metering Standards.

.2 Industry Notice 6-202, Use of Panelboards to subdivide the main consumer's service.

.3 Industry Notice 14-614, Current supply from more than one system.

.4 Industry Notice 6-0, Services and service equipment.

.5 Industry Notice 26-250, Overcurrent protection for power and distribution transformer circuits rated over 750V.

.5 National Electrical Manufacturers Association (NEMA):

.1 NEMA ICS 1, Industrial Control and Systems: General Requirements.

.2 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

.6 National Electrical Testing Association (NETA):

.1 ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.7 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.8 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

.9 Underwriters Laboratories (UL):

.1 UL 508A, Standard for Industrial Control Panels.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Coordinate the selection for all protective devices with Appendix 18K Special Studies and Models, Power Study Model. The submission for the initial Power Study Model shall be provided prior to submission for the equipment herein.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

.1 Shop Tests: testing of assembled system prior to it shipping to site.

.2 Site acceptance tests: testing of installed system prior to, or as part of, the start-up phase.

.3 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer’s factory prior to shipping equipment to site.

.2 City reserves the right to witness the final shop tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of fourteen (14) Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider Electric, This product was standardized by the City via RFP 756-2013.

2.2 Performance Criteria

.1 Supply Characteristics:

.1 600 V 3-phase 60 Hz 3-wire system with an NGR for systems supplied by a transformer rated 1000 kVA or higher.

.2 600 V 3-phase 60 Hz 3-wire system, solidly grounded neutral for systems supplied by a transformer rated less than 1000 kVA.

.3 120/208 V 3-phase 60 Hz 4-wire system, solidly grounded neutral to serve 120 / 208 V loads requiring motor starters.

.2 General Description:

.1 MCCs shall comply with the *WWD Electrical Design Guide*.

.2 Compartmentalized vertical sections with common power bus bars.

.3 Each motor control centre is to be of dead front construction and incorporate vertical buses connected to horizontal bus. The motor control centre to be so designed as to permit future section additions or change of units by the user.

.4 Indoor NEMA Type 1A gasketed enclosure. Provide neoprene gaskets on all compartment doors. Foam type gaskets shall not be permitted.

.5 Temporary lifting lugs provided for slinging of assemblies.

.6 Motor control centre is to provide an integrated hardware, software, and communication solution.

2.3 Configuration, Components and Features

.1 Provide motor control centres with vertical sections assembled to form a rigid, free-standing assembly, having a common power bus and forming an enclosure to which additional sections may be readily added.

.2 For each section or structure, provide a 3 phase horizontal bus rated as required, with a minimum of 800 amperes. Provide a 3 phase vertical bus rated as required with a minimum of 300 amperes.

.3 Provide fully rated neutral busbar extending entire width and height of motor control centre.

.4 Copper ground bus extending entire width of motor control centre with minimum dimensions of 0.25” x 1’’.

.5 The MCC horizontal and vertical power bus bracing shall have a short circuit rating as required, with a minimum of 42,000 A rms symmetrical.

.6 NEMA 1, gasketed, Type B, metal enclosed, free standing dead front, complete with all required accessories.

.7 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.

.8 Bus shall be tin plated copper. Tin-plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section.

.9 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tie supports. Insulate wireways from horizontal and vertical bus.

.10 Provide all sectionals complete with bussing hardware with provisional space to allow for an additional combination starter. Provide barriers to isolate the space from all bus work.

.11 Incorporate starters, circuit breakers, etc., as indicated on the drawings. Provide Shop Drawings for review before commencing fabrication. Provide plugin type units.

.12 Provide tin-plated copper bus bar stabs reinforced with strong spring steel to ensure high contact pressure.

.13 Provide appropriate flanges and bus connections for incoming line and feeders.

.14 Provide all wireways, ducts, etc., required to feed the MCC. Install main lugs on vertical bus and make terminations in a dedicated fed cell as shown on drawings.

.15 All joints and connections to be tin-plated, cadmium plate all bolts, nuts and lock washers to resist corrosion.

.16 Provide network communication to the plant PLC/SCADA system(s) as indicated on the network drawings.

.17 Provide pull apart terminal block plug in each starter for all control connections, such that each starter and VFD unit may be easily removed. All terminals shall be identified in both starter unit and master terminal section.

.18 Provide barriers to isolate all bus work to prevent accidental contact when starter units are removed, or spaces are provided. Barriers shall also provide phase to phase isolation of the vertical bus.

.19 Complete as-built control wiring diagrams for each starter with conductor identification clearly shown. Diagram shall be affixed to the interior cover of the starter section and provide a book of wiring diagrams for all starters and drives in each MCC.

.20 Motor control centres shall be finished in ANSI #61 grey enamel and unit insert pans shall be finished in white enamel.

.21 Unit Mounting:

  .1 Compartments shall be draw-out, plug-in, self-disconnect type for starter units NEMA size 4 and smaller, circuit breaker units 225 A and smaller. Guide rail supports for units to make sure that stabs make positive contact with vertical bus. Include provision for units to be installed and removed, off load, while buses energized.

    .1 Engaged position - unit stabbed into vertical bus.

      .1 Withdrawn position-unit isolated from vertical bus but supported by structure. Terminal blocks accessible for electrical testing of starter.

      .2 Include provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position. Provide positive means of grounding unit before stabs engage vertical bus.

      .3 Stab-on connectors shall be free-floating tin-plated clips, self-aligning, backed up with steel springs.

    .2 Provide external operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provide defeater mechanism for this interlock. Include provision for up to three padlocks to lock operating handle in "off" position and lock door closed.

  .2 Hinge unit doors on same side throughout MCC equipment.

.3 Mount pushbuttons, selector switches, indicating lights, meters, and the like on compartment door front.

.4 Devices and components shall all be by one Manufacturer to facilitate maintenance.

.5 Unused, spare, or “space” compartments shall be provided with hinged access doors.

2.4 Wiring

.1 Provide terminal blocks for power and control wiring. All terminals shall be number coded or otherwise suitably identified to indicate which Section or module of the MCC they are associated with and their function. Terminals blocks and wiring identification shall match the MCC wiring diagrams.

.2 Provide MCCs with all necessary interconnecting wiring and interlocking.

.3 Adequate space must be providing for the trouble shooting and/or removal of wires and cables inside MCC cabinets. This may preclude using half space buckets for starters.

.4 Control wire shall be 16 AWG stranded copper wire, rated 90°C.

.5 Power wire shall be stranded copper insulation rated 90°C, sized to suit load; minimum power wire size shall be 12 AWG copper stranded.

2.5 Communication

.1 Modbus TCP/IP components supplied with the MCCs under this Specification shall interface to the automation system components seamlessly as defined in this Section and Section 17800 – General Requirements for Automation Systems. Additional third-party network gateways shall not be permitted.

.2 All spaces where motor starter equipment could be installed shall be pre-wired with Modbus TCP/IP communications.

.3 The MCC shall employ a network communication cabling system to interconnect units within the MCC.

.4 Network cabling shall be routed through the lower horizontal wireway to isolate the network from the horizontal bussing routed through the top.

.5 A communication barrier in the full-depth vertical wireway shall serve to separate communications from power cabling and to prevent noise interference on the network cable.

.6 Provisions for appropriate terminators and grounding shall be provided.

.7 Addition, removal, or rearrangement of units shall not interrupt the trunk line and shall not affect the cabling of other units attached to the trunk line.

.8 The cabling is to be configured in a star configuration.

.9 Cabling shall be Category 6 shielded twisted pair Modbus TCP cable with RJ45 connector.

.10 Modbus TCP cable insulation rating shall be 600V minimum.

.11 Monitoring of individual load circuit breaker statuses (open/closed), and field devices statuses (disconnect switch position, motion sensor trip status, etc.) shall be by hardwired I/O, where indicated on drawings.

2.6 Network Switches

.1 MCC's shall be provided with 24 VDC powered, managed switch. Speed and number of ports per the Final Design.

.2 Provide dual power network switches for redundancy with separate fused disconnects. One shall be fed from a control power transformer within the MCC and one fed from the UPS.

2.7 Motor Starters and Control Devices

.1 Provide motor starters, VFD's, RVSS's, and control devices in accordance with Section 16226 – Motor Starters to 600V.

2.8 Ground Fault Monitoring System

.1 The ground fault alarm system shall give alarm and phase indication in the event of a ground fault on the power system of the MCC's main incoming and tie feeders.

.2 For all MCC equipment, provide a ground fault monitoring system.

.3 Ground fault alarm indicator shall be monitored by the ground fault detection system and automation system.

2.9 Transient Voltage Surge Suppression

.1 Provide transient voltage surge suppression (TVSS) device on power bus of MCC. TVSS shall occupy a dedicated cubicle space in the MCC complete with breaker or fuse protection.

.2 TVSS units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 latest edition).

.3 Voltage: per the final design.

.4 Maximum Continuous Operating Voltage (MCOV): The MCOV shall not be less than 115 percent of the nominal system operating voltage. In cases where a neutral grounding resistor is part of the distribution, utilize minimum MCOV levels specifically designed for operation with an NGR.

.5 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels.

.6 Protection Modes – The TVSS must protect all modes of the electrical system being utilized. The required protection modes are:

  .1 3Ø, 3W System: L-L, and L-G.

.2 3Ø, 4W Wye System: L-L, L-N, L-G, and N-G.

.3 1Ø, 3W Wye System: L-L, L-N, L-G, and N-G.

.7 Voltage Protection Rating (VPR) per ANSI/UL 1449 latest edition.

.8 The TVSS shall be maintenance free and shall not require any user intervention throughout its life. TVSSs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted.

.9 TVSS device shall be complete with status indicator lights on each phase and a flashing alarm status/trouble light indicator. Device shall include an alarm condition activated relay contact, SPDT, for use as a remote monitoring point.

.10 Surge capacity as required by the Final Design.

2.10 Power Meter

.1 Provide multifunction power meter with Modbus TCP/IP communication port.

.2 Requirements:

.1 Multifunction electrical measurement on 3 phase power systems.

.2 Accept a direct voltage input range of up to 600 Volts Line to Line.

.3 Programmable for current to any CT ratio.

.3 Acceptable Manufacturer:

.1 Schneider Electric PM5500 or PM8000 as indicated on the single lines, front mounted, visible from outside the MCC.

2.11 Finishes

.1 Unless specified otherwise, Manufacturer shall paint electrical equipment and materials.

.2 Galvanized finishes, where specified, shall comply with CAN/CSA G64.

.3 Fabricated metal components which have not been painted as part of a mass production procedure shall be treated as follows:

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish.

.2 Paint exterior electrical equipment Grey #GP122-ASA 61.

.3 Paint indoor MCCs, switchgear and distribution enclosures white, to EEMAC 2Y-1, enamel.

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

.5 Field-clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting and finish with two coats of finish.

.6 Apply Galvacon touch-up paint to damaged portions of galvanized surfaces and threads.

2.12 Identification

.1 Wiring Identification:

.1 Provide wiring identification in accordance with Sections 16010 – Electrical General Details.

.2 Equipment Identification:

.1 Individual unit compartments shall be identified with engraved nameplates showing the equipment number of the device and a description of the drive or equipment.

.2 Components inside each unit compartment shall be identified with engraved nameplates.

.3 Labels clearly visible and positioned such that the removal of the device identified does not remove the label.

2.13 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

.2 For each size and type of device in use, provide:

.1 Power fuses – three (3) of each size used.

.2 Ten (10) control fuses.

.3 Ten (10) pilot lamps including a lamp-removing tool if necessary.

.4 One (1) control relay.

.5 One (1) time delay relay.

.6 Two (2) relay sockets for plug-in devices.

.7 Two (2) coils for starters and contactors.

.8 Two (2) sets stationary contacts for starters and contactors.

.9 Two (2) sets NO/NC auxiliary contacts.

.10 Two (2) control transformers.

.11 Touch-up paint, two (2) 750 mL aerosol cans.

.12 Any other additional components which the Manufacturer recommends shall be kept as spares.

2.14 Factory Acceptance Testing

.1 Make sure that moving and working parts are lubricated.

.2 Verify the correct operation of all disconnects, circuit breakers, contactors, interlocks and auxiliary contacts, relays, control switches and push buttons, ground fault protection and manual operation and digital displays.

.3 Perform point-to-point tests of all wiring to verify correct connections, continuity and dielectric integrity.

.4 Initial tests shall be done by Manufacturer to verify proper system operation, free of grounds, open, and short circuits.

.5 Following the above tests, provide full Modbus TCP/IP configuration and Factory Acceptance Testing (FAT) of MCC equipment at the MCC factory prior to equipment shipment.

.6 With all sections inter-wired permanently or temporarily and with control power applied, perform:

  .1 Functional test of control circuits. Simulate field contacts where necessary. i.e., provide Hand-Off-Auto switch pre-wired to a terminal block or harness for easy plug and test.

  .2 Insulation resistance test on power wiring, free from grounds, open and short circuits.

  .3 Functional test of Modbus TCP/IP communications, control and monitoring systems.

.7 Configure Modbus TCP/IP addressing into each unit at the factory.

.8 All control and monitoring parameters for Modbus TCP/IP operation of motor control and monitoring shall be pre-configured at the factory.

.9 Modbus TCP/IP control and monitoring shall be factory tested for operations under normal and adverse conditions.

.10 Submit a certified test report of all standard equipment production tests at time of Factory Acceptance Testing. Equipment that is shipped without evidence of the required tests being performed to verify satisfactory operation will be subject to non-acceptance.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.4 Configure all Modbus TCP/IP input and output data assemblies in accordance with City's MCC Programming and Documentation Standards.

.5 The intent shall be to verify that all MCC starters, drives and other Modbus TCP/IP components for Modbus TCP/IP control and monitoring functions correctly via communication links to the automation system. The verification shall include point-to-point control functionality testing to confirm that all components are fully functional.

.6 Setup and configure all MCC Modbus TCP/IP components such that upon loading the supplied application program, all Modbus TCP/IP based control, diagnostics and monitoring function of supplied devices in the tested MCC can be verified.

.7 Prepare check out sheets covering all test requirements and verifications, detailing all tested points and functionality.

.8 Record by hardcopy and electronic means the final factory settings of all equipment. This shall form part of the test results submitted under this Section of the Specification.

3.2 Field Quality Control

.1 Perform tests/validations in accordance with Division 16, and the Manufacturer's instructions.

.2 Provision of all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks, and written system verification reports to provide a complete line-up that is ready for commissioning and start-up.

    .1 Submit all test/validation results a minimum of 4 weeks prior to commissioning. Once all building and plant commissioning activities have been completed, submit all changes and all commissioning data/results.

.3 Operate switches, contactors to verify correction functioning.

.4 Perform starting and stopping sequences of contactors, relays, and VFDs.

.5 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

.6 Ensure moving and working parts are lubricated where required.

.7 Operate starters in sequence to prove satisfactory performance of Motor Control Centre during an eight (8) hour period.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 Summary

.1 This Section covers work related to Section 16010 - Electrical General Requirement for the provision of motor starters to 600 Volts.

1.2 Standards

.1 Canadian Standards Association (CSA):

   .1 CSA C22.2 No. 14 - Industrial Control Equipment.

.2 Canadian Electrical Code (CEC) as adopted by the Province of Manitoba.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 Electrical General Requirements and the following:

   .1 Manufacturer's descriptive literature for materials that shall include the following:

      .1 Mounting method and dimensions.

      .2 Starter size and type.

      .3 Layout of identified internal and front panel components.

      .4 Enclosure types.

      .5 Wiring and schematic diagram for each type of starter.

.2 Provide operation and maintenance data for each type and style of motor starters for incorporation into manual specified in Appendix 18F.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

   .1 Shop Tests: testing of assembled system prior to it shipping to site.

   .2 Site acceptance tests: testing of installed system prior to, or as part of, the start-up phase.

   .3 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer’s factory prior to shipping equipment to site.

.2 City reserves the right to witness the final shop tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of seven (7) Business Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

.5 Coordinate tests in accordance with Section 16225 – Motor Control Centres.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider Electric, this product was standardized by the City via RFP 756-2013.

2.2 Manual Motor Starters

.1 Single- and three-phase manual motor starters shall be of size, type, rating as required, with components as follows:

.1 Switching mechanism, quick make and break.

.2 Overload heater(s), manual reset, trip indicating handle.

.2 Separately mounted starters shall be in CSA-approved enclosures.

.3 Enclosures: Dry locations shall be NEMA-12, corrosive atmospheres shall be NEMA-4X, hazardous areas shall be NEMA-7, Process areas shall be NEMA-4.

.4 Accessories:

.1 Key switches and pushbuttons shall be heavy-duty, oil-tight, labelled as indicated, and colours in accordance with Section 16010 – Electrical General Requirements.

.2 Indicating lights shall be heavy-duty, oil-tight, LED type and colours in accordance with Sections 16010 – Electrical General Requirements.

.3 Locking tab shall permit padlocking in “ON” or "OFF" position.

2.3 Full-Voltage Non-Reversing Magnetic Starters

.1 Combination starters of type indicated. Starters shall be rated for continuous operation of motor loads at the nominal motor HP rating, with a continuous output current not less than identified by table 44 of the Canadian Electrical Code.

.2 Starters shall be NEMA rated, minimum size shall be Size 1. Half-size starters shall not be permitted.

.3 Starters shall be provided for the following applications:

.1 Integrated into a Motor Control Centre in accordance with Section 16225 – Motor Control Centre.

.2 Integrated within a wall mount enclosure for 120 / 208 V applications where the quantity of starters does not warrant an MCC. Enclosures shall be NEMA 1 for installation within an Electrical room.

.1 Starters shall be suitable for three-phase operation, as well as field-configurable for single phase 1P, or 2P operation, as required to suit supplied motors.

.4 Fused disconnect switch with operating lever on outside of enclosure and provision for:

.1 Locking in 'OFF' position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to 'ON' position while enclosure door is open.

.5 NEMA contactor, solenoid operated, rapid action type.

.6 Electronic overload relay used for starter control using star Ethernet connection topology to Ethernet switches within MCC.

.1 Schneider electric Tesys T.

.2 Or approved equal.

.7 Power and control terminals.

.8 Wiring and schematic diagram inside starter enclosure in visible location.

.9 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.10 The starter shall be controlled with panel mounted 3 position H-O-A switch and Ethernet controls.

.1 Hand – Starts Motor.

.2 Off – Stops motor.

.3 Auto control of starter via Ethernet controls.

.11 Accessories:

.1 Pushbuttons, selector switches: 22 mm, heavy duty, oil tight, labelled as indicated.

.2 Indicating lights: 22 mm, heavy duty, oil tight, LED-type, push to test, and colour as indicated.

.3 Control transformer, fused.

.4 Auxiliary contacts:

.1 Contactors shall be equipped with auxiliary contacts rated 10 A at 120 VAC. Each contactor shall be equipped with one (1) spare NO and one (1) spare NC field convertible electrically isolated auxiliary contacts. Wire auxiliary contacts out to terminal blocks. Refer to Drawings for quantities.

.2 Overload shall be equipped with a minimum of two contacts. One contact shall interlock operation of the starter. A second contact shall be used for panel lamp indication.

.5 Additional protection relays including but not limited to thermal / leak relays recommended by the pump / motor manufacturer shall be integrated into the starter enclosure.

.6 Terminal blocks:

.1 Provide quick disconnect on terminal blocks to allow terminal block to be pulled without wiring disconnection.

.2 Provide terminal blocks with integral marking strips and to be permanently marked with the conductor number per Final Design.

.3 Internal wiring shall be connected on one side of the terminal block; outgoing conductors to be connected to the other side.

2.4 Full-Voltage Reversing Magnetic Starters

.1 Identical features as for full-voltage non-reversing magnetic starters, except:

.1 Two (2) 3-pole magnetic contactors mounted on common base.

.2 Interlocks shall prevent both contactors from operating at same time.

2.5 Reduced Voltage Starters (RVSS, Soft Starters)

.1 Solid state reduced voltage soft start to provide linear ramp starting and stopping of 3-phase induction motors.

.2 Soft starters shall be CSA / cUL approved, rated 690 V for operation of a 600 V rated motor, sized as indicated.

.3 Soft starters shall be rated for continuous operation of motor loads at the nominal motor HP rating indicated, with a continuous output current not less than identified by table 44 of the Canadian Electrical Code.

.4 NEMA bypass and overload contactor, solenoid operated, rapid action type.

.5 Electronic overload relay used for starter control using star Ethernet connection topology to Ethernet switches within MCC.

.1 Schneider electric Tesys T.

.2 Or approved equal.

.6 The soft start shall be controlled with panel mounted 3 position H-O-A switch, a keypad/ display unit and Ethernet controls.

.1 Hand – Starts Motor and accelerates to full speed using programmed ramp settings.

.2 Off – Ramps down and stops motor by decelerating according to ramp settings.

.3 Auto control of starter via Ethernet.

.7 Operator interface and drive keypads installed on the MCC door, shall be mounted at a height taking into account the housekeeping pad height for ease of operator viewing.

.8 Accessories:

.1 Pushbuttons, selector switches: 22 mm, heavy duty, oil tight, labelled as indicated.

.2 Indicating lights: 22 mm, heavy duty, oil tight, LED-type, push to test, and colour as indicated.

.3 Control transformer, fused.

.4 Auxiliary contacts:

.1 Contactors and soft starters shall be equipped with auxiliary contacts rated 10 A at 120 VAC. Each contactor shall be equipped with one (1) spare NO and one (1) spare NC field convertible electrically isolated auxiliary contacts. Wire auxiliary contacts out to terminal blocks. Refer to Drawings for quantities.

.2 Overload shall be equipped with a minimum of two contacts. One contact shall interlock operation of the starter. A second contact shall be used for panel lamp indication.

.5 Additional protection relays including but not limited to thermal/ leak relays recommended by the pump / motor manufacturer shall be integrated into the starter enclosure.

.6 Terminal blocks:

.1 Provide quick disconnect on terminal blocks to allow terminal block to be pulled without wiring disconnection.

.2 Provide terminal blocks with integral marking strips and to be permanently marked with the conductor number per Final Design.

.3 Internal wiring shall be connected on one side of the terminal block; outgoing conductors to be connected to the other side.

.9 Reduced voltage starters to include circuit breakers with operating lever on outside of enclosure to control circuit breaker and provision for:

.1 Locking in 'OFF' position with up to 3 padlocks.

.2 Provision for preventing switching to 'ON' position while enclosure door is open.

.10 Approved products:

.1 Square D Altistart.

2.6 Finishes

.1 Apply finishes to enclosure in accordance with Section 16010 – Electrical General Requirements and 16225 – Motor Control Centre.

2.7 Identification

.1 For separately mounted starters provide a nameplate identifying the number of the starter, the device from which it is fed, and the equipment description.

2.8 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

.2 For integrally and separately mounted starters, include the following spare parts for each size and type of starter, except that no more spares than the actual quantity installed need be listed:

.1 Two (2) stationary contacts.

.2 Two (2) movable contacts.

.3 Two (2) NO/NC auxiliary contacts.

.4 Two (2) control transformers.

.5 Two (2) operating coils.

.6 Five (5) control fuses.

.7 Ten (10) indicating lamps.

.8 One (1) spray can of touch-up paint.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Ensure correct fuses and overload devices elements and settings are suitable for the nameplate ratings of motors supplied.

.3 Set the trip adjustment on the motor circuit protectors.

.4 Configure motor protection settings on reduced voltage starters to suit motor nameplates and as required to achieve stable operation of electrical and process functions.

.5 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.6 Perform tests in accordance with Section 16020 – Electrical Testing.

3.1 Field Quality Control

.1 Perform tests in accordance with Section 16010 – Electrical General Requirements and Manufacturer's instructions.

.2 Coordinate with the Systems Integration Testing (SIT) and Site Acceptance Testing (SAT) activities.

.3 Operate switches and contactors to verify correct functioning.

.4 Perform starting and stopping sequences of contactors and relays.

.5 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

.6 Confirm complete testing of motor starter operation.

.7 Submit test results to the Contract Administrator.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers work related to Section 16010 – Electrical General Requirements for the provision of LV Variable Frequency Drives to 600 Volts.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

  .1 D178, Standard Specification for Rubber Insulated Matting.

.2 Canadian Standards Association (CSA):

  .1 C22.2 No. 5, Molded-case Circuit Breakers, Molded-case Switches and Circuit-breaker Enclosures (Trinational standard with NMX-J-266-ANCE and UL-489).

  .2 C22.2 No. 100, Motors and Generators.

  .3 C22.2 No. 145, Electric Motors and Generators for Use in Hazardous (classified) Locations (Trinational standard with NMX-J-652-ANCE and UL 674).

  .4 C22.2 No. 156, Solid-State Speed Controls.

  .5 C22.2 No. 268, Power Circuit Breakers up to 1000 Vac and 1500 V dc Used in Enclosures (Binational standard with UL 1066).

  .6 C22.2 No. 274, Adjustable Speed Drives.

  .7 C22.3 No. 3, Electrical Coordination.

.3 Institute of Electrical Engineers (IEEE):

  .1 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

  .2 519, Standard for Harmonic Control in Electric Power Systems.

.4 Manitoba Hydro:

  .1 PQS2000, Power Quality Specification for Interconnection to Manitoba Hydro's Electrical System.

.5 National Electrical Manufacturer Association (NEMA):

  .1 ICS2, Controllers, Contactors and Overload Relays Rated 600 V.

  .2 KS1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

  .3 MG1, Motors and Generators.

.1 National Electrical Testing Association (NETA):

.1 ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.2 Underwriters Laboratories Canada (cUL):

.1 508, Industrial Control Equipment.

.3 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.4 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Physical layout in MCC.

.3 Wiring Diagram showing terminal blocks and terminal numbers.

.4 Complete dimensional drawing including front panel details (not typical).

.5 Circuit breaker ratings & fuse sizes.

.6 Recommended spare parts list.

.7 Cooling system and heat rejection calculations for each size/ type of VFD.

.8 The product data shall indicate the efficiency, power factor, kW output, heat rejection and harmonic distortion of the drive at 25%, 50%, 75% and 100% operating points.

.9 Complete layout, wiring, dimension, schematic drawings for stand alone VFDs within separate enclosure.

.10 VFD configuration sheets.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

.1 Shop Tests: testing of assembled system prior to it shipping to site.

.2 Site acceptance tests: testing of installed system prior to, or as part of, the start-up phase.

.3 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer's factory prior to shipping equipment to site.

.2 City reserves the right to witness the final shop tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of seven (7) Business Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

.5 Coordinate tests in accordance with Section 16225 – Motor Control Centres.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider as per Appendix 18E – Standardized Goods.

2.2 Performance Criteria

.1 VFDs shall be rated for continuous operation of motor loads at the nominal motor HP rating indicated, with a continuous output current not less than identified by table 44 of the Canadian Electrical Code.

.2 VFDs shall be CSA / cUL approved, rated 690 V for operation with a nominal 600 V, 60 Hz, 3 phase supply.

.3 Integrated into a Motor Control Centre in accordance with Section 16225 – Motor Control Centres.

.4 Digitally controlled AC variable frequency drive (VFD):

.1 Sensorless flux vector control.

.2 For motors 224kW and less: minimum 6-pulse width modulated (PWM) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices.

.5 The VFD will be controlled with panel mounted 3 position H-O-A switch, potentiometer and a keypad / display unit.

.1 Hand – Starts Motor and accelerates to speed set manually set by door mounted potentiometer.

.2 Off – Ramps down and stops motor by decelerating according to ramp settings.

.3 Auto control of VFD via Ethernet controls.

.1 Provide Ethernet Modbus TCP connection to all VFDs except for HVAC packaged systems. VFDs integral with packaged HVAC equipment (where a central controller has Ethernet Modbus TCP communication) do not require the communication card.

.6 Provide the following auxiliary controls:

.1 Manual speed potentiometer.

.2 Local Emergency Stop button.

.3 Input terminals for remote interlocks. Allow for two interlocks.

.1 Wire the auxiliary contacts from local disconnect switch to interlock VFD when disconnect switch is open.

.7 VFD Output: 0-60 Hz, with standard Volts/Hertz VFD curve, 3 phase. The drive shall be able to start into a spinning motor.

.8 Operator interface and drive keypad installed on the MCC door, shall be mounted at a height taking into account the housekeeping pad height for ease of operator viewing.

.9 Provide ventilation fans, vents, filters, and associated equipment to adequately cool the compartments.

.10 Provide pad-lockable thermal-magnetic circuit breaker and/or semiconductor fuse short circuit protection as required by drive manufacturer for equipment approvals. Interlock doors for VFD to prevent access unless disconnect is open.

.11 The VFD shall be configured to provide the following protection functions which will lock out the VFD until manually reset:

.1 Motor short circuit.

.2 Motor thermal overload

.3 VFD Overtemperature

.4 VFD internal fault.

.5 External signal trip

.6 Motor phase loss.

.7 Motor stall protection.

.8 Ground fault.

.12 The VFD shall be configured to provide the following auto-reset protection functions that allow return to operation following reinstatement of utility supply without manual reset:

.1 Input phase loss.

.2 Undervoltage / overvoltage.

.13 Accessories:

.1 Pushbuttons, selector switches: 22 mm, heavy duty, oil tight, labelled as indicated.

.2 Indicating lights: 22 mm, heavy duty, oil tight, LED-type, push to test, and colour as follows:

.1 Running (Green).

.2 VFD Fault (Amber).

.3 Overload Tripped (Amber).

.3 Control transformer, fused.

.14 Line Reactor:

.1 Provide three percent (3%) line reactor.

.15 Load Reactor:

.1 VFD load reactors will be installed for all motors greater than 37 kW (50 HP) regardless of cable length between VFD and motor.

.2 VFD load reactors shall be installed for all motors where cabling between the VFD and motor exceeds 30 m.

.16 Filters:

.1 DV/DT Filters shall be installed where power cables between the VFD and the motor exceed 150 m or where recommended by the VFD vendor for the specific size and application.

2.3 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) complete set of all plug-in drive components for each size and type of controller supplied.

.2 One (1) set of three power fuses for each different drive rating.

.3 Ten (10) control fuses of each type used.

.4 Ten (10) indicating lamps of each type used.

.5 One (1) main control board of each type used.

.6 One (1) inverter module of each type used.

.7 One (1) inverter snubber module of each type used.

.8 One (1) set of other field-replaceable items for each type used.

.9 Any other additional components, which the Manufacturer recommends be kept as spares.

.10 Two (2) spray cans of touch-up paint.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Ensure correct fuses and overload devices elements and settings are suitable for the nameplate ratings of motors supplied.

.3 Set the trip adjustment on the motor circuit protectors.

.4 Configure motor protection settings to suit motor nameplates and as required to achieve stable operation of electrical and process functions.

.5 Perform tests in accordance with Section 16020 – Electrical Testing.

.1 Test each drive over the total speed control range that it will be required to operate through for the load being driven. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between minimum and maximum speeds:

.1 Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.

.2 Output to the driven load in kilowatts.

.3 For each drive size, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.

.4 Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.

.5 Test each drive by using the actual control signal for remote and local operation.

.6 Test each drive's alarm functions.

.7 Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

.8 Testing determined not in compliance with Contract documents shall be repeated by the Contractor at no additional cost to the Owner.

.6 Coordinate with the Systems Integration Testing (SIT) and Site Acceptance Testing (SAT) activities. Provide certified documentation of all tests performed.

END OF SECTION

DC STATION BATTERY POWER SUPPLY

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of 125 VDC DC station battery power supplies.

.2 The 125 VDC control power distribution shall consist of separate 125 VDC battery systems each with its own battery bank, dedicated charger, manual transfer switch and 12 circuit DC circuit breaker distribution panel.

.3 The transfer switches shall be arranged to be able to receive power from either battery bank and deliver it to its load distribution panel. This arrangement shall permit each battery bank to feed one or both DC distribution panels, or be isolated from both for maintenance but shall not allow one battery bank to be paralleled with the other battery bank.

.4 Each charger DC output shall be connected in parallel with the load side of one transfer switch to feed the load distribution panel so the charger can continue to feed the load while the transfer switch is moved to the alternate battery source position.

1.2 Standards

.1 ANSI/UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

.2 CSA C22.2 No.107.2 – Battery Chargers.

.3 IEEE 485 - Recommended Practices for sizing Lead-Acid Batteries for Stationary Applications.

.4 Canadian Electrical Code as adopted by the Province of Manitoba (CEC).

1.3 Submittals

.1 Provide submittals for Division 16 in accordance with Sections 01300 and 16010 and the following:

  .1 Manufacturer's descriptive literature for materials.

.2 Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished. The data (in metric units) and specifications for each unit shall include, but not be limited to, the following:

  .1 120V DC Power Supply.

  .2 Overall Dimensions.

  .3 Materials of Construction.

  .4 Installation Details.

  .5 Ventilation Requirements.

.6 Any Special Mounting or Support Requirements.

.7 Functional Line Diagram Showing All System Components.

.8 Internal and External Wiring Diagrams.

.9 Equipment Data Sheet.

.3 Distribution Panel Board-Breaker Type:

.1 Overall Dimensions.

.2 Materials of Construction.

.3 Any Special Mounting or Support Requirements.

.4 Detail of Panel.

.5 Branch Breaker Type.

.6 Ampacity and rating.

.4 Submit calculations for battery sizing.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 RIC Electronics.

.2 Staticon (CD Nova).

.3 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Equipment will be designed for long service life under conditions specified herein, including corrosive atmospheres and intermittent or continuous operation.

.2 All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials.

.3 All status indication shall be normally open, Form C, dry contacts, rated 5 A at 120 V AC, which close to indicate the respective condition.

.4 The power supply modules, base unit and panel board shall be the standard product offering of the manufacturer.

.5 Battery Characteristics:

.1 The nominal battery voltage shall be 125 VDC.

.2 The battery shall be valve regulated lead acid (VRLA) or absorbed glass mat (AGM) (sealed) type with a life expectancy of twenty (20) years, based on demonstrated longevity of the class and construction of the cell at an average ambient of 25°C.

.3 The battery cell safety valve shall have a flame arrestor to prevent the possibility of external sparks entering the cell.

.4 The battery cells shall be provided in high-impact, non-flammable polypropylene or thermoplastic (nominal 12 volt) 6-cell containers with ample space at the bottom for sediment collection. Batteries shall be sealed low-maintenance type (no watering or special ventilation) and complete with all inter-cell cables, hardware and terminals. Inter-cell connectors shall be tin-plated (low maintenance) and protected by clear flame retardant plastic covers unless inherently insulated (no exposed conducting material) in normal use.

.5 All battery cells shall perform at 100 percent rated capacity upon shipment.

.6 All cells shall float at a voltage within plus/minus 0.05 V of the average.

2.3 Configuration, Components and Features

.1 General:

.1 Provide charger to recharge/float charge a battery and power DC loads.

.2 Provide VRLA (valve-regulated lead acid) batteries to power DC loads.

.2 Battery Charger:

.1 Battery charger will be rated as listed below:

.1 Input AC voltage: 120/208 V, 1Ø

.2 Frequency: 60-Hertz ± 5%

.3 Efficiency at:

.1 Nominal Load: >85%

.2 Output DC Voltage: 125(130) V

.3 Output Current: As require

.4 Temperature: 10°C to 40°C

.5 Humidity: 0 to 95%

.6 Altitude: 1250 m or per final design

.7 MTBF: 300,000 hours

.2 The battery charger shall be an automatic IGBT controlled and filtered unit designed for an industrial environment, housed in a steel cabinet with hinged door. The charger shall be designed and manufactured to operate a lead-calcium type battery and floating load connected to its output terminals.

.3 The charger shall be rated for a 208 V, 3 Ph, 3- or 4-wire, 60 Hz AC input. The charger shall fully recharge a 100 percent discharged battery within ten (10) hours and simultaneously carry a minimum load of 1200 W. The nominal output voltage shall be 125 VDC. The charge system output current rating shall be minimum 25 A, continuous, such that if one battery bank is disconnected for maintenance, the opposite charger can supply both DC distribution panels loaded together up to 19 A continuous, and use remaining 6 A to recharge the remaining battery if required.

.4 The charger shall include transient voltage protective circuitry to minimize the effects of transient voltages in either the internal or external AC or DC circuits.

.5 The DC output voltage shall be adjustable over the recommended range of float voltages of the batteries.

.6 When float charging a battery, the DC voltage variation shall not exceed plus or minus 1 percent of the setting under any rated condition of operation including plus or minus 10 percent input voltage variation.

.7 The charger shall have an automatic constant voltage operating mode with current limit. The battery charger shall limit DC output current to 110 percent of its full load rating under any condition of load demand up to and including a completely discharged battery. No AC or DC circuit breaker shall operate (trip open) when the charger is connected to a discharged battery under normal operating conditions.

.8 The maximum RMS ripple voltage shall not exceed 5 percent of the average DC voltage when connected to a battery with ampere-hour capacity of at least four times the charger DC current rating. The maximum RMS ripple voltage shall not exceed 2 percent when disconnected from the battery.

.9 The charger will include a low DC voltage alarm with a fifteen (15) second time delay and an adjustable pick-up range of 105 to 125 V. Alarm LED lamp and status contacts (Form C rated for 120 VAC) wired to terminal blocks shall be available for use as follows:

.1 AC power failure.

.2 DC ground fault, positive or negative.

.3 High DC voltage, with fifteen (15) second time delay alarm.

.4 Low DC voltage, with fifteen (15) second time delay alarm.

.5 Charger failure (no DC current) or rectifier failure.

.6 Battery discharging.

.7 Direct current limit.

.8 Common lamp test/reset switch.

.9 The charger shall automatically control the charging rate depending upon the condition of the battery and load.

.10 The charger shall also include the following features, as a minimum:

.1 DC voltmeter (2 percent accuracy).

.2 DC ammeter (2 percent accuracy).

.3 Independently adjustable float and high rate (equalize) potentiometer.

.4 Adjustable current limit potentiometer.

.5 Float-equalize selector with equalize rate timer. Manual selection provided.

.6 High rate (equalize) indicating light.

.7 AC power "ON" light.

.8 Ground detection lamps.

.9 Power transformer.

.10 Rectifying circuitry.

.11 AC and DC surge voltage suppressors.

.12 Reverse polarity protection.

.13 "Soft" start circuit.

.14 Charger shall be designed to prevent component failure if the AC input is energized prior to closing the DC output circuit breaker to load or battery.

.11 Provide 12 pulse charger to reduce the input line harmonics and to reduce AC ripple.

.12 Charger Protection:

.1 Provide one two-pole thermal magnetic circuit breaker with shunt trip for charger input. Standard thermal magnetic breaker 10 kA rated or per final design.

.2 Provide two-pole thermal-magnetic circuit breaker with shunt trip for charger output. Charger shall trip breaker when the high-voltage shutdown circuit senses rising charger voltage. Standard thermal magnetic breaker – 2pole 5 kA rated or per final design.

.13 Metering:

.1 Provide flush-mounted digital DC voltmeter and ammeter, 3.5-digit scale, plus/minus 1 percent of full scale accuracy.

.14 Temperature Probe: provide 9.5 mm diameter, shock-resistant type probe, hermetically sealed in glass rod. Equip probe with 7 m of cable.

.3 Battery Characteristics:

.1 General:

.1 Provide VRLA batteries rated minimum 160 ampere-hours or greater with a 20- year float life.

.2 Battery shall be of an absorbed glass mat (AGM) sealed valve regulated lead acid type. Battery shall not release electrolyte if positioned on its side or accidentally dropped, cracked or broken.

.3 Battery electrolyte specific gravity shall not exceed 1.300.

.4 Equip battery cell with a catalyst vent assembly that can reduce the float current water loss, positive grid corrosion, and cell impedance.

.5 Equip battery cell with tin bath dipped copper posts for each cell. Each post shall be capable of torque values of 110 inch pounds. Posts shall be capable of supporting inter-tier or inter-step cabling without additional support bracket.

.6 Battery module will be capable of top, front or side termination.

.2 Ratings:

.1 The battery will consist of the required number of lead-calcium cells interconnected with proper connectors provided by the battery manufacturer to provide a nominal battery rating of 125 V.

.2 The battery will have an ampere-hour capacity equal to at least 125 % of the sub-station's direct-current requirements including normal continuous loads plus intermittent loads.

.3 Normal continuous load capacity shall be adequate for a 24 hour period.

.4 Intermittent load capacity shall be adequate so at least three closings of each of the switchgear's associated circuit breakers can occur in an 8-hour period with no more than three circuit breaker units simultaneously operating.

.5 Battery circuits shall be ungrounded.

.6 Provide battery designed for 1200 cycles at 80% depth of Discharge (DOD) to 1.75 volts per cell.

.7 Provide battery string capable of making a minimum of 90% of its rated ampere-hour capacity at the 8-hour rate to 1.75 V pc (volt per-cell). 100% of all cells shall be capacity tested at the factory.

.8 Battery string will have no cell fall below the 1.89 V pc limit when discharged at the 5-hour rate. The battery manufacturer shall provide test data at 1 and 3-year intervals.

.9 Provide battery string with a minimum cell capacity of 90% and on average a string capacity of 100%.

.10 Provide battery with cell recharge efficiency of at least 90% when delivered.

.11 Battery cell shall have 98% recombination efficiency upon delivery when operated at normal float conditions.

.3 Provide calculations for the battery and associated charger, indicating the basis used in defining loads, selecting cell types, and determining the battery ampere-hour capacity and physical size. Calculations shall be provided to determine capacity for the battery charger and be similar to those shown in the Appendix to IEEE Std. 485, including explanatory data. Calculations for the battery charger shall demonstrate that the output voltage and current provided are adequate to comply with the preceding requirements.

.4 Battery Rack:

.1 When multi-tier: Bottom tier minimum 120 mm above floor, top of battery cells on highest tier not more than 1200 mm above floor. Arrangement shall allow cell replacement without disturbing or removing other cells.

.2 Freestanding bolted to floor.

.3 Exposed external sides adjacent to batteries shall have easily removable clear cover.

.4 Frames: Angle iron with welded joints ground smooth.

.5 Rails: Steel channels, welded or bolted to frame.

.6 Rubber strips shall insulate rails from cells.

.7 Primed and epoxy painted to prevent corrosion.

.8 Corrosion-resistant bolts and hardware.

.9 Configuration shall allow any one cell container to be removed without removing any other cell container.

.10 Dimensions of space available as per final Design.

.11 Steel for battery racks: to CAN3-G40.20-M

.5 Battery Accessories:

.1 The battery system shall be furnished as a complete assembly. All cell interconnecting cables and straps (including inter-step and back-to-back inter-rack connector ions), terminal plates, connectors, bolts, washers and nuts required shall form a complete assembly to be included with the system. Cell interconnections shall be insulated, with no live parts exposed.

.2 The battery system shall be furnished with following accessories:

.1 Two (2) thermometers.

.2 Cell lifting device (if available).

.3 Cell number set.

.4 No-oxide grease.

.3 Two (2) spare inter-cell cables with connectors, nuts and bolts.

.4 Two (2) spare inter-tier cables with connectors, nuts and bolts.

.6 Transfer Switches:

.1 Two (2) 250 VDC, 200 A, two-pole, three-terminal, three-position manual-transfer switches shall be supplied to receive 125 VDC from either of two (2) batteries, each connected to one of the switch source terminals and supply a circuit breaker distribution panel connected to its load terminals. The contacts of the transfer switch shall be break- before-make as the switch is moved from source A to OFF to source B position. The switch mechanism shall be a load break design rated for a minimum of 1000 operations at rated current. Auxiliary Form C contact shall be provided for each switch position, rated 120 VAC 5 A and 30 VDC 2 A and wired out to Weidmuller terminal blocks for external connection.

.7 DC Breaker Distribution Panels:

.1 The DC circuit breaker distribution panels shall be rated 250 VDC, 200 A and have a 100 A main breaker with a power bus arrangement to house a minimum of six two-pole magnetic molded case load breakers with a minimum of 10 kA interrupting capacity or per final design.

.2 The ampere rating of the molded case circuit breakers shall be coordinated with the trip and close circuit fuses of the upstream equipment so an overload or fault occurring on a breaker trip or close circuit will not trip the molded case circuit breaker supplying the switchgear 125 VDC control bus. The circuit breaker rating shall support the charging or tripping of the downstream breakers simultaneously without being activated to trip.

.3 Each circuit breaker, main and feeder, shall have means for padlocking in the open position.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This section specifies the requirements for uninterruptible power systems static.

1.2 Standard

.1 Canadian Standards Association (CSA):

  .1 CAN/CSA-C813.1 - Performance Test Method for Uninterruptible Power Supplies.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

  .1 Manufacturer's descriptive literature for materials.

  .2 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.

  .3 Description of system operation, referenced to schematic diagram, for:

    .1 Manual control during initial start-up and load transfer to bypass and back to inverter output.

    .2 Inverter.

    .3 Bypass.

  .4 Estimate with supporting data for Mean Time to Repair factor (MTTR).

  .5 Full load kVA output at 0.8 lagging power factor.

  .6 Efficiency of system at 25%, 50%, 75% and 100% rated load.

  .7 Type of ventilation: natural or forced.

  .8 Battery:

    .1 Number of cells.

    .2 Maximum and minimum voltages.

    .3 Type of battery.

    .4 Type of plates.

    .5 Catalogue data with cell trade name and type.

.6 Size and weight of each cell.

.7 Cell charge and discharge curves of voltage, current, time and capacity.

.8 Derating factor for specified temperature range.

.9 Nominal ampere hour capacity of each cell.

.10 Maximum short circuit current.

.11 Maximum charging current expected for fully discharged condition.

.12 Recommended low voltage limit for fully discharged condition.

.13 Expected life.

.9 Inverter:

.1 Type and catalogue number.

.2 DC current at minimum battery voltage to produce full load AC output.

.10 Rectifier:

.1 Type and capacity, with catalogue number.

.2 Battery charging sequence.

.3 Current-time data for Silicon Controlled Rectifier (SCR) protective devices.

.4 Guaranteed noise level.

.5 Estimated life.

.6 Metering.

.7 Alarms.

.11 Manufacturer's field experience with UPS of similar ratings including engineering expertise, manufacturing facilities, and listing of UPS units manufactured and installed during last 5 years including model, customer, location and installation dates.

.12 Evaluation of Canadian content.

.13 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.

.14 Cooling air required in m^3/s.

.15 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

.16 Typical operation and maintenance manual.

.17 Description of factory test facilities.

.18 Include outline schematics showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

1.4 Protection of Systems

.1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during Work on inverter.

.2 Automatic circuit breakers and protection included in:

.1 AC input to rectifier.

.2 Battery input.

.3 Bypass circuit input.

.4 Inverter output.

.3 Surge suppressors:

.1 To protect system against supply voltage switching transients.

.2 To protect internal circuits where necessary against voltage transients.

.4 Current limiting devices, with panel front indication of device operation, to protect inverter SCR's.

.5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.

.6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

1.5 Quality Assurance

.1 Submit for approval records, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01300 - Submittals.

1.6 Extended Warranty

.1 In addition to the Warranties requirements as set out in the DBA, provide the following from Substantial Completion:

.1 Thirty-six (36) months warranty for the work of this Section.

.2 Contractor shall warrant battery against defects in material and workmanship in accordance with GC 24, but for twenty (20) years. This warranty is for 100% replacement for first year and prorated in equal yearly decreasing increments for remaining nineteen (19) years until expiration of warranty at end of twenty (20) years from date of Certificate of Substantial Performance.

2. PRODUCTS

2.1 System Description

.1 System to consist of:

.1 Rectifier.

.2 Invertor.

.3 Battery.

.4 Bypass switch cubicle.

.5 Microprocessor controlled logic and control panel.

.6 Input and output filters.

.7 Chopper.

.2 Load side isolation transformer: Ensure system uses normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

.3 Equipment: Capable of operating continuously and unattended.

.4 Ensure that Uninterruptible Power Systems (UPS) is compatible with equipment that it feeds, and with source from which it is fed.

2.2 Performance

.1 Normal operation:

.1 System operates on mains power when mains voltage is within +/-10 % of nominal value and mains frequency is between 59.5 and 60.5 Hz.

.2 System performance and reliability:

.1 Consider any deviation from the required output power waveform as failure in UPS.

.2 Submit estimate, with supporting calculations, of Mean Time Between Failures (MTBF) expressed in hours.

.2 Battery operation:

.1 System transfers automatically to battery operation.

.1 When manually selected at control panel.

.2 When mains power fails.

.3 When mains voltage varies more than 10 % from nominal or mains frequency varies more than +/-0.5 Hz from 60 Hz.

.4 When mains power is restored and mains voltage is within 10 % of nominal and mains frequency is within +/- 0.3 Hz of 60 Hz, system automatically resynchronizes with mains.

.5 Slew rate of frequency during transition period of system output automatically synchronizing with mains and return to its internal frequency to be set between 0.5 to 1.0 Hz per second.

.3 Internal Static Bypass operation:

.1 Ensure system can be bypassed for maintenance purposes, automatically by manual selection at control panel to connect load directly to AC mains. Transfer without load interruption and leaving inverter energized.

.2 Load transfer from mains back to system automatically by manual selection at control panel when maintenance completed.

.3 Automatic transfer of load to mains in not more than 1/4 cycle including sensing with inverter left energized but disconnected from load in case of:

.1 Inverter overloaded.

.2 Short circuit in load.

.4 Automatic retransfer of load to system without load interruption when above conditions disappear.

.5 Automatic transfer of load to mains in not more than 1/4 cycle including sensing and shutdown of inverter in case of inverter internal malfunctions.

.6 Automatic transfer of load to mains without load interruption and inverter shutdown in case of:

.1 Over temperature harmful to system.

.2 Loss of forced ventilation.

.3 Low voltage of DC supply to inverter.

.7 Bypass capable of closing onto and withstanding momentary fault current of 800% of rating for 0.01 s.

2.3 Uninterruptible Power System

.1 Input power:

.1 Three phase, 600 V, 3 wire plus ground, 60 Hz.

.2 Normal supply from AC mains.

.3 Emergency supply from standby automatic diesel-electric unit.

.2 Output power:

.1 Three phase, 208 V, 4 wire, grounded neutral, 60 Hz.

.2 Overload capability: 125% of rated full load current at 0.8 power factor and rated voltage for 10 minutes.

.3 Frequency - nominal 60 Hz:

.1 Adjustable from 58.5 to 61.5 Hz.

.2 Maximum variation from set value under load changes, including transients, +/-0.5 Hz maximum.

.3 Drift from set value - after two months normal operation within ambient temperature range of 0 degrees to plus 40 degrees C, not to exceed 0.6 Hz.

.4 Duration of full load output after mains failure not less than 15 minutes.

.5 Output voltage control:

.1 Continuously adjustable on load at least 5% from rated value.

.2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

.3 Transient voltage changes not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.

.4 Harmonics over entire load range:

.1 Total harmonic distortion (THD): 1% typical, 3% maximum under linear load.

.2 Single harmonic not to exceed 3% of total output voltage.

.5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.

.6 Efficiency: Overall system efficiency at rated load with battery fully charged not less than 85%.

.7 Interference suppression:

.1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.

.2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

2.4 Electrical Requirements

.1 In accordance with Section 16010 – Electrical General Requirements.

.2 Bring out test points to protected coded pin jacks at convenient locations to permit testing without hazard, including:

.1 Inverter output ahead of output switch, 3 phase and neutral.

.2 Mains power 3 phase.

.3 Voltage across each SCR or IGBT.

.4 Points requiring monitoring for on-site alignment, for determination of faulty sub-assemblies or printed circuit cards, including indication of oscillator pulse and operation of voltage control.

.3 No battery other than main battery incorporated in design.

.4 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.

.5 Variable resistors: fine adjustment, rheostat type.

.6 Phasing marked on input and output terminals, viewed from front of equipment:

.1 Left to right.

.2 Top to bottom.

.3 Front to back.

.7 Indicator lamps: long life incandescent or neon, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.

.8 Solid state circuits used where more reliable than mechanical timers or control relays.

.9 Standard components available from commercial sources used throughout, with eight (8) years minimum shelf life.

.10 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.

.11 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.

.12 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.

.13 Components and sub-assemblies accurately made for interchangeability.

2.5 Enclosure

.1 Dead front free standing sheet steel 2.5 mm minimum thick, CSA Enclosure 1.

.2 Access from front only, or from front and rear.

.3 Meters, indicating lamps and controls group mounted in panel front.

.4 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping.

.1 Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with two (2) keys.

.2 Hinges to permit doors to be lifted off cubicle.

.5 Cubicle height: 1.8 m maximum.

.6 External cable connections at top of cubicle through bolted plate for drilling at site to suit.

.7 Ambient temperature range during operation -20 degrees C to +40 degrees C. Natural or forced ventilation as required.

.1 For forced ventilation power from inverter output and fan directly driven by single phase motor mounted on vibration isolators.

.2 Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.

.8 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.

.9 Maximum operating sound level not to exceed 45 db(A) as measured on sound level meter with A weighting and slow response, at distance of 1.0 m.

.10 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

2.6 Rectifier

.1 Input power supply from:

.1 AC mains.

.2 Input disconnect: bolt-on moulded case three pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

.3 Isolating transformer: connected between AC input and rectifier input.

.4 Surge suppressor: to protect equipment from supply voltage switching transients.

.5 Rectifier:

  .1 Silicon controlled rectifier assembly or sealed silicon diodes.

.6 Filter: for rectifier DC output.

.7 Fuse: to protect DC output.

.8 Meters:

  .1 DC voltmeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output voltage.

  .2 DC ammeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output current.

.9 Adjustments and controls:

  .1 Line voltage adjusting taps to allow for +/-10% variation from nominal.

  .2 Manual adjustment of float voltage with range of +/-5%.

  .3 Manual adjustment of equalizing voltage.

  .4 Automatic current limiting on rectifier adjustable between 80 and 120% of normal rating.

  .5 Provision to disconnect rectifier from inverter and battery if rectifier dc output exceeds safe voltage limits of battery.

.10 Metres, adjustments and controls to be grouped on front panel.

.11 Performance of rectifier:

  .1 Automatically maintain battery in fully charged state while mains power available and maintain DC float voltage within +/-1% of setting, no load to full load, during mains voltage variations up to +/-10%.

  .2 Battery charging rate such that after battery has provided full load power output for specified duration, charger returns battery to 95% of fully charged state in 4 hours.

  .3 Automatic equalize charging circuit to initiate equalize charging of battery for 24 hours after discharge of 5% of ampere hour battery rating.

.4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 hours to return unit to float charge.

2.7 Inverter

.1 Input power supply from:

.1 Rectifier DC output.

.2 Battery DC output.

.2 Input disconnect: bolt-on moulded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

.3 Input filter: with separately fused computer grade capacitor banks and indicator lights, to eliminate inverter source noise and restrictions on input cable length.

.4 Power stage: high frequency switching type, dual cooled disc type silicon controlled rectifier (SCR) or insulated gate bipolar transistor (IGBT). Components, solid state devices capable of satisfactory operation under ambient conditions of -20 degrees C to +55 degrees C.

.5 Logic module:

.1 Integrated circuit logic.

.2 Silicon semiconductors.

.3 Plug-in modules.

.4 Gold plated plug-in connector.

.5 Front accessible field adjustments for voltage and frequency.

.6 Front accessible test points: suitably protected coded pin jacks.

.7 Frequency reference module.

.8 Current limiting module, automatic high speed by controlled reduction of output voltage.

.9 Voltage regulator.

.6 Output filter: output of high frequency switching stage contains elements of carrier frequency which are filtered to low harmonic sine wave.

.7 Meters shall be internal to the UPS and include feedback for voltages (input and output), current (input and output), power usage (kW and kVA), battery power, power factor (p.f.), and frequency. Meters and controls shall be grouped on the front panel.

.8 Output disconnect: bolt-on, moulded case, three pole circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

2.8 Battery

.1 Battery rack: in accordance with Section 16241 – DC Station Battery Power Supply.

.2 Battery type and electrical characteristics: in accordance with Section 16241 – DC Station Battery Power Supply.

  .1 Discharge current to supply inverter at full load output, for fifteen (15) minutes.

2.9 Static Bypass Switch

.1 Two solid state closed circuit automatic transfer switches.

.2 Logic unit with three normal source voltage sensors, which monitor overvoltage undervoltage and loss of voltage.

.3 High speed automatic transfer from normal voltage to alternate source when:

  .1 Normal source voltage lost: transfer time and sensing 1/4 cycle.

  .2 Normal source: undervoltage at 80% of nominal value; adjustable.

  .3 Normal source: over voltage at 110% of nominal value.

  .4 Loss of normal source static switch continuity.

  .5 Short circuit on normal source trips normal source breaker.

.4 Return to normal source:

  .1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.

.5 Switch position lights and contacts.

.6 Synchronizing verification light.

.7 Manual reset pushbutton.

.8 Transfer test switch.

.9 Alternate power source monitor light.

.10 Accessories:

  .1 Manual bypass switch for maintenance and testing without load disturbance.

.2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.

.3 Alternate power source loss alarm contacts.

2.10 Operating Devices

.1 Operating accessories:

.1 Counter for number of failures of normal mains AC power: non-reset type, zero to 99,999 operations.

.2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.

.3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.

.2 Statuses, indicators, and Alarms on the front panel to include:

.1 AC output on inverter.

.2 AC input available.

.3 Inverter and AC input synchronized.

.4 Inverter and AC input not synchronized.

.5 Static bypass switch in bypass position.

.6 Overtemperature alarms:

.1 Rectifier.

.2 Inverter.

.3 Bypass switch.

.7 Cooling fan fuse open.

.8 Inverter output over voltage.

.9 Inverter output under voltage.

.10 Battery over voltage.

.11 Battery under voltage.

.12 Inverter fuse/breaker open.

.13 Rectifier fuse/breaker open.

.14 Static bypass switch fuse/breaker open.

.15 UPS on battery operation.

.16 Rectifier in equalize mode.

.17 Battery discharging indicator, to change from steady to flashing during final 5 to 10 min of battery duration.

.3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

.1 Buzzer to sound when any mode light at main UPS panel shows red.

.4 Remote status alarm system:

.1 UPS shall come with a minimum of three (3) programmable dry contacts for status and remote monitoring.

.2 UPS shall come with a minimum of one (1) TCP/IP port for status and remote monitoring.

2.11 Communication

.1 Modbus TCP/IP protocol and connection to a PLC for remote monitoring of the system.

2.12 Fabrication

.1 Shop assembles:

.1 Rectifier unit.

.2 Inverter unit.

.3 Bypass switch unit.

.4 Battery rack and battery.

.2 Interconnect units, and add remote mode lights, alarms and controls to produce complete uninterruptible power system before notifying the Contract Administrator that the system is ready for factory tests. Provide the Contract Administrator a minimum notice of ten (10) business days to allow witnessing of factory testing if desired.

2.13 Finishes

.1 Apply finishes in accordance with Section 16010 – Electrical General Requirements.

.2 Cubicles:

.1 Inside finish: white.

.2 Exterior finish: Manufacturers standard colour.

.3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

2.14 Equipment Identification

.1 Identify equipment in accordance with Section 16010 – Electrical General Requirements.

.2 On major components such as AC input breaker, inverter breakers, bypass switch.

2.15 Source Quality Control

.1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery shall be factory tested.

.2 Notify Contract Administrator:

.1 Ten (10) Business Days advance of date of factory test.

.2 That system has completed factory testing, meets the design requirements. Submit all completed testing results and reports.

.3 Test procedures:

.1 Prepare blank forms and check sheet with spaces for recording data.

.2 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach meter recordings.

.3 Include results and reports in the Operations and Maintenance Manual (O&M).

.4 Test equipment:

.1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.

.2 Dummy load for testing, adjustable to 100% of system rated output at 0.8 power factor lagging. Load on each phase adjustable from zero to 100% so that unbalanced output maybe tested for 3 phase systems.

.5 Tests:

.1 Visual inspection to determine:

.1 Materials, workmanship, and assembly conform with design requirements.

.2 Parts are new and free of defects.

.3 Battery and components are not damaged.

.4 Battery cells are of identical construction.

.5 Electrolyte in each cell is at Manufacturer's recommended full level.

.6 Each battery cell polarity and polarity of connections to inverter are correct.

.7 Proper size fuses are installed.

.8 Metres have suitable range.

.9 Accessories are present.

.10 Portable metres for acceptance tests are suitable and instrument transformers connected correctly.

.2 Demonstrate:

.1 System start-up and shut down.

.2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times.

.3 Adjustable settings.

.4 Record values measured at test points using oscilloscope, digital multimetre, visicorder and camera attachment.

.5 Protective devices and indications function as designed. Record actual settings and note operation of remote indications and transfer to bypass. Tests to include:

.1 Annunciator lights correct indication.

.2 Overcurrent on inverter output.

.3 Over voltage and under voltage of inverter output.

.4 DC input voltage to inverter too low. Gradually reduce DC input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.

.6 Simulate over temperature by applying heat to sensor with hot air blower.

.7 Simulate fuse blowing to test indication response.

.8 Simulate fan failure.

.9 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.

.10 Over voltage of rectifier DC output.

.3 Harmonic test:

.1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion meter at output terminals.

.2 Determine each harmonic magnitude with harmonic wave analyzer.

.3 Measure phase to neutral at 0.8 lagging power factor.

.4 Transients:

.1 With normal power input, apply full load to system.

.2 Remove one half load from each phase.

.3 Reapply one half load instantly.

.4 Record voltages and currents using oscilloscopes.

.5 Steady load:

.1 Switch system onto AC mains, start inverter and connect dummy 0.8 power factor load.

.2 Operate system at full rated load for 24 hours and at 125% load for 10 minutes in ambient temperature of 40 degrees C.

.3 Record data at start of test and at half hour intervals thereafter; including:

.1 Input frequency.

.2 Input voltage each phase.

.3 Input current each phase.

.4 Input kW.

.5 Output voltage phase to phase, phase to neutral.

.6 Output current each phase.

.7 Output kW.

.8 Temperature of ventilating air-in.

.9 Temperature of ventilating air-out.

.10 Temperature at critical zones.

.11 DC voltage to inverter.

.12 DC current to inverter.

.13 Rectifier DC current.

.6 Varying loads:

.1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.

.2 Calculate efficiencies of rectifier, inverter, and complete system.

.7 Unbalanced loads:

.1 Adjust loads on inverter to full load on two phases, 80% load on third phase.

.2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.

.3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.

.8 Battery:

.1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:

.1 Ambient temperature.

.2 Temperature of each cell.

.3 Voltage of each cell.

.4 Voltage of battery.

.5 Charging current.

.6 Specific gravity of each cell (lead acid battery only).

.2 Discharge battery by operating uninterruptible power system with AC mains open, at full rated output for duration quoted in design requirements. Record, at 5 minutes intervals:

.1 Voltage of battery.

.2 Current.

.3 Voltage of 10% random cells.

.4 Ambient temperature.

.5 Battery temperature.

.6 Specific gravity of 10% random cells (lead acid only).

.3 Recharge battery automatically by closing AC mains supply to system for 4 hours period, with dummy load connected. Record at 15 minutes intervals.

.1 Battery voltage.

.2 Charging current.

.4 At start and finish of charge record ambient and battery temperatures, and specific gravity of each cell (lead acid only).

.5 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 hours charge period.

.6 Recharge battery.

.9 Operating sound level:

.1 Operator to take reading by placing meter in front of him with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.

.2 Measure sound level during low ambient sound level.

2.16 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Examination

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for uninterruptible power systems static (UPS) installation in accordance with Manufacturer's written instructions.

.1 Visually inspect substrate in presence of the General Contractor.

.2 Inform Contract Administrator 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 the Contract Administrator.

3.3 Installation

.1 Locate UPS cubicles, battery rack and battery(ies).

.2 Assemble and interconnect components to provide complete UPS as specified.

.3 Connect AC mains to main input terminal.

.4 Connect UPS output to load.

.5 Start-up UPS and make preliminary onsite tests to ensure satisfactory performance.

3.4 Testing

.1 Perform tests in accordance with Section 16010 - Electrical General Requirements and CSA C813.1.

.2 Provide:

- .1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.
- .2 Dummy load adjustable to 100% of system rated output.

.3 Notify the Contract Administrator a minimum of ten (10) working days in advance of the testing date.

.4 Tests:

- .1 Inspection of cubicles, battery rack and battery(ies).
- .2 Inspection of electrical connections.
- .3 Inspection of installation of remote mode lights and alarms.
- .4 Demonstration of system start-up and shut-down.
- .5 Run UPS for minimum period of four (4) hours at full rated load to demonstrate proper operation with AC mains input, emergency generator input, no AC input.
- .6 Discharge battery by operating UPS with AC mains open for specified duration of full load. Record readings of temperature of each cell.
- .7 Recharge battery automatically with full rated load on UPS for four (4) hours and record readings of voltage of each cell.

.5 Submit results and reports to the Contract Administrator, and include in the Operations and Maintenance Manual (O&M).

3.5 Start-Up

.1 Arrange with General Contractor:

.1 For factory service representative to supervise start-up of system, checking, adjusting and testing on site.

.2 For instruction of four (2) personnel on theory, construction, installation, operation and maintenance of system:

.1 After installation and during site testing.

.2 At factory during shop testing.

.2 Advise on:

.1 Expected failure rate of equipment.

.2 Type of expected failures.

.3 Estimated time between major overhauls based on a 20-year equipment life.

.4 Estimated cost of major overhaul based on current costs and excluding travelling expenses.

.5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

3.6 Cleaning

.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 Section 01741 – Final Cleaning.

3.7 Protection

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by UPS installation.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of lighting and control distribution transformers.

1.2 Standards

.1 American National Standards Institute (ANSI):

  .1 C57. 12.90 - Test Code for Distribution and Power Transformers.

.2 Canada Energy Efficiency Act and Energy Efficiency Regulations:

  .1 National Resources Canada (NRCan).

.3 Canadian Standards Association (CSA):

  .1 CSA C9 - Dry-Type Transformers.

  .2 CSA C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

  .3 CSA C22.2 No.47 - Air-Cooled Transformers (Dry Type).

  .4 CSA C22.3 No.7 - Underground Systems.

  .5 CSA C802.2 - Minimum Efficiency Values for Dry Type Transformers.

.4 Institute of Electrical and Electronics Engineers (IEEE):

  .1 C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers.

  .2 C57.12.28 - Standard for Pad-Mounted Equipment - Enclosure Integrity.

.5 Manitoba Energy Code for Buildings (MECB):

  .1 Manitoba amendments to the National Energy Code of Canada for Buildings.

.6 National Electrical Testing Association (NETA):

  .1 ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.7 National Electrical Manufacturers Association (NEMA):

  .1 ST 20 - Dry Type Transformers for General Applications.

.8 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.9 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Indicate type, capacity, voltages, overall dimensions, weight, impedance, X/R ratio, primary and secondary voltages, nameplate data, frequency, BIL, insulation type and temperature rise, full load efficiency, polarity or angular displacement, energy efficiency ratings, and transformer damage curve.

.3 Test report to include sound test, for dry type transformers.

2. PRODUCTS

2.1 General

.1 Low-Sound-Level Requirements: Maximum sound levels when factory tested according to NEMA ST 20, applied to all transformers, including those with K-factor ratings up to 20.

2.2 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Hammond Power Solutions.

.2 Marcus Transformer.

.3 Delta.

.4 Schneider Electric.

.5 ABB.

.6 Or approved equivalent.

2.3 600 V – 120 / 208 V Transformers

.1 CSA certified.

.2 Type: ANN for indoor use.

.3 Rating: As required, with minimum 25% spare capacity.

.4 Mounting: Wall Mounted for ratings 45 kVA and below. 75 kVA and above floor mounted on housekeeping pad.

.5 Primary Winding: 600 V configured in delta.

.6 Secondary Winding: 120 / 208 V wye, four wire with neutral brought out.

.7 Winding Material: Copper.

.8 Voltage taps: 2 FCBN, 2 FCAN, in 2.5% increments.

.9 Insulation: Class 220ºC, 150ºC temperature rise.

.10 Efficiency: Meets NRCan efficiency levels.

.11 Basic Impulse Level (BIL): 10 kV.

.12 Sound level: Standard.

.13 Impedance: Standard.

.14 Enclosure:

.1 CSA enclosure type 3R, type 4, type 4X, type 12 or other as indicated on the Drawings.

.2 Exterior mounted transformers to be a minimum of Nema 3R.

.3 Exterior finish: ANSI 61 gray.

2.4 Factory tests

.1 Perform equipment specific Hi-Pot tests for each transformer in the factory, prior to shipment, and submit test results for each unit.

2.5 Finishes

.1 Provide equipment finishes in accordance with Section 16010 – Electrical General Requirements.

2.6 Quality and Environmental Assurance

.1 On-Site Testing Qualifications: Accredited by NETA.

.2 Certified ISO 9001 Quality Management System.

.3 Certified ISO 14001 Environmental System.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

  .1 Perform visual Electrical and Mechanical Inspection.

  .2 Report: Prepare a written report recording voltages on the primary and secondary sides and tap settings. Record and include all tests and their results regardless of type (i.e., include resistances, voltages, current etc.), include equipment used during testing and their calibration data, etc. All test sheets shall be signed and provided to the Contract Administrator for review.

.3 Provide metal brackets, bolts and structural support members for wall mounted transformers.

.4 Provide concrete housekeeping pads for floor mounted transformers.

.5 Ensure all transformers have adequate ventilation. Ensure that equipment and transformer clearances do not impede on the transformer ventilation.

.6 Vacuum dirt and debris; do not use compressed air to assist in cleaning.

  .1 Electrical Tests:

    .1 Measure resistance at each winding, tap, and bolted connection.

    .2 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to Manufacturer's published data. In the absence of Manufacturer's published data, comply with NETA ATS, Table 100.5.

    .3 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 V phase to neutral. Set tap connections for above 120 V rather than below.

.7 Provide certified factory test reports for each of the power transformers.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section describes materials, installation, and testing of outdoor pad-mounted transformers.

1.2 Standards

.1 American National Standards Institute (ANSI):

.1 Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.

.2 American Society for Testing and Materials (ASTM):

.1 ASTM 36 - Standard Specification for Structural Steel.

.2 ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

.3 ASTM D117 - Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Oils of Petroleum Origin.

.4 ASTM D4059 - Standard Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography (PCB).

.3 Canadian Standards Association (CSA):

.1 C2.1 - Single-Phase and Three-Phase Liquid-Filled Distribution Transformers.

.2 CAN3-C235 - Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.3 C2-M91 - Single-Phase and Three Phase Distribution Transformers, Types ONAN and LNAN.

.4 C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

.5 C22.2 No. 0 - General Requirements – Canadian Electrical Code – Part II.

.6 C22.2 No. 295 - Neutral Grounding Devices.

.7 C22.3 No. 1 - Overhead Systems.

.8 C22.3 No.7 - Underground Systems.

.9 C227.3 - Low-Profile, Single-Phase, Dead Front, Pad-Mounted Distribution Transformers.

.10 C227.4 - Three-Phase, Dead Front Pad-Mounted Distribution Transformers with Separable Insulated High-Voltage Connectors.

.11 C802.1 - Minimum Efficiency Values for Liquid-Filled Distribution Transformers.

.12 C802.3 - Maximum Losses for Power Transformers.

.4 International Electrotechnical Commission (IEC):

.1 60076-8 - Power Transformers – Application Guide.

.2 60214-2 - Standard for Tap-changers.

.5 Institute of Electrical and Electronics Engineers (IEEE):

.1 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.

.2 C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

.3 C57.12.10 - Standard Requirements for Liquid-Immersed Power Transformers.

.4 C57.12.26 - Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 Grd Y/19 920V and Below; 2500 kVA and Smaller).

.5 C57.12.28 - Standard for Pad-Mounted Equipment Enclosure Integrity.

.6 C57.12.34 - Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High-Voltage, 34.5 kV Nominal System Voltage and Below; Low-Voltage, 15kV Nominal System Voltage and Below.

.7 C57.12.70 - Terminal Markings and Connections for Distribution and Power Transformers.

.8 C57.12.90 - Test Code for Liquid Immersed Distribution, Power and Regulating Transformers.

.9 C57.32 - Standard for Requirements, Terminology, and Test Procedures for Neutral Grounding Devices.

.10 C57.91 - Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators.

.11 C57.98 - Guide for Transformer Impulse Tests.

.12 C57.109 - Guide for Liquid Immersed Transformer Through-fault Current Duration.

.13 C57.131 - Standard Requirements for Tap Changers.

.14 C57.153 - Guide for Paralleling Regulating Transformers.

.6 Manitoba Workplace Safety and Health Act, and Regulations.

.7 Manitoba Energy Code for Buildings (MECB):

.1 Manitoba Amendments to the National Energy Code of Canada for Buildings.

.8 National Electrical Manufacturers Association (NEMA):

.1 TRI: Transformers, Regulators and Reactors.

.9 National Electrical Testing Association (NETA):

.1 ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.10 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.11 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Manufacturer's installation and maintenance manuals on the transformers and accessories.

.3 Catalog cuts for transformer pads.

.2 Submit Shop Drawings giving equipment dimensions, anchoring information, and weights for each rating shown in the drawings and giving ratings of transformers, switches, fuses, and breakers. Provide data on pressure-relief valves, oil sampling valves, gauges, and separable connectors.

.3 Factory Tests: Furnish Manufacturer's certified standard test reports for the transformer ratings shown in the drawings and for the tests specified herein.

1.4 Quality Assurance

.1 Manufacturer Qualifications: Single source Manufacturer regularly engaged in manufacturing pad-mounted transformers complying with requirements of these Specifications and experienced with at least 5 projects of similar size and scope.

.2 Product Selection for Restricted Space: Drawings indicate size, profiles, and dimensions for pad-mounted transformer equipment including clearances between pad-mounted transformers and adjacent surfaces and items and are based on manufacturer’s preliminary information.

.3 Materials provided under this Section shall be CSA certified and/or be listed cUL.

.4 Materials and installations shall comply with Canadian Electrical Code (CEC).

1.5 Sequencing and Scheduling

.1 Coordinate size and location of concrete bases and pads. Cast anchor bolt inserts into pad.

1.6 Maintenance

.1 Extra Materials:

.1 Furnish extra materials matching products installed as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

.2 Touch-Up Paint: 3 half-pint (240 mL) containers of paint matching enclosure exterior finish.

.3 Contact Lubricant: 1 container.

2. PRODUCTS

2.1 Manufacturers

.1 Eaton

.2 ABB.

.3 Pioneer Transformer.

.4 Carte International.

.5 Or approved equal.

2.2 Transformer

.1 General: Liquid-filled, pad-mounted transformer, with primary gang-operated load break disconnect switch(es), tap changer, expulsion and current-limiting fusing provisions, HV bushings, secondary terminals in separate compartments, and accessories in a weather-resistant, tamper-proof enclosure. Isolate and interlock high- and low-voltage compartments. Doors shall be provided with padlockable three-point latch, Kirk key interlock and pentahead bolt.

.2 Transformers shall comply with the Efficiency Standards for Distribution CSA-C802.1.

.3 Enclosure: Enclosure base shall have a 4 mil (0.1 mm) thick tar-mastic undercoat.

.4 Transformer Rating Requirement:

.1 Rating:

.1 3,750 kVA (for ID Tag: XFMR-V0711 and XFMR-V0712).

.2 1,5000 kVA (for ID Tag: XFMR-V0711 and XFMR-V0712).

.2 Primary Winding: 12.47 kV, 3 phase, 60 Hz, delta winding, 95k V BIL.

.3 Secondary Winding: 600 V, 3 phase, 60 Hz, wye-neutral winding, 10 kV BIL.

.4 Temperature Rise: 65 degree C at 40 degree C ambient.

.5 Cooling: KNAN.

.5 The transformer insulation shall use less-flammable natural ester dielectric insulating fluid:

.1 EnviroTemp™ FR3

.2 Or approved equal.

.6 Percent Impedance Voltage: Provide the following impedances subject to a +/- 7.5 percent impedance variation:

kVA	Percent IZ
150 and smaller	2.0
225	3.5
300	4.0
500	4.0
750 and larger	5.75

.7 Transformer shall be designed and constructed to minimized audible noise generated at the rated voltage and kVA level. The audible sound level shall not exceed 65dB in accordance with NEMA TR-1.

.8 Primary Compartment: Provide the following equipment as a minimum:

.1 Dead-front construction.

.2 Radial construction.

.3 Load-break switch.

.4 Draw-out dry well mounted expulsion and current-limiting fuses.

.5 Primary side, medium-voltage bushing wells, bushing inserts and separable elbow connectors conforming to IEEE 386 and rated for 15kV95 kV BIL, 200 amperes continuous, with ability to withstand short-circuits as defined and tested in accordance with CSA C227.4. Provide a parking stand for each elbow connector. Equip connector with steel-reinforced hook-stick eye, grounding eye, test point, and arc-quenching material.

.6 External tap changing handle operable only when the transformer is de-energized.

.9 Low-Voltage Compartment: Provide the following equipment as a minimum:

.1 Secondary low-voltage bushings with spade terminals designed for copper conductors.

.2 Neutral terminal shall be brought out as the Xo bushing.

.3 Liquid level gauge, dial type.

.4 Thermometer, dial type.

.5 Oil filling connection.

.6 Drainage and oil sample valves.

.7 Neutral ground strap, removable.

.8 Corrosion-resistant nameplate and connection diagram in conformance with CSA C227.4 except that the number of gallons (litres) of coolant shall be shown.

.9 Transformer case grounding pad.

.10 Circuit breakers as indicated in the drawings.

.11 Non-PCB and CSA certified label.

2.3 Factory Finish

.1 Provide with a factory-applied, corrosion-resistant finish which shall withstand 3,000 hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to the metal surface in excess of 1/16 inch from the scribed test mark. Finish colour shall be Munsell 7GY3.29/1.5 Green.

.2 Cut edges or otherwise damaged surfaces of galvanized steel shall be coated with a zinc-rich paint.

2.4 Transformer Pads

.1 Provide precast concrete transformer pads sized per transformer manufacturer requirements. Provide reinforcement for parkway (nontraffic) loading.

.2 Provide precast concrete slab box, where indicated, consisting of transformer pad and precast concrete box below, sized per the drawings. Box shall have reinforcement for H-20 traffic bridge loading. Provide hot-dipped galvanized steel parkway covers for access openings.

2.5 Factory Test

.1 Routine Tests:

.1 Test report shall be submitted for review and acceptance to the Purchaser for the routine tests performed in accordance with CSA C227.4 and ANSI/IEEE C57.12.00.

.2 Design Tests:

.1 Perform design tests specified in accordance with CSA C227.4 and ANSI/IEEE C57.12.00, including but not limited to, the following:

.1 Resistance measurement of all windings at all taps.

.2 Ratio tests.

.3 Polarity and phase relation tests.

.4 No load losses and excitation current at 100% of rated voltage.

.5 Temperature rise test.

.6 Dissolved Gas Analysis (DGA).

.7 Windings and core insulation resistance test.

.8 Dissipation Factor (Tan-delta) test.

.9 Lightning impulse test shall be carried out on each terminal of every transformer. The tests shall be based on 100% of BIL given in CSA C227.4, Table 9 and shall be carried out in the sequence one reduced full wave followed by one fullwave. Low potential windings rated less than 1.5 KV class need not be impulse tested.

.10 Partial discharge test.

.11 Tank leak test.

.3 Test reports with oscillography chart shall be submitted for review and acceptance by the Purchaser prior to release for shipment.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Installation

.1 Install pad-mounted transformer in conformance to the Manufacturer's mounting instructions including securing it to the concrete slab by at least four anchor bolts.

3.3 Grounding

.1 Pad-mounted transformer shall have all noncurrent-carrying metal parts connected to a solid earth ground electrode.

3.4 Signs

.1 Install "DANGER--HIGH VOLTAGE--KEEP OUT" signs with tamper-proof stainless steel screws on each accessible side of pad-mounted transformers.

3.5 Field Tests

.1 Perform tests in accordance with Division 1 and Division 16.

.2 Check factory made connections of transformer unit for mechanical security and electrical continuity.

.3 Check transformer insulating liquid for correct quantity/level and Specification according to Manufacturer's instructions.

  .1 Check oil level and temperature indicators.

  .2 Inspect for oil leaks and excessive rusting.

.4 Confirm that the neutral X0 terminal is insulated and not internally grounded.

.5 Perform field tests in accordance with NETA ATS Part 7.2.2.

  .1 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20 degrees C.

    .1 High voltage to ground with secondary grounded for duration of test.

    .2 Low voltage to ground with primary grounded for duration of test.

    .3 High to low voltage.

  .2 Complete turn to turn ration tests for all tap changer positions.

  .3 Inspect primary and secondary connections for tightness and for signs of overheating.

  .4 Inspect and clean bushings and insulators.

.6 Check fuses for correctness of type and size.

.7 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

.8 Set transformer taps to rated voltage as specified.

.1 Adjusting: Adjust primary taps so secondary voltage is above, and within 2 percent of rated voltage.

.9 After the installation has been completed, conduct an operating test demonstrating that all equipment devices operate in accordance with the requirements of the drawings and Specifications.

.10 Operating Test: Energize the transformer and adjust the output voltage to the specified value. Further readjust tap settings, if necessary, after the facility being served is in normal operation.

.11 Have transformer oil sample taken once transformer has been energized and conduct Oil and Gas analysis on sample.

.12 Have a second sample taken after three months operation and conduct Oil and Gas analysis on sample. Test facility will produce a report comparing the results of both tests.

.13 Submit to the Contract Administrator the standard factory test certificates of each transformer and type test of each transformer with high voltage accessories in accordance with CSA C227.4.

.14 Prior to end of Transformer warranty period the contractor will again take an oil sample and conduct DGA analysis on sample. Test facility will produce a report comparing the results of all three tests.

.15 After the installation has been completed, conduct an operating test demonstrating that all equipment devices operate in accordance with the requirements of the drawings and Specifications.

.16 Operating Test: Energize the transformer and adjust the output voltage to the specified value. Further readjust tap settings, if necessary, after the facility being served is in normal operation.

.17 Adjusting: Adjust primary taps so secondary voltage is above and within 2 percent of rated voltage.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of dry-type power transformers up to 2 MVA.

1.2 Standards

.1 American National Standards Institute (ANSI):

  .1 C57. 12.90 - Test Code for Distribution and Power Transformers.

  .2 Canada Energy Efficiency Act and Energy Efficiency Regulations:

  .3 National Resources Canada (NRCan).

.2 Canadian Standards Association (CSA):

  .1 CSA C9 - Dry-Type Transformers.

  .2 CSA C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

  .3 CSA C22.2 No.47 - Air-Cooled Transformers (Dry Type).

  .4 CSA C22.3 No.7 - Underground Systems.

  .5 CSA C802.2 - Minimum Efficiency Values for Dry Type Transformers.

.3 Institute of Electrical and Electronics Engineers (IEEE):

  .1 C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers.

  .2 C57.12.28 - Standard for Pad-Mounted Equipment - Enclosure Integrity.

.4 Manitoba Energy Code for Buildings (MECB):

  .1 Manitoba amendments to the National Energy Code of Canada for Buildings.

.5 National Electrical Testing Association (NETA):

  .1 ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems

.6 National Electrical Manufacturers Association (NEMA):

  .1 ST 20 - Dry Type Transformers for General Applications.

.7 Winnipeg Electrical By-law (WEB):

.1 Winnipeg amendments to the Canadian Electrical Code (CEC).

.8 Winnipeg Building By-law (WBB):

.1 Winnipeg amendments to the National Building Code of Canada (NBC).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 16010 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Indicate type, capacity, voltages, overall dimensions, weight, impedance, X/R ratio, primary and secondary voltages, nameplate data, frequency, BIL, insulation type and temperature rise, full load efficiency, polarity or angular displacement, energy efficiency ratings, and transformer damage curve.

1.4 Quality and Environmental Assurance

.1 On-Site Testing Qualifications: Accredited by NETA.

.2 Certified ISO 9001 Quality Management System.

.3 Certified ISO 14001 Environmental System.

2. PRODUCTS

2.1 General

.1 Low-Sound-Level Requirements: Maximum sound levels when factory tested according to NEMA ST 20, applied to all transformers, including those with K-factor ratings up to 20.

2.2 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Hammond Power Solutions.

.2 Marcus Transformer.

.3 Delta.

.4 ABB.

.5 Schneider Electric.

.6 Siemens.

.7 Eaton Transformers.

.8 Or approved equivalent.

2.3 Performance Criteria

.1 $_{C}$UL labelled Dry type transformer, 3 phase, 60 Hz, convection air cooled ANN type for indoor use.

.2 Nominal primary voltage:

.1 12.47 kV, 60 Hz, 3 phase, 3 wire, ungrounded.

.2 4.16 kV, 60 Hz, 3 phase, 3 wire, ungrounded.

.3 Nominal secondary voltage:

.1 4.16 kV wye connected, 3 phase, 4 wire, 4 bushings suitable for resistance grounding with insulated X0 bushing.

.2 600V wye connected, 3 phase, 4 wire, 4 bushings suitable for resistance grounding with insulated X0 bushing.

.4 Efficiency: Meet or exceed NRCAN standards.

.5 Basic Impulse Level (BIL):

.1 12.47kV Primary: 95 kV.

.2 4.16kV Primary: 60 kV.

.3 4.16kV Secondary: 60 kV.

.4 600V Secondary: 30 kV.

.6 Operating Duty:

.1 Two parallel transformers are sized to normally operate at less than or equal to 50% load, with each transformer capable of delivering full load rating for an indefinite duration when required.

.2 The transformer shall have the capacity to allow inrush of transformers connected to the secondary in addition to remaining standing loads.

.7 Windings: Copper primary and secondary.

.8 Impedance: Standard.

.9 Short Circuit Withstand:

.1 The transformer shall be designed to withstand 3-phase short circuit condition on either the primary or the secondary for a minimum of two (2) seconds.

.2 The transformer shall have a fully line-to-line voltage and BIL insulated neutral and shall withstand the mechanical and thermal stresses for single phase line-to-ground short circuits with the neutral solidly grounded.

.10 Voltage Taps:

.1 Four (4) 2.5 percent taps, two (2) - FCAN, two (2) - FCBN.

.11 Tap Changer:

.1 Off-load tap changer with controls located in cable compartment, with provision for padlocking.

.12 Bushings:

.1 Three bushings for primary winding terminations.

.2 Four bushings for secondary winding terminations.

.13 Temperature Rise: 200ºC insulation system class, 80ºC temperature rise.

.14 Enclosure:

.1 Heavy duty ventilated NEMA 3R enclosure fabricated from sheet steel.

.2 Bolted removable panels for access to tap connections, enclosed terminals.

.3 Anti-vibration pads/isolators shall be used between the transformer core and coil and the enclosure.

.4 Brace coils to provide high mechanical strength to resist displacement at high fault currents.

.15 Voltage Taps:

.1 2 x 2.5% FCAN and 2 x 2.5% FCBN.

.16 Tap Changer:

.1 Bolted-link type.

.17 Coil and Core Assembly:

.1 Vacuum cast epoxy.

.2 Taps located at front of coils for accessibility.

.18 Method of Cooling:

.1 Self-cooled and/or forced fan cooling.

.19 Accessories:

.1 For transformers above 75kVA, provide a winding temperature detector relay with digital display and two sets of SPDT contacts. Sensing elements shall be provided for each of the three coils and connected to the relay.

.2 Wiring and terminal box for protective devices.

.3 Grounding terminal: inside of enclosure.

2.4 Finishes

.1 Painting:

.1 All external metal surfaces shall be thoroughly cleaned and primed to protect against corrosion and finished with a final coat of epoxy paint.

.1 ASA No. 61, light grey.

.2 All paint shall be rated for outdoor duty in a corrosive atmosphere. One (1) 1-litre can, and one (1) non-CFC aerosol can of each type of paint to be supplied for each.

2.5 Identification

.1 All wires shall be identified at both ends with the wire numbers. Thomas & Betts type "SM" single markers shall be used. All terminal blocks shall be identified and marked with the wire numbers.

.2 Nameplates:

.1 Nameplates shall be laminated plastic in accordance with Section 01580 – Project ID and Signs and as indicated in the Standard Details.

.2 All relays, selector switches, breakers within the control cabinet shall be clearly identified and this identification will agree with the schematic and wiring diagrams.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 A complete list of control fuses for each transformer.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020.

.1 Perform visual Electrical and Mechanical Inspection.

.2 Report: Prepare a written report recording voltages on the primary and secondary sides and tap settings. Record and include all tests and their results regardless of type (i.e. include resistances, voltages, current etc.), include equipment used during testing and their calibration data, etc. All test sheets shall bee signed and provided to the Contract Administrator for review.

.3 Vacuum dirt and debris; do not use compressed air to assist in cleaning.

   .1 Electrical Tests:

      .1 Measure resistance at each winding, tap, and bolted connection.

      .2 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to Manufacturer's published data. In the absence of Manufacturer's published data, comply with NETA ATS, Table 100.5.

      .3 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 V phase to neutral. Set tap connections for above 120 V rather than below.

.4 Provide certified factory test reports for each of the power transformers.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers work related to the provision of low voltage harmonic filtering equipment.

1.2 Standards

.1 WWD Electrical Design Guide in Appendix 18D – City Standards.

.2 Institute of Electrical and Electronics Engineers (IEEE):

  .1 IEEE 519: Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

.3 Manitoba Hydro PQS2000: Power Quality Specification for Interconnection to Manitoba Hydro's Electrical System.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

  .1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

  .1 Eaton.

  .2 Schneider Electric.

  .3 Or approved equivalent.

2.2 Configuration, Components and Features

.1 The low voltage harmonic filtering equipment shall be responsible for simultaneous harmonic correction, and power factor correction:

  .1 Closed loop, digital FFT harmonic cancelation to meet IEEE 519 for harmonic limits apparent at reference busbar for operation on Utility power and standby generator.

  .2 Power factor correction to achieve 0.95 lag power factor at reference busbar:

.2 Supply Voltages and Ratings:

.1 Operating Voltage of 600V +10% / -15%, for operation on system nominally rated 600 V, 3 phase 4 wire, 60 Hz.

.3 Output current rating of each unit as required to meet harmonic correction and power factor correction requirements at each reference busbar, with spare capacity per Schedule 18 Technical Requirements.

.1 The equipment output shall be self-limited, and compatible with selected upstream circuit breaker protection.

.2 Equipment capacity requirements shall be based on loads that are required to operate to meet facility peak flow requirements, in addition to operation of all auxiliary systems and building services connected to that reference busbar.

.1 Equipment ratings that rely on a diversity factor to satisfy the harmonic and power factor requirements shall be subject to approval. Calculations and diversity assumptions shall be submitted for review.

.2 Equipment selection shall be validated by harmonic analysis per Appendix 18K – Special Studies and Models.

.4 Harmonic spectrum cancellation: 2nd to 51st.

.1 Harmonic correction time: 2 cycles.

.2 Resonance detection and avoidance.

.3 Optimized power factor control to set-point of 0.95 lagging.

.4 Discrete outputs configured as indicated.

.5 Color HMI.

.6 CSA certified.

.7 Enclosure: Freestanding NEMA 1 for installation in electrical rooms.

.5 Each unit to have three reference CTs, to be installed downstream of main circuit breaker associated with the reference busbar. CTs to be free-issued to MCC Manufacturer for shop integration.

3. EXECUTION

3.1 General

.1 Install in accordance with the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

.4 Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the General Contractor and Contract Administrator, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

.5 Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

.6 Provide final protection and maintain conditions in a manner acceptable to the Manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.2 Installation

.1 Mount equipment where indicated on the Drawings.

.2 Ensure adequate clearance for ventilation.

.3 Install in level upright position.

.4 Make primary and secondary power connections, and all control inter-wiring in accordance with wiring diagram.

3.3 Field Quality Control

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Perform functional tests, commissioning, and first parameter adjusting. Test and adjust controls and safeties, fully test the performance at full current and voltage while functioning as a harmonic correction device to assure compliance as specified herein. Replace damaged or malfunctioning controls and equipment. Report any discrepancies or issues with the installation.

.3 The Contractor shall certify in writing prior to functional demonstration testing that the equipment has been installed, adjusted, and tested in accordance with the Manufacturers recommendations and is ready for operation. Submit all certifications, testing results, system settings, and final report to the Contract Administrator a minimum of ten (10) business days prior to demonstrating functional and operational features.

.4 The Contractor shall demonstrate the functional and operational features of the active harmonic filter with the harmonic power sources used in sizing the AHF in operation. These demonstrations shall be witnessed by the General Contractor and optionally by the Contract Administrator if desired.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers system requirements for the Active Harmonic Filter Power Factor Correction

.2 Provide a company to design, supply, install, and test an Active Harmonic Filter Power Factor Correction..

1.2 Codes and Standards

.1 Design Builder shall comply with the standards set out in this Section.

- .1 UL 1449 – Standard for Transient Voltage Surge Suppressers.
- .2 CSA C22.2 No. 233.1- Surge withstand capacity.
- .3 CSA C22.2, No. 14 – Industrial Control Equipment.
- .4 CSA C22.2, No. 66 – Specialty Transformers, Industrial Products.
- .5 ANSI IEEE 519 – Guide for Harmonic Control and Reactive Compensation of Static Power Converters.
- .6 UL 508 - UL requirements for power conversion equipment.

1.3 Submittals

.1 Submit Shop Drawings and product data in accordance with Section 01300 - Submittals:

- .1 Shop drawings to be submitted as outlined herein and contain all items within one complete submission.
- .2 Shop Drawings will include a complete material list with manufacturer, style, model number and quantities.

.2 Product Data:

- .1 Submit manufacturer’s printed product literature, specifications and datasheets and include product characteristics, performance criteria, and limitations.

.3 Submit Shop Drawings and indicate:

- .1 Outline dimensions, front, side and sectional views.
- .2 Anchoring and support details.
- .3 Enclosure construction, lifting, supporting points, and weight.

.4 Conduit/cable entrance locations and requirements.

.5 Electrical single line diagram and equipment electrical ratings including voltage, frame size and trip rating, withstand ratings, and time current curves of equipment and components.

.6 Recommended supply breaker and cable sizes.

.7 Standard catalog sheets for current transformer.

.8 Compartment layout drawings showing device location.

.9 Wiring diagram indicating:

.1 Terminal Blocks and terminal numbers.

.2 C.T. recommended wiring arrangement.

.3 Control systems and signals.

.4 Indicate field wiring as well as internal wiring. Differentiate between contractor field installed wiring.

.10 Recommended spare parts list.

.11 Harmonic Filter/Power Factor correction size calculation.

.4 Submit certified factory test results.

.5 Closeout Submittals

.1 Complete set of Shop Drawings and submittals.

.2 Operations and maintenance manuals.

.3 Factory test reports.

.4 Literature detailing the programming and set points.

1.4 Maintenance

.1 Provide maintenance materials for incorporation into O & M manuals in accordance with the proper section (Common Work Results – Electrical).

1.5 Quality Issuance

.1 Prior to shipment, the Manufacturer shall fully the performance at full current and voltage while functioning as a harmonic correction device to assure compliance with equipment Specification defined here-in.

.2 The Manufacturer to provide a factory certified report at successful completion of Performance Tests.

.3 Provide testing and Commissioning documentation, signed by a factory certified representative.

2. PRODUCTS

2.1 Characteristics

.1 CSA Approved.

.2 3 Phase.

.3 Voltage: 600 VAC.

.4 Run: 60 Hz.

.5 Equipment to perform harmonic mitigation, power factor correction, load balancing and VAR support.

.6 Rated Compensation Current: As indicated on drawing.

.7 Size equipment to correct the system power factor to between 0.96 and 0.99 lagging.

.8 Interrupting Rating: As indicated on drawing.

.9 Operating Ambient Temperature rating: 0 degrees C to plus 40 degrees C.

.10 Storage Temperature: minus 40 degrees C to plus 65 degrees C.

.11 Active harmonic power factor filter shall be suitable for operation on an electrical system having a generator as its power source. The harmonics filter shall be designed and suitable to operate with either one of the main breakers open, and the tie breaker closed.

.12 Ability to run multiple filters in parallel may be used to achieve total current requirements for combined power factor correction and harmonic cancellation.

.13 Shall include internal current limiting devices for protection of IGBTs.

.14 Harmonic distortion shall be less than or equal to 5 percent THD for the 2^{nd} thru 50^{th} order harmonics.

.15 Total Demand Distortion (TDD) less than limits indicated in IEEE 519, Table 10.3.

.16 Filter shall have automatic restart capability upon power loss return and fault resets.

.17 120VAC, 5A form “C” rated dry contacts for alarm output, indicating any internal alarm condition. Provide LED indication visible from exterior.

.18 Digital Human Machine Interface (HMI) accessible from exterior.

.19 Controller shall be capable of but not limited to the following communication abilities:

  .1 Ethernet TCP/IP.

  .2 RS$*% Modbus RTU.

  .3 USB.

  .4 Automatic Email Reporting with frequency of reporting determined by customer.

  .5 Android application for remote control, logging, monitoring and setting.

.20 Modbus TCP/IP communication from the controller/HMI for feedback and status to external devices.

.21 Separate grounding lug.

.22 All equipment shall be CSA, or ULC rated. IEC rated equipment is not accepted.

2.2 Capacitor

.1 CSA and UL approved.

.2 Self-healing type utilizing a low-loss metalized polypropylene film dielectric system with a pressure sensitive interrupter. Metalized paper is not acceptable.

2.3 Enclosure

.1 NEMA Type 12 free standing enclosure with a door interlocked disconnect. When power is turned on the door cannot be opened.

.2 Required fans and louvers to maintain specified temperature in enclosure.

.3 Appropriate warning labels indicating dangerous voltages in enclosures.

.4 Lifting lugs to allow for transport.

.5 Size: to fit within the proposed location as shown on the Drawings.

2.4 Current Transformers

.1 Three current transformers (one for each phase) located at the main breaker and at the tie breaker.

.2 Rated Primary Current: Based on peak RMS Current, indicated on Drawing.

.3 Nominal Voltage: 600 VAC.

.4 Accuracy Class: 1.0 or better.

.5 Output Power/ Burden: 2.5 VA per active filter used. (i.e. 5 VA for 2 active filters used in parallel).

.6 Current transformer wiring as per Drawings and in accordance with the Manufacturer’s recommendations.

.7 Provide shorting terminal block, to allow for the system to be taken out of service for maintenance in a safe and reliable manner.

2.5 Approved Manufacturers

.1 Active Harmonic Power Factor Filter Manufacturer: Schneider Electric Accusine PCS+ or Electrotek Sinexcel AHF.

2.6 Accessories

.1 Lifting lugs (minimum of 4).

.2 Spare fuses (minimum 3 of each type or size).

2.7 Finish

.1 Finish exterior of unit in accordance with Section Common Work Results -Electrical.

2.8 Equipment Identification

.1 Provide equipment identification in accordance with Section Common Work Results – Electrical.

.2 Nameplate for each active filter to be size 9, example as followed:

HF-R701 ACTIVE HARMONIC FILTER 200 A, 600V, 3Ø

2.9 Warning Signs

.1 Provide warning signs in accordance with Section Common Work Results - Electrical and in accordance with the requirements of the CEC.

2.10 Source Quality Control

.1 Submit to the Departmental Representative standard factory test certificates of each active harmonic power factor filter in accordance with CSA C2 and the Acceptable Testing document. Include test results in the O & M Manuals.

3. EXECUTION

3.1 Manufacturer’s Instruction

.1 Compliance: comply with Manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 Installation

.1 Install and connect active harmonic power factor filter. Installation shall comply with Manufacturer’s instructions, drawings, and recommendations. Provide correct breaker in accordance with the Manufacturer’s recommended size.

.2 Ensure filter is grounded.

.3 Wire and connect in accordance with the Manufacturer’s instructions.

.4 Manufacturer shall provide a certified technical service representative to review the contractor’s installation and to oversee the testing and commission the unit. Programming shall be performed by the Manufacturer’s approved representative.

3.3 Field quality Control

.1 Perform tests in accordance with the Common Work Results – Electrical document and Acceptance Testing document.

3.4 Start-up and site testing

.1 Provide a Manufacturer’s certified field service representative to provide start-up and testing. Site testing shall be in accordance with Manufacturer’s standards. The Manufacturer’s approved service representative must perform Commissioning.

.2 A three phase harmonic analyzer shall be used to measure TDD and THD (V) levels to verify performance meets Specification herein. Test reports shall be prepared for each point of test. Test reports shall be documented, signed, and dated. All tests shall be submitted.

.3 Set-up and verify all parameters and settings. Verify correct operation with loads in operation.

.4 Provide formatted, typed forms indicating all settings as programmed. Include in Operations and Maintenance manuals.

.5 Provide all equipment to perform system programming. Turn over to the department representative.

.6 The Contractor shall measure and verify using field data logging devices, the harmonics contribution of each branch breaker feeding process and mechanical equipment in order to assist the mechanical and process systems contractor in trouble shooting their equipment, and to make sure that the equipment is performing within the required Specification.

.7 The Contractor will coordinate the start-up of the harmonic filter power factor correction unit with the mechanical and process equipment contractor, to ensure proper operation of the system with all the process and mechanical loads online.

3.5 Training

.1 Furnish the services of a competent, factory trained engineer or technician for a period of two 8 hour sessions to instruct City personnel in the operation and maintenance of the equipment, on a date requested by the Contact Administrator.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers work related to:

.1 Section 16010 – Electrical General Requirements for the provision of Power Metering.

.2 Section 16225 – Motor Control Center.

.3 Section 16312 – Medium Voltage Switchgear.

.4 Section 16431– Low Voltage Switchgear.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 CAN3-C17 - Alternating - Current Electricity Metering.

.2 C22.2 No. 0 - General Requirements — Canadian Electrical Code, Part II.

.3 C22.2 NO. 229 - Switching and Metering Centres.

.4 C22.2 No. 115 - Meter-mounting Devices.

.5 C22.2 No. 61010 Misc. - Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements (Tri-national standard).

.2 International Electrotechnical Commission (IEC):

.1 61000 misc., Electromagnetic Compatibility (EMC).

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C37.90.1 - Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.2 IEEE 519 - Standard for Harmonic Control in Electric Power Systems.

.3 IEEE 1588 - Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.

.4 Underwriters Laboratories Canada (cUL):

.1 508A - Industrial Control Panels.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

.1 Shop Tests: testing of assembled system prior to it shipping to site.

.2 Site acceptance tests: testing of installed system prior to, or as part of, the start-up phase.

.3 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer's factory prior to shipping equipment to site.

.2 City reserves the right to witness the final shop tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of seven (7) Business Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

.5 Coordinate tests in accordance with Section 16225 – Motor Control Centres.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider Electric. PM5500 or PM8000, front mounted.

.2 Or approved equal.

2.2 Power Metering

.1 Power meters shall be provided in accordance with City standards and include as a minimum:

.1 Voltage.

.2 Active, reactive and apparent power.

.3 Current.

.4 Frequency.

.5 Total current harmonic distortion THDi.

.6 Total voltage harmonic distortion THDv.

.7 Power factor.

.2 The metering package to include the following features:

.1 True RMS measurement.

.2 Min / Max recording capability.

.3 Accuracy:

.1 Enhanced meters shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (class 0.2s).

.2 Basic meters shall have an accuracy of +/- 0.5% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (class 0.5s) and ANSI C12.20 (Class 0.2).

.4 Instrument Connections:

.1 Potential Transformers:

.1 Provide three (3) potential transformers for metering requirements.

.2 Direct connection for 600 V, 3 phase, 4-wire configurations.

.2 Current Transformers:

.1 Provide current transformers for metering requirements. Provide shorting switches or test blocks for all meter CT inputs.

.5 Remote display for mounting on MCC door.

.6 Communication:

.1 Power meter to include Ethernet communications module suitable for connection to the control system Ethernet switch, communications protocol Modbus TCP.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Mount in the control section of the appropriate switch gear breaker cubicle or adjacent meter compartment.

.4 Install appropriate potential transformer and current transformers required for sensing signals for the meter system.

.5 Install, wire and connect all electrical circuits to the instrumentation package and provide wiring to an external terminal strip for the relay outputs, digital status inputs and analogue output port.

.6 Install, wire and connect the communications port of each meter and extend communications wiring to a location which is easily and safely accessible to facilitate diagnostics, testing and firmware upgrades.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16010 – Electrical General Requirements and Manufacturer's instructions.

.2 Coordinate with the Systems Integration Testing (SIT) and Site Acceptance Testing (SAT) activities.

.3 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.

.4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.

.5 Provide the services of a factory-authorized service representative of the Manufacturer to provide start-up service and to demonstrate and train the City's personnel.

.6 Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

.7 Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the electrical power monitoring and control equipment shall be without damage at time of Substantial Completion.

.8 Train the City's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

.9 Review data in operation and maintenance manuals with the City's personnel. Schedule training with the City, through the Contract Administrator, with at least seven day's advanced notice.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of ground fault (GF) equipment and systems.

.2 Neutral grounding system includes 100 percent continuously rated neutral ground resistors (NGRs), control panels and communication cabling required to complete the system.

.3 The NGR system will include ground fault detection monitoring and alarming system for 12.47 kV transformers, 4.16kV transformers, and 600V transformers rated 1000 kVA and above.

1.2 Standards

.1 American National Standards Institute (ANSI):

  .1 Z535 - Safety Alerting Standards.

.2 Canadian Standards Association (CSA):

  .1 CSA C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/MEC elsewhere in this document shall include reference to such amendments.

  .2 CSA C22.2 No. 14 - Industrial Control Equipment.

  .3 CSA C22.2 No. 31 - Switchgear Assemblies.

  .4 CSA C22.2 No. 94.1 - Enclosures for Electrical Equipment, Non-environmental Considerations (Tri-national standard with NMX-J-235/1-ANCE and UL-50).

  .5 CSA C22.2 No. 144 - Ground Fault Circuit Interrupters.

  .6 CSA C22.2 No. 295 - Neutral Grounding Devices.

.3 Institute of Electrical and Electronics Engineers (IEEE):

  .1 IEEE C37.20.1 - Standard for Metal-Enclosed Low-Voltage (1000 VAC and below, 3200 VDC and below) Power Circuit Breaker Switchgear.

  .2 IEEE C57.32 - Standard for Requirements, Terminology, and Test Procedures for Neutral Grounding Devices.

  .3 IEEE C62.92.1 - Guide for the Application of Neutral Grounding in Electrical Utility Systems – Part 1: Introduction.

  .4 IEEE C62.92.2 - Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part II: Synchronous Generator Systems.

.5 IEEE C62.92.3 - Guide for the Application of Neutral Grounding in Electrical Utility Systems – Part III: Generator Auxiliary Systems.

.6 IEEE C62.92.6 - Guide for Application of Neutral Grounding in Electrical Utility Systems, Part VI: Systems Supplied by Current-Regulated Sources.

.7 IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

.4 International Electrotechnical Commission (IEC):

.1 IEC 60529 - Degrees of Protection Provided by Enclosures.

.2 IEC 61439-1 - Low-voltage switchgear and controlgear assemblies – Part 1: General rules.

.5 National Electrical Manufacturers Association (NEMA):

.1 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 NEMA ICS 6 - Industrial Control and Systems: Enclosures.

.3 NEMA PB 2 - Deadfront Distribution Switchboards.

.4 NEMA PB 2.2 - Application Guide for Ground-Fault Protective Devices for Equipment.

.6 Underwriters Laboratories Canada (cUL):

.1 UL 1053 - Standard for Safety Ground-Fault Sensing and Relaying Equipment.

.2 UL 1558 - Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

1.3 Definitions

.1 Neutral Grounding Resistor (NGR): A resistor that connects the neutral point of a power source to ground to limit the fault current when one phase of the system shorts or arcs to ground.

.2 High-Resistance Grounding (HRG):

.1 A grounding system with a particular resistor with an impedance is designed to limit the amount of fault current of the system between 1 A and 10 A.

.2 The grounding system can be rated for 100 percent of the restricted fault current for continuous operation or limited duration (typically ten (10) seconds or less).

.3 Low-Resistance Grounding (LRG):

.1 A grounding system with a particular resistor with an impedance is designed to limit the amount of fault current of the system between 100 A and 500 A.

.2 The grounding system can be rated for 100 percent of the restricted fault current for continuous operation or limited duration (typically 10 seconds or less).

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit test reports for field testing of ground fault equipment to Contract Administrator and a certificate that system as installed meets criteria specified herein. Refer to Part 3 described herein for additional criterion.

2. PRODUCTS

2.1 Performance Criteria

.1 These devices are used:

.1 To ground the neutral of a three-phase power system using a power resistor.

.2 To limit the magnitude of the ground fault to a predetermined non-damaging level.

.3 To reduce the frequency and number of arc flash and arc blast hazards.

.4 To give immediate indication of ground faults.

.2 Electrical System Parameters:

.1 Systems requiring an NGR with a line-to-neutral voltage of 347 VAC or 2.4kV shall utilize high resistance grounding.

.2 Systems requiring an NGR with a line-to-neutral voltage of 7.2kV shall utilize low resistance grounding.

.1 NGR systems with a line-to-neutral voltage of 7.2kV shall be coordinated with the existing NGR system ratings and protection settings of the Area E substation.

.3 Select components to ensure correct interface between sensing resistor and CT within NGR enclosure with the relay.

.4 Upon detection of a phase-to-ground fault, the NGR system and downstream protection will:

.1 Provide zone selective feeder trip by initiating a trip signal directly to the shunt trip of the feeder breaker identified as the faulted feeder with the lowest assigned priority.

.1 Monitor each individual critical feeder breaker via zero sequence sensor and compatible protection relay.

.2 Provide Alarm upon detection of alarm level ground fault at the NGR relay associated with the transformer or generator main breaker.

2.2 Factory Testing

.1 The following standard factory tests shall be performed on the equipment provided under this Section. All tests shall be in accordance with the latest standards.

.1 Completely test the high resistance grounding system for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment.

.2 The wiring and power circuits shall be given a dielectric test of 1500 volts for one minute, and 1800 volts for one second for control circuits.

.2 A certified test report of all standard production tests shall be provided to the Contract Administrator.

2.3 Neutral Grounding Resistors

.1 IEEE C57.32 compliant and CSA approved.

.2 Resistance based on requirements of HRG and LRG configuration, and total system charging current.

.1 NGRs shall be 10-second rated.

.2 The power study and model prepared in accordance with Appendix 18K – Special Studies and Models shall be used to determine individual requirements and settings for NGR equipment.

.3 Include current transformers of suitable sensitivity and compatible across the full range of trip settings of the ground fault relay installed at switchgear. Current transformer shall be suitable for the connected relay burden plus the associated cable length between the NGR and the switchgear.

.4 NGR enclosure to include a CSA approved sensing resistor to correctly interface with the protection relay installed within the switchgear. Sensing resistor required by the ground fault relay in order to monitor the continuity of the NGR.

.5 The resistive elements shall be low temperature coefficient, resistor grade stainless steel or nickel chromium rigidly supported at each end to allow for expansion due to heating.

.6 The resistors shall be mounted in corrosion resistant support frames, using stainless-steel hardware.

.7 The entire resistor frame shall be mounted on insulators rated for the system voltage.

.8 Connections between resistors and bushings or current transformers shall be solid copper or stainless steel bus or copper cables.

.9 NGR enclosures shall be NEMA 3R suitable for outdoor installation on a concrete pad. Cables will be bottom entry. Cable connection bushings or terminals shall not extend outside of the enclosure.

.10 Approved Manufacturers:

.1 I-Gard.

.2 Approved equal.

2.4 Ground Fault Protection Relays

.1 CSA approved ground fault protection relays installed within switchgear line-up.

.2 Relay must continuously measure NGR resistance and trip on detection of NGR fault indicated by a high neutral displacement voltage.

.3 Trip delay to coordinate with downstream ground fault relays.

.4 Provide ground fault system data logging capabilities, including time and date stamping for a minimum of 99 of the most recent events.

.5 Provide Modbus TCP protocol for communication. Communications to be networked together and integrated into the automation system.

.6 Monitor phase to ground voltages.

.1 Provide ground fault alarm auxiliary relay output Form C, 10 A, 240 VAC contact for remote indication.

.2 Provide harmonic filtering for high frequency noise and current attenuation above 90 Hz.

.7 Provide Main-Tie-Main interlocking of LRG or HRG system to prevent closing tie into phase-to-phase-to-ground fault.

.8 Approved products:

.1 Bender.

.2 Startco SE-330.

.3 I-guard SIGMA.

.4 Approved Equal.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) set of spare fuses for all types of fuses used.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Preparation

.1 Provide test instruments required for all activities as defined in the commissioning documents.

.2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.

.3 Confirm all scheduled activities have identified personnel available.

.4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

3.3 Field Quality Control

.1 Perform tests in accordance with Division 1 and Division 16.

.2 Provide the services of a qualified factory-trained Manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this Section. The Manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein. The Contractor shall provide three (3) copies of the Manufacturer's field startup report.

.3 Conduct performance testing of ground fault system. Document results on ground fault test record form supplied with the equipment and turn over the test records to the customer.

.4 Ensure the system operates as intended during testing of the individual equipment and during process commissioning.

.5 This trade shall assemble all testing data and commissioning reports and submit them to the Contract Administrator.

.6 Each form shall bear signature of recorder, and that of the supervisor of reporting organizer.

.7 Arrange and pay for field testing of ground fault equipment by ground fault equipment Manufacturer before commissioning service.

.8 Check trip unit settings to ensure proper working operation and protection of components.

.9 Demonstrate simulated ground fault tests.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers system requirements for lightning protection.

.2 Design, supply, install, and test a complete lightning protection system. The design shall include a risk assessment as per CSA B72 and NFPA 780 for all the new structures. Statistical or statutory meteorological data must be consulted to make a proper determination of the protection level required.

.3 Buildings and structures shall be properly grounded to prevent damages from a lightning strike/discharge.

.4 System to consist of metallic air terminals, lightning conductors connecting air terminals to ground, and interconnected ground electrodes, and/or ground cables.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- .2 ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- .3 ASTM B33 - Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

.2 Canadian Standards Association (CSA):

- .1 CSA B72 - Installation Code for Lightning Protection Systems.
- .2 CSA C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC/WEB elsewhere in this document shall include reference to such amendments.
- .3 CSA C22.2 No. 41 - Grounding and Bonding Equipment (Trinational standard with NMX-J-590-ANCE and UL 467).
- .4 CSA C22.2 No. 269.1 - Surge Protective Devices – Type 1 – Permanently Connected.
- .5 CSA C22.2 No. 269.2 - Surge Protective Devices – Type 2 – Permanently Connected.

.3 City of Winnipeg:

- .1 Water and Waste Department Electrical Design Guide.
- .2 Water and Waste Department Automation Design Guide.

.3 The Winnipeg Electrical By-law (WEB) and associated bulletins.

.4 Winnipeg amendments to the National Building Code of Canada (NBC).

.4 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.

.2 IEEE IA-18, No. 6 - Grounding Where Corrosion Protection Required.

.3 IEEE P81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

.4 IEEE 80 - Guide for Safety in AC Substation Grounding.

.5 IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.

.6 IEEE 3002.3 - Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems.

.7 IEEE 3003.1 - Recommended Practice for System Grounding of Industrial and Commercial Power Systems.

.8 IEEE 3003.2 - Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems.

.5 National Fire Protection Association (NFPA):

.1 NFPA 780 - Standard for the Installation of Lightning Protection Systems.

.6 Lightning Protection International (LPI):

.1 LPI 175 - Standard for the Design – Installation – Inspection of Lightning Protection Systems.

.2 LPI 177 - Inspection Guide for Certified Systems.

.7 Underwriter Laboratories Canada (cUL):

.1 UL 96A - Standard for Installation Requirements for Lightning Protection Systems UL Lightning Protection Components.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings as outlined herein and contain all items within one complete submission.

.1 Shop Drawings shall include a complete material list with Manufacturer, style, model number and quantities.

.2 Shop Drawings shall indicate materials, methods of construction, attachment and anchorage points for conductors to air terminals and electrodes, erection diagrams, connections, explanatory notes, and other information necessary for completion of the Project.

.3 Submit datasheet of all components used, including make, model number, part number, physical details and measurements.

.4 Submit all pre-design and finalized installation ground continuity and all ground resistance system test results.

2. PRODUCTS

2.1 Manufacturers, Products, and Installers

.1 All lightning protective components shall be cULus listed to UL 96, or CSA certified to C22.2 No. 41. Installations shall be performed to CSA B72.

.2 Acceptable Manufacturers:

.1 Thompson Lightning Protection Inc

.2 Dominion Lightning Rod Co. Ltd.

.3 Harger Lightning & Grounding.

.4 Or approved equal.

.3 Acceptable Installers:

.1 Western Lightning Protection.

.2 Or approved equal.

2.2 Performance / Design Criteria

.1 Coordinate the design for the grounding system with Section 16060 – Grounding and coordinate the submission for the onsite pre-design ground continuity test results.

.2 System Description and General Requirements

.1 Should any ground/soil results be available for pH, Chloride Content, Sulphate Content, and Redox potential through other onsite testing activities as part of the work under other divisions include these values in determining the minimum grounding system size for a service life of 40 years.

.1 Where only the Ohm-cm (Ω-cm) results from the pre-design site soil testing results are known, use the following table as part of considerations in determining the minimum grounding system size for a service life of 40 years:

Soil Resistivity Results (Ω-cm)	Design Considerations
< 2000	Very Corrosive
2000 to 5000	Corrosive
5000 to 10000	Moderately Corrosive
10000 to 25000	Mildly Corrosive
> 25000	Rarely Corrosive

.2 Use of copper is restricted only to specific instances where galvanic interaction of dissimilar metals will cause corrosion and there is no other reasonable means to attach components. In these cases, copper shall not come in contact with galvanized steel, steel, aluminum, and copper-clad aluminum.

.2 All lightning protection system components shall be listed and approved for use as part of a lightning protection system, with the exception of basic hardware such as screws, bolts, washers, and nuts.

.3 Air terminals (Lightning Rods): Aluminum a minimum of 305 mm (12”) to a maximum of 1200 mm (48”) in height. Use of copper is restricted only to specific instances where galvanic interaction of dissimilar metals will cause corrosion and there is no other reasonable means to attach aluminum components.

.4 Conductors:

.1 Grounding and bonding conductors for all point locations, bare (un-insulated) and insulated type (Green), shall be annealed copper type conforming to ASTM B3, tinned in accordance with ASTM B33, stranded, with 98 percent conductivity.

.2 Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8, tinned in accordance with ASTM B33.

.3 Where portions of the underground installation are in RPVC conduit for transition to bare conductor: use green jacketed RWU90 XLPE, Aluminum, size as indicated.

.4 Where portions of the installation are above ground and run in RPVC raceways and run on surfaces: use green jacketed RWU90 XLPE, Aluminum, size as indicated.

.5 Conductors on roof: copper, stranded, insulated jacket (Green), of minimum sizes required for the Class of structure. Provide compatible connection when splicing dissimilar conductors to prevent galvanic interaction between dissimilar metals.

.1 Use Aluminum compatible conductors, terminals, connectors and fastenings for aluminum sheathed and non-aluminum sheathed buildings, or equipment.

.6 Down conductors: Tinned copper, stranded, insulated jacket (Green), minimum size#2 AWG for Class 1 installations, and a minimum of #2/0 AWG for Class 2 installations. Provide and install the required number of down conductors for each zone, minimally spaced in parallel for the calculated bonding distance. Provide compatible metal connection when splicing dissimilar conductors to prevent galvanic interaction of dissimilar metals.

.5 Fastening and attachment straps: Aluminum.

.6 Ground Rod electrode:

.1 Tinned copper, minimum 19 mm diameter, and minimum length of 3 m. Should the design require two (2) ground rods connected to form a 6 m long ground rod, the rod shall come with cone-shaped point on the first section, connected through a threadless compression coupling.

.2 The design shall include a minimum of two (2) ground wells, minimum a 305 mm deep, 205 mm diameter well with flush lid for accessibility and inspection of compressed connections. The inspection well material shall be suitable to withstand light traffic, tin/galvanised inspections wells are not acceptable.

.7 Grounding conductor electrode:

.1 All underground outdoor portions of the installation shall be direct burial in contact with bare earth: bare Aluminum (i.e., unjacketed), with a minimum size of 4/0 AWG.

.8 Ground plate electrode:

.1 Plate electrodes shall only be used in areas where bedrock prevents the use of vertical Rod electrodes. Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Minimum copper surface area 2 m^2, 2 mm thick.

.9 Concrete encased electrode:

.1 Copper conductor: minimum 6.0 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.

.2 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails.

.3 Bonds between Aluminum and lead in concrete, galvanized steel in concrete, and galvanized steel in concrete is acceptable. Bonds between Aluminum and steel in concrete is unacceptable.

.10 Connections:

.1 Where possible, all connections shall be formed by an exothermic weld process. For Aluminum connections, exothermic weld connections are required. For other connections, use compression connections (compression tap or CT).

.2 Where several ground rods are connected to the underground electrode they shall be equally spaced. Splicing and use of ground clamps are unacceptable.

.11 All connectors and splicers shall be of suitable configuration and type for the intended application and shall be of the same material as the conductor or of electrolytically compatible materials. When dissimilar materials are in contact their combined electro-chemical potential shall be less than 0.6 V, when dissimilar metals may be in the presence of an electrolyte their combined electro-chemical potential shall be less than 0.2 V.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Examination

.1 Verification of Conditions: verify conditions of substrates and facilities previously installed under other Sections or Contracts are acceptable for the lightning protection installation in accordance with design and Manufacturer's written instructions.

.2 Visually inspect substrate in presence of Contract Administrator. Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

.3 The Contractor shall be responsible for compaction of substrate to native soil conditions in order to install ground electrodes.

.4 Include inspection of facilities and buildings for compliance of the installed lightning protection system with building code. All penetrations shall be sealed, insulation and vapor barrier maintained, fire seals complete etc.

3.3 Installation

.1 Provide and install lightning protection to CSA B72, UL 96A, and NFPA 780 standards for a permanent, complete, and functional system.

.2 Coordinate the installation for the grounding system with Section 16060 – Grounding.

.3 Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.

.4 Provide and install ground electrodes. Protect exposed grounding/bonding conductors from mechanical injury during and after construction.

.5 Paint buried ground connection with a bitumastic paint.

.6 Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor. Arrange conductors and connectors so no strain on connections.

.7 Air terminal layout and placement position with at least 2 directional paths to ground.

.8 Protect all objects elevated above the normal roof height and with a surface thinner than 4.7 mm (3/16”). This includes exhaust fan housings, air handling units, masts, exhaust vents and ducting, etc.

.9 Metallic objects having a thickness greater then 4.7 mm (3/16”) shall serve as strike termination devices without the addition of air terminals provided they are not an equipment or material that may be damaged from such a strike. These bodies shall be made a part of the lightning protection system by connection and bonding fittings with 2000 mm² (3 in²) of surface contact area.

.10 Attachment of cable secured to air terminals, and building shall be secured along the cable run and attachment shall not be more than 915 mm apart.

.11 Cable bend radius at corners and over building sidewalls with 90 degrees minimum 204 mm (8”) radiuses.

.12 Penetrations and connections to roof systems shall be done in accordance with the roofing contractor’s recommendations and requirements. Connection to the roofing system shall in no way compromise the integrity or warranty of the roof system.

.13 Structural elements and design features shall be used whenever possible to minimize the visual impact of exposed conductors.

.14 Cable down conductors shall be protected and concealed using rigid PVC conduit (RPVC).

.15 Bond discharge conductors to service mast and all other metallic non-current-carrying electrical parts.

3.4 Inspection

.1 Perform tests before energizing electrical system.

.2 Complete grounding testing and validations prior to backfill.

.3 Coordination for the temporary disconnection to the facility grounding busbar(s) will be required as part of validating the grounding systems final resistance. Coordinate disconnection to ground fault indicator(s) during tests.

.4 Grounding systems limits:

.1 Ensure that final resistance of interconnected ground system is 5 ohms, or less.

.2 Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms (50 mΩ).

.3 Total resistance for on the lightning protection system that includes a grounding conductor, and its connections shall have a maximum end-to-end electrical resistance less than 30 milliohms (30 mΩ).

.4 Total resistance for of any single object bonded to the lightning protection system shall not exceed 1 ohm (Ω).

.5 Ground resistance and counterpoise tests must be made during dry weather and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.

.5 Perform ground continuity and resistance tests for the complete interconnected ground system using the method appropriate to site conditions and to approval of Contract Administrator and local authority having jurisdiction over the installation.

.1 Temporary disconnect the two grounding conductors between the facility ground busbar and the facilities underground grounding system. Reconnect when testing is complete.

.2 Mark on the drawings clarifying ground rod(s) where the testing took place (i.e., Gridline X and Gridline X).

.3 Optional Method 1 – The 4-pole Earth Resistance Test:

.1 On the markup drawing, include the Testing instrument electrode names and distance between them.

.2 Place auxiliary grounding electrodes in accordance with instrument Manufacturer's recommendations but not less than 50 feet (15 m) apart, in accordance with IEEE Standard P81.

.4 Optional Method 2 – The Induced Frequency Method (Radio method):

.1 If proceeding with this method, ensure a minimum of 4 ground rods are checked (i.e., at each corner of the grid or facility).

.2 Measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard P81.

.6 Submit all ground continuity and resistance test results and markup sheets within 3 days of field tests, and prior to commissioning activities for AECOM's review. Include inspection certificate certifying that the installation is compliant with applicable codes and standards from an LPI-IP Certified Field inspector/installer for the system.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies design, supply, factory testing, delivery to Site, installation, field testing and commissioning of 12.47 kV arc-resistant medium voltage metal-clad switchgear.

.2 Two (2) 12.47kV metal-clad switchgear lineup (SGR-T0711 and SGR-T0721) shall be provided on a Main-Tie-Main configuration. Refer to Purchaser's Drawing for the number of cells required for the lineup.

.3 Provide switchgear with 125 VDC power supply and backup battery system for switchgear controls and monitoring requirements.

1.2 Standards

.1 Canadian Standards Association (CSA):

  .1 C22.2 No. 31 - Switchgear Assemblies.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC), now known as Electro-Federation Canada.

  .1 G8-3.2, Metal-Clad and Station-Type Cubicle Switchgear.

.3 American National Standard Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE):

  .1 C37.04 - Standard for Ratings and Requirements for AC High Voltage Circuit Breakers with Rated Maximum Voltage Above 1000V.

  .2 C37.06 - Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000V.

  .3 C37.09 - Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000V.

  .4 C37.11 - Electrical Control for AC High Voltage (< 1000V) Circuit Breakers.

  .5 C37.20.2 - Metal Clad Switchgear.

  .6 C37.20.7 - Testing Switchgear Rated Up to 52kV for Internal Arcing Faults.

  .7 C37.55 - Standard for Medium-Voltage Metal-Clad Switchgear Assemblies – Conformance Test Procedures.

  .8 C37.90 - Standard for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 International Organization for Standardization (ISO):

.1 9001 - Quality Management Systems – Requirements.

.5 National Electrical Manufacturers Association (NEMA):

.1 C37.55 - Medium Voltage Metal-Clad Assemblies – Conformance Test Procedures.

.2 ICS 1 - Industrial Control and Systems: General Requirements.

.6 National Electrical Testing Association (NETA):

.1 ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Coordinate the selection for all protective devices with DBA Schedule 18K Special Studies and Models, Power Study Model. The submission for the initial Power Study Model shall be provided prior to submission for the equipment herein.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

.1 Factory Test: testing of assembled system prior to it shipping to site.

.2 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer’s factory prior to shipping equipment to site.

.3 Site Acceptance Test: testing of installed system prior to, or as part of, the start-up/pre-commissioning phase.

.2 City reserves the right to witness the final factory tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of seven (7) Business Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Schneider Electric.

.2 Siemens.

.3 Powell Canada Inc.

.4 Eaton.

.5 Or approved equivalent.

2.2 Performance and Design Criteria

.1 All items listed shall be capable of satisfactory operation indoors in a wastewater treatment plant atmosphere, subject to the following design criteria and conditions to Winnipeg and the following electrical system.

.1 Nominal Supply Characteristics:

.1 12.47 kV, 3 phase, 3 wire, LRG neutral.

.2 4.16 kV, 3 phase, 3 wire, LRG neutral .

.3 Frequency: 60 Hz.

.2 Arc Resistant Protection:

.1 The switchgear assembly shall be design and manufactured to meet all the CSA and ANSI metal-clad switchgear standards plus the requirement of ANSI/IEEE Type 2B arc resistant equipment.

.2 Provide arc blast plenum and exhaust vent to the outside of the electrical room. The vent system shall be designed by the switchgear Manufacturer and form an integral component of the switchgear assembly.

.3 Short Circuit Withstand:

.1 The switchgear shall be designed to withstand:

.1 System maximum phase-to-ground short circuit current determined based on power study required by Appendix 18K – Special Studies and Models.

.2 System maximum 3-phase short circuit current at nominal system voltage (to compare directly with interrupting capability of switchgear rated on a symmetrical current basis).

.3 System maximum available momentary current at nominal system voltage (to compare directly with bus bracing and closing and latching capability of switchgear rated on a symmetrical current basis).

2.3 Configuration, Components and Features

.1 Medium-voltage switchgear assemblies shall include the following features as appropriate for the application:

.1 Metal clad enclosure (indoor).

.2 Busbars.

.3 Grounding bus and connections.

.4 Circuit breakers.

.5 Multifunction protection relays.

.6 Control functions.

.7 Control panels.

.8 Switchboard metering instruments.

.9 Instrument transformers.

.10 Lightning and surge protection.

.11 Key Interlocks

.12 Tools and accessories

.1 Lifting trolley for removal of breakers

.2 Remote racking device.

.3 Grounding Truck, provide a 6-pole ground and test device.

2.4 Switchgear Enclosures

.1 The equipment shall be of modular, metal enclosed, floor mounted, dead-front free-standing type.

.1 Medium voltage equipment shall be compartmentalized such that busbars, breaker compartment, cable compartment and LV equipment are housed within separate enclosures. Grounded steel barriers shall be provided between each section. No access to busbar shall be possible from circuit side or LV compartments.

.2 Accessible from front and rear.

.3 Relays, control circuits and their power supplies shall be housed in separate low voltage and controls section for each panel within the switchgear line-up, safely accessible without exposure to high voltages and without equipment shutdown.

.1 Control switches, lamps and protection relays shall be mounted on the low voltage compartment door.

.4 Use non-corrosive bolts and hardware.

.5 100mm steel channel sills for base mounting in single length common to multi-cubicle switchboard. Sills shall have removable lifting points.

.6 Access doors to have hinges on left side, open at least 90º with stops and shall be secured using multi point latches with the provision for multiple padlocking.

.7 Viewing window of transparent shatterproof material for visual verification of circuit breaker positions.

.8 Infrared (IR) viewing windows to inspect the cable termination on all phases in the cable compartment.

.9 Each shipping section shall be provided with lifting lugs adequately sized for the equipment.

.10 Arc Venting:

.1 Plenums shall be provided on the top of the assembly for containment and directing of material and gases caused by arcs or explosion.

.2 Provide all necessary ducts, transitions and mounting accessories to connect plenums to exterior wall vents.

.3 Plenum vents suitable for the application shall be provided for exterior wall transitions. Arc vents shall be Explovent or equal with a core insulation rating of R-16.

2.5 Circuit Breakers

.1 The circuit breakers shall be horizontal draw-out type, capable of being withdrawn on rails. The interrupting medium shall be vacuum.

.2 The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by an installed electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.

.3 Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily.

.4 A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment.

.5 The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design.

.6 The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

.7 A grounded metal shutter system shall automatically cover the line and load stab connections when the circuit breaker unit is moved to the disconnected position. The shutter shall be pad-lockable in the closed position. The shutters must be clearly identified as either busbar or circuit shutters.

.8 Circuit breaker control and indication circuits wired via the breaker umbilical shall allow operation for maintenance while the circuit breaker is in the test position.

.9 Truck operated switch, device "52H". This auxiliary cell switch shall indicate breaker position as follows:

    .1 NO contacts (open when breaker is in the "test" position and closed when breaker is in the "operate" position).

    .2 NC contact (closed when breaker is in the "test" position and open when breaker is in the "operate" position).

    .3 All required contacts including spare contacts shall be wired to identified terminal blocks.

.10 Mechanism operated switch, device "52S". This stationary mounted auxiliary cell switch to be operative only when breaker is in the "operate" or "fully engaged" position and shall provide indication of breaker status as follows:

    .1 NO "a" type contacts (open when breaker is open and closed when breaker is closed).

    .2 NC "b" type contacts (closed when breaker is open and open when breaker is closed).

    .3 The use of contact multiplying relays to obtain the required quantity of 52S and 52H contacts shall not be permitted.

.11 Trip free and anti-pumping circuits.

.12 Each circuit breaker shall have a mechanical operations counter.

.13 The following interlocks shall be provided:

    .1 Interlock to prevent opening the compartment door unless the circuit breaker is in the disconnected position and safety shutters are closed. This interlock shall also include an indication of shutter position on the front of the compartment door.

    .2 Interlock to prevent opening the rear door(s) unless the circuit breaker in the front compartment of the vertical section is in the disconnected position.

.3 Interlocks shall be provided to prevent the circuit breaker from connecting to or disconnecting from the main bus stabs unless the circuit breaker is open.

.4 Interlock to prevent racking a circuit breaker into a compartment with the door in the open position.

.5 Interlock to discharge stored energy mechanisms upon insertion or removal from the housing.

.6 Mechanical interlocks / barriers to prevent manual mechanical operation of circuit breakers where mechanical operation of circuit breakers is possible using truck mounted close buttons. A caution notice should also be placed near any such interlock. Manual mechanical operation is not desirable as this would bypass any check-synch protection. This inhibit shall not affect manual (local) electrical operation.

.14 The design shall allow normal circuit breaker functions to be carried out with the door closed. Those functions includes manual open and close, manual racking to and from connected position, and manual charging of the circuit breaker closing springs.

.15 Shatter proof viewing windows shall be provided on the door to enable viewing of circuit breaker position inside the compartment, circuit breaker contact status (open/closed), and spring charged/discharged indication.

.16 It shall be possible to padlock all operating mechanisms, control switches and panel doors.

.17 Provide circuit breaker lift truck for positioning and insertion of circuit breakers if required.

2.6 Auxiliary PT Units

.1 Potential transformers suitable for three phase metering, protection relaying, control devices and having the following characteristics:

.1 Nominal voltage class: 4.16 kV or 12.47 kV as required.

.2 Rated frequency: 60 Hz.

.3 Basic impulse level: 60 kV for 4.16kV system and 95kV for 12.47kV system.

.4 Accuracy rating: Burden to be verified by design builder.

.2 Provide separate compartments for PT’s. The compartments shall be independently padlockable.

.3 PTs shall be draw out type transformer assembly complete with two (2) PTs and three (3) primary HRC fuses. PTs shall be connected (phase to phase – open delta) to the main bus.

2.7 Current Transformers

.1 Current transformers for indoor use, suited for operating the applicable relays and having the following characteristics:

.1 Nominal voltage class: As Required.

.2 Rated frequency: 60 Hz.

.3 Basic impulse level: 60 kV for 4.16 kV system and 95 kV for 12.47 kV system.

.4 Relay accuracy rating: C100 at 20 x I_N.

.5 Bar primary with ratios as indicated.

.6 The current transformer shall be rated thermally and dynamically to withstand short circuit current in the primary winding for a period of 2 seconds.

.7 VA rating of the instrument and sizing of leads connecting the CT to the associated equipment shall be suitable for the loop impedance of the secondary winding connections.

.8 For all CT secondary winding connections including those that are run externally to the associated switchgear or equipment, the loop impedance shall be less than 1 ohm and cable not smaller than #12AWG.

.9 Continuous-current rating factor: 2.0 at 30°C.

.2 Metering relay current transformers suited for operating the applicable meters and having the following characteristics:

.1 Rated frequency: 60 Hz.

.2 Basic impulse level: 60 kV for 4.16 kV system and 95 kV for 12.47 kV system.

.3 Relay accuracy rating: 0.3 for B-0.1 to B-1.0 burdens.

.4 Bar primary with ratios as indicated.

.5 The current transformer shall be rated thermally and dynamically to withstand short circuit current in the primary winding for a period of 2 seconds.

.6 Continuous-current rating factor: 1.0 at 30°C.

2.8 Busbars

.1 All bus bars shall be tin-plated copper. All joints shall be secured with vibration proof lock washers.

.2 The main bus shall be rated per Final Design and shall extend through all units. All bus bars on the load and on bus side of each breaker shall be rated the same as the breaker.

.3 Bus bars shall be fully insulated with flame retardant, non-hygroscopic, track resistant, insulating material. Field taping shall be minimized. All insulation to ground shall be porcelain or epoxy, e.g., porcelain or epoxy inserts in the bus support barriers, porcelain or epoxy standoff insulators and porcelain or epoxy bushings for supporting PT cables.

.4 Bus bars and insulation shall be designed and braced to withstand the momentary and short time current ratings of the highest rated breaker in the switchgear assembly, without charring, ageing, melting or permanent deformation.

2.9 Ground Bus:

.1 A copper ground bus, minimum 6 x 50 mm in cross section, shall extend the entire length of the switchgear assembly and be bolted to all units. Also, a copper ground bus extension of the same size shall be provided in all high voltage cable termination compartments. All non-current carrying metallic parts and all instrument transformer circuits shall be bonded to this ground bus.

.2 Two cable lugs shall be included on the ground bus for the Facility ground connections and, in addition, lugs shall be provided in each unit for power cable ground terminations.

2.10 Cable Terminations:

.1 The high voltage terminating compartments in the breaker units shall include necessary cable lugs, cable entrance terminators (glands) for the specified cables and a ground bus extension located in close proximity to the phase bus connections to permit short conductor sheath ground connections.

.2 Cable entrance terminators shall be mounted on the top or bottom plates.

.3 Control cables shall enter either at top or bottom of the unit.

2.11 Maintenance Grounding:

.1 Readily accessible from supply breaker cell rear door, provide on each main phase (and neutral bus if provided) supply and load sides, a grounding “ball” for attaching grounding strap for use during de-energized maintenance. Similarly, provide ground balls on the ground bus at each breaker.

.2 Provide same in each phase on load side of each breaker.

2.12 Protection and Control Functions

.1 Protective Relays:

  .1 All protective relays shall be of microprocessor type.

  .2 Protection functions per WWD Electrical design guide as a minimum.

  .3 All protective relays shall be switchboard draw out type, flush or semi flush mounting in dustproof cases.

  .4 All relays, other than type 86, shall be supplied with a cover and shall be self-reset.

  .5 Alarm contacts shall be closed during normal and open during abnormal conditions and wired to terminal blocks.

.6 Ethernet communication capabilities using Modbus TCP.

.7 GPS clock and time synchronizing equipment. Coordinate equipment selection and interconnection for time synchronization purposes of protective relays and metering equipment.

.8 Each relay shall have a dedicated test block flush-mounted on the LV control panel door to assist with testing and disconnection of the relay.

.9 Acceptable Manufacturer and model:

.1 Schweitzer Engineering Laboratories (SEL).

.2 GE Multilin.

.3 Or approved equivalent.

.2 Ground Fault Relays:

.1 Ground fault protection relays installed within switchgear line-ups coordinated between sensing resistor and CT within NGR enclosure per Section 16292 – Ground Fault Equipment.

.2 Relay shall continuously measure NGR resistance and trip on detection of NGR fault indicated by a high neutral displacement voltage.

.3 Trip delay to coordinate with downstream ground fault elements.

.4 Ethernet communication capabilities using Modbus TCP.

.5 Each relay shall have a dedicated test block flush-mounted on the LV control panel door to assist with testing and disconnection of the relay.

.6 Approved product: Startco SE-330 or I-guard SIGMA.

.3 Meters and Instruments:

.1 Details provided in Section 16291 – Power Metering.

.4 Circuit Breakers

.1 Circuit breakers shall have local electrical operation. In addition, the circuit breaker shall allow operation from a remote source (plant PCS or PMCS output relays) for the open and close operations. Interposing relays shall be provided in the switchgear to interface between the remote signal and the trip / closing circuit, unless the interface/control can be safely achieved without the use of interposing relays, as demonstrated by Design Builder and accepted by the City, acting reasonably. Should the Final Design require interposing relays then these shall be added at no impact to cost or schedule.

.2 Each breaker shall have “Local / Remote” and “Open / Close” control switches. Where remote is selected, only controls from a remote source shall have an effect. Where local is selected, only local electrical control shall operate the circuit breaker.

.3 Circuit breakers shall have a control voltage of 125 VDC, provided from the battery system.

.4 Red and green panel lamps to indicate breaker position.

.5 Include spring charge motors, motor control circuit and spring charged indicating lamps where applicable.

.6 Operations counter.

.7 Circuit breakers shall accept shunt trip inputs to open the switching device as required.

.8 Provide mechanical lockout relay (86) for each circuit breaker.

.9 Provide hard-wired interlocks as required to prevent paralleling of transformers supplies in switchgear other than the 12.47kV synchronizing bus and generator bus.

2.13 Control Panels

.1 Enclosures are to be completely dead front type with flush panel mounted equipment having back connection terminals.

.2 Cut-outs for panel-mounted equipment are to be neatly cut, properly aligned and sized so that the hole is completely covered by the front bezel. Equipment and instrument cases are to be preferably held in place by rear connected fittings. Any front fixing required is to be only by means of chrome plated machine screws.

.3 Equipment is to be mounted to ensure adequate clearance between door mounted and backplane mounted components with the panel door closed. Relay base and terminal block rails are to be located square to the backplane. Door mounted instruments are to align horizontally and vertically on edges or centrelines as generally indicated. All internally mounted equipment is to be arranged for ease of access and removal when necessary.

.4 Group components symmetrically on panel face and backplanes into logical groups.

.5 Indicator Lights:

  .1 Indicator lights are to be heavy duty oil-tight type with back mounted screw terminals with a 30.5 mm face, 125V DC, LED lamp with push-to-test function.

.6 Pushbuttons and Control Switches:

  .1 Pushbuttons and control switches are to be heavy duty, oil-tight type with multi-element stackable contact blocks with side wired screw terminals.

  .2 Pushbutton operators are to be momentary contact type, flush head construction; black in colour.

.3 Rotary operators are to be two, three or four position, wing type, maintained or momentary contacts as required.

.4 Illuminated operators are to have clear wing style operator toggles, with internal indicating lamp.

.5 Pushbuttons and control operators are to be generally provided as follows:

.1 Pushbuttons to be 30.5 mm full-face operator type.

.2 Control Switches to be a 30.5 mm two or three-position multi-pole as required.

.7 Wiring and Terminal Blocks:

.1 The switchgear assembly shall be completely wired and documented using Manufacturer produced schematic diagrams showing all supplied equipment, devices and details. Wiring between units shall be included and, at shipping splits, shall be disconnected, tagged and pulled back into an adjacent unit.

.2 Each control panel shall be neatly arranged using plastic wiring duct for routing of internal wiring, and for field wiring to be terminated.

.3 Wiring harnesses for connection to door-mounted equipment shall be protected with nylon or polyethylene spiral wrap. Provide sufficient cable slack so that cables are not stressed. Protect wiring from any sharp edges using grommets. Fasten wire harnesses using nylon tie-wraps.

.4 Terminal blocks shall be provided for control interfaces using screw compression type terminals. Control wires leaving the cubicle of origin must first terminate on a terminal block. No control wire may leave a cubicle directly from any other device.

.5 All control wiring shall be without splices, stranded copper, minimum 14 AWG, non-flammable, 600 V (or higher). Vinyl or nylon insulated lugs shall be used for terminating wiring at all terminal blocks and at all other points of connection. Spare terminal blocks, minimum twelve (12) extra points, shall be provided in each unit for future circuits.

.6 All terminal blocks shall be identified and marked with the wire numbers. Sleeve type plastic wire markers shall be used at both ends of all wires, with the wire number machine imprinted on the sleeve.

.8 DC Control Circuits:

.1 Auxiliary power supply for control and protection purposes shall be 125 VDC and shall include a two-pole miniature circuit breaker, 125 VDC, complete with Form C auxiliary alarm contact, for protection and complete isolation from all power sources.

.2 Control power shall be monitored with loss of 125 VDC control power alarm signal to the main switchgear automation system.

.3 Close and trip circuits shall be separately fused. Fuse blocks shall be dead front, pullout type that provides the means of disconnecting the control power.

.4 Breaker trip circuit supervision shall be provided in each breaker section by wiring inputs to protection relay.

.9 Ethernet Switches and communications:

.1 Provide Ethernet switches in accordance with Division 17 requirements within LV compartment for connection to PMCS or PCS as required. Redundant DC supply power from external battery backed supplies.

.2 Provide connection from each Ethernet supported device to the Ethernet switches installed in LV compartments.

.3 IEC61850 shall be used for monitoring and control from the PMCS. Provide I/O, cabling and harness to monitor status of main breaker, each feeder breaker, isolating and switch positions.

2.14 Future Equipment:

.1 There shall be provision for future extension on both sides of the switchboard.

.2 In each location where space for future equipment is indicated, leave such space clean. Install conduit, wiring and other work in such a manner that necessary connections can be made in future without dismantling existing equipment, raceways or wiring. Bus Conductors and Insulation:

2.15 Accessories

.1 A full set of maintenance accessories.

.2 100 mm (4 inch) IR window for each breaker allowing view of cable connections.

.3 Complete remote racking system.

.4 Other equipment-specific accessories as recommended by the Manufacturer.

2.16 Finishes

.1 Painting:

.1 Paint procedures and materials shall be Manufacturer’s system designed and proven for resistance to chemical attack in industrial wastewater treatment plant environments.

.2 All metal surfaces shall be thoroughly cleaned, primed to protect against corrosion, and finished with a final coat of enamel:

.1 ASA No. 61, light grey.

.2 Cubicle interior, white.

.3 All paint to be rated for indoor duty in a damp, corrosive atmosphere.

.4 One (1) 1 L can, and one (1) aerosol spray can (for every four units) of each type of paint shall be supplied for touch up after installation.

2.17 Identification

.1 Provide equipment identification nameplates on each item of instrumentation and equipment specific to this Section.

.2 Nameplates to comply with City labelling and identification requirements.

.1 Unit number and identification nameplates shall be included on the front door, rear cover, and on the inside rear of the unit.

.2 All relays will have nameplates which will include relay function, IEEE device number and appropriate phase. Nameplates shall be furnished for all instruments, meters, control switches, push buttons, indicating lights, terminal blocks, fuse blocks, PT and CPT compartment doors, both on the front door (and rear of front door) and inside the unit.

.3 Nameplates for fuse blocks will include the fuse size. Nameplates shall be clearly visible and not covered by wiring.

.4 Exterior nameplates shall be attached by screws or rivets only. Glue attachment shall not be permitted. Electrical warning signs shall be provided.

2.18 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) complete spare breaker.

.2 One (1) spare CT to match all ratios used in switchgear.

.3 One (1) spare PT to match all ratios used in switchgear.

.4 Six (6) spare fuses of each type and rating of fuse used, including voltage and control power transformer fuses.

.5 One (1) spare indicating lamp of each type installed.

.6 One (1) spare breaker control switch.

.7 One (1) spare control relay of each type used in switchgear.

2.19 Factory Acceptance Testing

.1 Submit a certified test report of all standard equipment production tests to the Contract Administrator as a submittal.

.2 The Manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the switchgear meets operating Specifications.

.3 Combined factory testing for the 4.16kV and 12.47kV switchgear shall be witnessed by the City Representative. A projected test schedule and test procedures shall be provided at least one (1) month in advance of the test date.

.4 The Vendor shall include the cost of transportation and lodging for two (2) City Parties for witness testing at the factory.

.5 Equipment shall be subjected to a primary current injection to verify operation of all current-sensitive components.

.6 Equipment to be subjected to a primary voltage injection to verify operation of all voltage-sensitive components.

.7 Lubricate all moving and working parts.

  .1 The circuit breaker shall be subjected to a minimum of thirty (30) electrical and mechanical operations.

.8 Test at the factory in accordance with IEEE C37.20.2 and CSA C22.2 No. 31, including operating and high potential tests.

  .1 Each vacuum interrupter shall receive a vacuum integrity test by means of the system AC high potential test.

.9 Test breakers in accordance with IEEE C37.09 and IEEE C37.20.2 and CSA C22.2 No. 31.

  .1 Test breakers in a switchgear cell of the basic design in which the breaker will be used.

  .2 Include continuous current test.

  .3 Include momentary current test.

  .4 Include BIL test.

  .5 Each breaker shall have a contact timing test, conductivity of current path test, coil check test and hi-pot test.

.10 Initial tests to be done by Manufacturer to verify system operates free of grounds, and open and short circuits.

.11 Complete assembly shall have a low frequency withstand test to verify insulation integrity.

.12 Perform point-to-point tests of all wiring to verify correct connections, continuity and dielectric integrity.

.13 Verify the correct operation of all circuit breakers, interlocks and auxiliary contacts, control switches and push buttons, relays, and metering.

.14 Following the above tests, provide full Ethernet configuration and factory acceptance testing of switchgear equipment at the switchgear factory prior to equipment shipment.

.15 With all sections per inter-wired permanently or temporarily and with control power applied, perform:

.1 Functional test of control circuits. Simulate field contacts; where necessary, provide Hand-Off switch pre-wired to a terminal block or harness for easy plug-and-test.

.2 Functional test of Ethernet communication, monitoring, protection, metering and interlocking systems.

.16 Provide documentation for Ethernet configuration, hardcopy and electronic, to integrate the communication equipment provided with the switchgear into the main control system.

.17 Prepare check-out sheets covering all test requirements and verifications, detailing all tested points and functionality. The sheet shall be completed during testing to verify compliance and functionality per switchgear component and signed off.

.18 Switchgear equipment shall not be shipped or made ready for shipping until factory acceptance testing test results have been reviewed by the Contract Administrator as a submittal for the complete switchgear assembly. Correct any deficiencies found during the factory acceptance testing procedures and re-test as required to verify operations. Equipment that is shipped without evidence of the required tests being performed to verify satisfactory operation will be subject to non-acceptance.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 Field Quality Control:

.1 Energize the space heaters as soon as each switchgear is delivered to the site. Obtain power for the heaters from the temporary power and lighting system until they can be energized from the source shown.

.2 Furnish the services of a representative of the Manufacturer of the switchgear to check the installation before it is energized. Submit copies of a signed statement from Manufacturer's representative confirming that the equipment has been properly installed and is in good working order. Include:

.1 Operation of each circuit breaker.

.2 All circuit breaker trip functions.

.3 Test in accordance with the latest standards of ANSI, NEMA, and NETA ATS.

.1 Inspection and test in accordance with NETA ATS, except Section 4.

.2 Perform inspections and tests listed in NETA ATS, Section 7.6.2.

.4 Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

.5 Check tightness of accessible bolted bus joints using calibrated torque wrench.

.6 Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.

.7 Perform power frequency withstand testing in accordance with IEEE C37.09.

.8 Perform contact resistance testing on the busbar joints and breaker contacts.

.9 Physically test key interlock systems to insure proper function.

.4 Adjusting:

.1 Adjust all operating mechanisms for free mechanical movement.

.2 Tighten bolted bus connections in accordance with Manufacturer's instructions after placing switchgear.

.3 Adjust protective relays in accordance with recommendations of the Short Circuit Analysis and Protective Device Coordination Study with Division 16, and as directed under contract.

.5 Equipment Checkout:

.1 Commission the switchgear on site, verify installation, test, adjust and otherwise make each component of the switchgear operational.

.2 Final verification of the switchgear installation shall include field wiring, relay settings and adjustment, proper functioning of kirk key interlocks, phase-to-phase and phase-to-ground insulation resistance, proper identification of cells, instruments, relays and meters.

.3 When the switchgear has been installed and tested, test to verify properly assembly, connections, adjustments and operation in accordance with the Final Design and submit all results.

.4 Test integration with standby generator controls system and main control system for breaker operation for automatic control.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of key interlocks to the electrical equipment rated up to12.47 kV for mechanical interlocking for safe operating and maintenance requirement.

.2 Related Sections:

.1 16020 – Electrical Testing.

.2 16225 – Motor Control Centres.

.3 16272 – Pad-Mounted Transformers.

.4 16312 – Medium Voltage Switchgear.

.5 16431 – Low Voltage Switchgear.

1.2 Standards

.1 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Kirk Key Interlock Co.

.2 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Key interlocks shall be applied as required at 4.16 kV, 600 V and 208 V voltage levels.

.2 Supply and install the key interlocks, including but not limited to, the following operating conditions:

.1 Interlocking to prevent paralleling of redundant incoming utility supply (i.e., closing of tie breaker) on the 208 V, 600 V and 12.47 kV when the two (2) main incoming breakers are closed.

.2 Interlocking to prevent opening of the 600 V and 12.47 kV switchgear cable and breaker compartment doors open when the breaker is closed.

.3 Interlocking to prevent the 12.47 kV padmount transformer doors open when the breaker feeding the transformer is closed.

.4 Interlocking to prevent opening of the non-load breaking isolation switch when the downstream breaker is closed.

.5 Interlocking to prevent closing of the grounding switch when the breaker is closed.

.3 Provide key transfer interlock as required to allow for access to multiple compartments from a single point of upstream isolation.

.4 Door mounted interlocks shall use a two-part system where the catch is required to be seated into the lock body in order to allow key removal.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.1 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 MCC, VFD and switchgear vendors to factory install and mechanically connect key interlocks in accordance with key Manufacturer's instructions.

.4 Interlocks to be fully integrated within design.

.5 Set key blocks in place, rigid plumb and square, with mechanical linkages and components designed to achieve mechanical integrity for the design life of the switchgear.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of circuit breakers rated up to 600 V.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 CSA C22.2 No. 5 – Molded-case Circuit Breakers.

.2 CSA C22.2 No. 31 – Switchgear Assemblies.

.2 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C37.13 - Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.

.2 IEEE C37.14 - Standard for DC (3200 V and below) Power Circuit Breakers Used in Enclosures.

.3 IEEE C37.17 - Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.

.3 National Electrical Manufacturer Association (NEMA):

.1 NEMA AB3 – Molded Case Circuit Breakers and their Application.

.2 NEMA C37.50, Switchgear – Low Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures.

.3 NEMA ICS 6 – Industrial Control and Systems: Enclosures.

.4 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Underwriters Laboratories (UL):

.1 UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosure.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Include continuous ratings, fault and withstand ratings.

.3 Include time-current characteristic curves for breakers.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide all circuit breakers from a single Manufacturer.

.2 Acceptable Manufacturers:

.1 Schneider Electric Canada Inc.

.2 Eaton

.3 Or approved equivalent.

2.2 Power Circuit Breakers – Draw-out

.1 Draw-out power circuit breakers shall be used for protection requirements above 400A. Frame ratings shall be 800, 1250, 1600, 2000 amperes as required by the Final Design. All frame ratings shall be the same product line.

.2 Circuit breakers shall be compatible with the equipment type in accordance with related standards.

.3 All breakers shall be ULC/CSA listed for application in their intended enclosures for 100% of their continuous ampere rating.

.4 All circuit breakers shall have a minimum symmetrical interrupting capacity of 42,000 amperes at 600 V. To ensure a fully selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

.5 Electrically operated complete with motor operators powered from 120 V DC source. The charging time of the motor shall not exceed 6 seconds.

.6 Circuit breakers shall be capable of remote automatic switching for control from the Power Control Management System (PCMS).

.7 Equipped with Open / Close pushbuttons with lockable guards, interposing relays to allow control of circuit breaker remotely as indicated and red / green indicating lights to indicate breaker contact position.

.8 To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

.9 The power circuit breaker shall have a closing time of not more than 5 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

.10 The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

.11 The breaker cell shall be equipped with draw out rails and primary and secondary disconnecting contacts. The secondary disconnecting devices shall be maintained in the “connected” and “test” positions.

.12 The removable power circuit breaker element shall be equipped with disconnecting contacts, wheels and interlocks for draw out application. It shall have four (4) positions: CONNECTED, TEST, DISCONNECTED and REMOVED all of which permit closing the compartment door. The breaker draw out element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank.

.13 Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall secure the breaker in the connected, test or disconnected position by preventing levering.

.14 Trip Units:

.1 Circuit breakers shall be equipped with an LSIG protection system consisting of current sensors, microprocessor-based trip device including:

.1 Programmable long-time setting.

.2 Programmable long-time delay with selectable I^2t or I^4t curve shaping.

.3 Programmable short-time setting.

.4 Programmable short-time delay with selectable flat or I^2t curve shaping, and zone selective interlocking.

.5 Programmable instantaneous setting.

.6 Programmable ground fault setting trip or ground fault setting alarm.

.7 Programmable ground fault delay with selectable flat or I^2t curve shaping and zone selective interlocking.

.2 Provide arc flash reduction system to allow the operator to enable a maintenance mode with a pre-set accelerated instantaneous override trip to reduce arc flash energy, for the equipment downstream of the main breakers.

.3 The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

.4 The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. If the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

.5 Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

.6 The unit shall be capable of monitoring the following data:

.1 Instantaneous value of phase, neutral and ground current.

.2 Instantaneous value of line-to-line voltage.

.3 Minimum and maximum current values.

.4 Watts, VARs, VA, Watthours, VAR hours and VA hours.

.7 The trip unit shall display the following power quality values: crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.

.8 The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

2.3 Molded Case Circuit Breakers – 400A and Below

.1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation (with temperature compensation for 40°C ambient).

.2 Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3 to 8 times current rating.

.4 Circuit breakers shall have a minimum symmetrical interrupting capacity as required based on the power study.

.5 Ground Fault interrupter breakers for circuits feeding heat tracing cables and as otherwise required.

.6 Thermal-Magnetic Breakers (Design A):

.1 Molded-case circuit breaker shall operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for overcurrent and short circuit protection.

.7 Magnetic-Only Breakers (Design B):

.1 Molded-case circuit breaker shall operate automatically by means of magnetic tripping devices with adjustable settings to provide instantaneous tripping for short circuit protection also referred to as motor circuit protection (MCP).

.8 Ground Fault Circuit Interrupter Breakers (GFCI Breakers):

.1 Provide GFCI breakers Class A, where indicated, for sizes 15-40 A, single and double pole 120/240 V, single-phase, and 120/208V, 3-phase, as applicable.

.2 GFCI breakers to be similar to design A, but with the added feature of ground fault protection in excess of 5 mA. Use when specified or noted.

.3 GFCI breakers to be mounted in panel boards or MCCs as required by the application.

2.4 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

3.2 Field Testing

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Perform tests as specified in the manufacturer's instructions and Division 16, and as follows:

.1 Check ratings of breaker trip and frame against Shop Drawings.

.2 Verify operation of mechanical interlocking systems between circuit breakers.

.3 Operate circuit breakers to verify correct operation.

.4 Check insulation with megger test. If values are not satisfactory, clean and dry the circuit breakers.

.5 Check phase rotation of each feeder and correct as necessary.

.6 Check for proper operation of instruments or metering.

END OF SECTION

DISCONNECT SWITCHES

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of disconnect switches for equipment rated for 600 VAC and below.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 CSA C22.2 No. 4 – Enclosed and Dead-Front Switches.

.2 CSA C22.2 No. 14 - Industrial Control Equipment (for motors).

.3 CSA C22.2 No. 39 - Fuse holder Assemblies.

.4 CSA C22.2 No. 248 - Low-Voltage Fuses.

.2 Canadian Electrical Code (CEC) as adopted by the Province of Manitoba.

.3 National Electrical Manufacturer Association (NEMA):

.1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 NEMA ICS 6, Industrial Control and Systems: Enclosures.

1.3 Submittals

.1 Provide submittals for Division 16 in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 All disconnect switches will be of the same type and from one Manufacturer throughout.

.2 Disconnects shall be CSA approved.

.3 Supply disconnect switches for motors based on motor rating per WWD Electrical Design Guide.

.4 Acceptable Manufacturers for disconnect switches not associated with MCCs, VFDs, or motor starters:

.1 Square D.

.2 Cutler Hammer.

.3 Adalet.

.4 Appleton.

.5 Crouse Hinds.

.6 Or approved equivalent.

2.2 Configuration, Components and features

.1 Disconnect Switches Above 250 V Duty:

.1 Fusible and non-fusible disconnect switch in NEMA 12 enclosure for dry indoor duty (electrical and control rooms), and NEMA 4X stainless steel enclosure for indoor process, damp, wet, and outdoor duty, NEMA 7 copper free aluminum with stainless steel hardware for hazardous locations; size as set out in the Final Design.

.2 Visible blade switch with breaking capacity of up to fifteen (15) times rated current for high efficiency motor applications.

.3 Provide window to allow view of blade position without opening access cover. Viewing windows are not required for NEMA 7 disconnect switches. Minimum rating for non-fused switches shall be 30 A.

.4 Provision for padlocking in OFF position by three padlocks. Provision for locking in OFF position with a lockout hasp or scissor (6 mm diameter).

.5 Mechanically interlocked door to prevent opening when handle in "ON" position.

.6 Disconnect switches to be supplied complete with NO auxiliary interlock contacts which break the power source control circuit before the main switch blade breaks.

.7 Fuses: HRC, size, type, and class as set out in Final Design.

.8 Fuse holders: Suitable without adaptors for type and size of fuse indicated.

.9 Quick-make, quick-break action.

.10 ON-OFF switch position indication on switch enclosure cover.

.2 Disconnect Switches for sump pumps above 250 V:

.1 Non-fusible disconnect switches in NEMA 4X watertight, impact- and corrosion-resistant thermoplastic enclosures for wet duty where possibility of flooding could occur. Size as set out in the Final Design.

.2 Suitably rated for motor applications including high efficiency.

.3 Provision for supply cable entry from below and for padlocking in OFF position.

.4 Disconnect switches shall be supplied complete with NO auxiliary interlock contacts which break before the main switch blade breaks (to OFF), unless otherwise required by the Final Design.

.5 Pre-wired IEC pin and sleeve interlocked 3 phase 4-wire, 30 A, 600 VAC rated receptacle, and matching plug, with interlocking feature preventing insertion or removable of plug while switch is in the ON position.

.6 “Top”-hinged colour-coded receptacle cover.

.7 ON-OFF switch position indication on switch enclosure cover.

.8 Finish: in accordance with per Section 16010 – Electrical General Requirements.

.9 Acceptable Products:

.1 Bryant model 430SMI5W plus N.O. contact and matching plug 430P5W.

.2 Or approved equivalent.

.3 Disconnect Switches 250 V duty and below:

.1 In NEMA 12 enclosure for dry indoor duty (e.g., electrical, control and computer rooms), and NEMA 4X enclosure stainless steel or non-metallic for indoor process, damps, wet and outdoor duty, size as set out in the Final Design.

.2 Breaking capacity of up to fifteen (15) times rated current for high-efficiency motor applications.

.3 Provision for padlocking in OFF position by three (3) padlocks.

.4 Mechanically interlocked door to prevent opening when handle in ON position.

.5 Fuses: HRC, size, type and class as set out in the Final Design.

.6 Fuse holders: suitable without adaptors, for type and size of fuse indicated.

.7 Quick-make, quick-break action.

.8 ON-OFF switch position indication on switch enclosure cover.

.9 Finish: in accordance with Section 16010 – Electrical General Requirements.

.10 Acceptable Manufacturers:

.1 Square D.

.2 Cutler Hammer.

.3 Hubbell or

.4 Approved equivalent.

2.3 Finishes

.1 Provide enclosure finish requirements in accordance with Section 16010 – Electrical General Requirements.

2.4 Identification

.1 Nameplates to comply with City labelling and identification requirements.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Three (3) fuses of each size and type used for fused disconnect switches.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Install disconnect switches within sight of and within 8 m of the associated equipment.

.3 Wire disconnect switch auxiliary interlock contact back to power source control circuit as indicated in the equipment schematic and wiring diagrams.

.4 Install fuses in disconnect switches immediately before energizing circuits.

3.2 Testing and Commissioning

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Check that the disconnect switch installed is sized properly for application.

.3 Check correct fuses sizes, and that fuses are properly installed.

.4 Operate disconnect switches to verify correct operation.

.5 Check for proper operation of auxiliary contact interlock.

END OF SECTION

LV SWITCHGEAR

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of low voltage switchgear.

1.2 Standards

.1 American National Standards Institute (ANSI):

.1 C37.50, Switchgear - Low Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures.

.2 C37.51, Switchgear - Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies – Conformance Test Procedures.

.2 Canadian Standards Association (CSA):

.1 C22.2 No. 31 - Switchgear Assemblies.

.2 C22.2 No. 268 - Power Circuit Breakers up to 1000 Vac and 1500 V dc Used in Enclosures (Binational Standard with UL 1066).

.3 C22.2 No. 178.1 - Transfer Switch Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE):

.1 C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.

.2 C37.16 - Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.

.3 C37.17 - Standard for Trip Systems for Low-Voltage (1000V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.

.4 C37.20.1 - Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 VDC and below) Power Circuit Breaker Switchgear.

.5 C57.13 - Standard Requirements for Instrument Transformers.

.4 International Organization for Standardization (ISO):

.1 9001 - Quality Management Systems – Requirements.

.5 National Electrical Manufacturers Association (NEMA):

.1 ICS 1 - Industrial Control and Systems: General Requirements.

.2 ICS 6 - Industrial Control and Systems: Enclosures.

.6 Underwriter Laboratories Canada (cUL):

.1 UL 1558 - Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials that shall include the following minimum:

.1 Catalogue and technical data including OEM Detailed Bulletins.

.2 Outline dimensions, front and rear-view elevations, shipping sections dimensions, weight, and foundation requirements for all assemblies.

.3 Configuration of each component.

.4 Cable entry and exit locations.

.5 Dimensioned position and the size of bus bars and details of provisions for future extension.

.6 Three-line power and protection diagrams.

.7 Control schematics and internal wiring and interconnection diagrams, that include tentative settings and sizes for circuit breakers, fuses, relays as applicable.

.8 External connection diagrams showing function and identification of all terminals.

.9 Floor anchoring method and dimensioned foundation template, recommended size and material Specifications of anchor bolts.

.10 Protection, control, metering and alarm equipment load requirement calculations for each switchgear listing equipment allowed for

.11 Time current characteristics curves for circuit breakers and fuses connected to busses and all pertinent data including short circuit interrupting capacity and peak let-through current data required to verify the overload and short circuit interrupting and current limiting ability.

.12 Coordinate the selection for all protective devices with DBA Schedule 18K Special Studies and Models, Power Study Model. The submission for the initial Power Study Model shall be provided prior to submission for the equipment herein.

1.4 Quality Assurance

.1 The following terms are used for describing quality assurance and testing requirements:

.1 Shop Tests: testing of assembled system prior to it shipping to site.

.2 Site acceptance tests: testing of installed system prior to, or as part of, the start-up phase.

.3 Factory Acceptance Tests (FAT): operation, programming, configuration and testing of assembled system shall be witnessed by City and performed at the Manufacturer's factory prior to shipping equipment to site.

.2 City reserves the right to witness the final shop tests and FAT. Provide notification to the Contract Administrator and City in writing a minimum of seven (7) Business Days in advance of the date the assembly is ready for testing.

.3 Submit certified test results.

.4 Provide full system operation programming, configuration and testing services for Factory Acceptance Testing as specified herein.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Eaton.

.2 Schneider Electric.

.3 GE.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 All items in this Section shall be capable of satisfactory operation in an indoor electrical room in a wastewater treatment plant atmosphere subject to the following design criteria and conditions particular to Winnipeg, MB and the following facility electrical system.

.1 Nominal Supply Characteristics:

.1 600 V, 3 phase, 3 wire, HRG neutral for systems >= 1000 kVA.

.2 600 V, 3 phase, 3 wire, solidly grounded neutral for systems <1000 kVA.

.3 Frequency: 60 Hz.

.2 Short Circuit Withstand:

.1 The switchgear shall be designed to withstand:

.1 System maximum phase-to-ground short circuit current determined based on power study.

.2 System maximum 3-phase short circuit current at nominal system voltage (to compare directly with interrupting capability of switchgear rated on a symmetrical current basis).

.3 System maximum available momentary current at nominal system voltage (to compare directly with bus bracing and closing and latching capability of switchgear rated on a symmetrical current basis).

.3 Arc Resistant Protection:

.1 The switchgear assembly shall be design and manufactured to meet all the ANSI metal-clad switchgear standards plus the requirement of ANSI/IEEE Type 2B arc resistant equipment.

.2 Provide arc blast vent to the outside of the electrical room. The vent system shall be designed by the switchgear manufacturer and form an integral component of the switchgear assembly.

2.3 Configuration, Components and Features

.1 Low voltage switchgear assemblies shall include the following features as appropriate for the application:

.1 Metal clad enclosure (indoor).

.2 Busbars.

.3 Grounding bus and connections.

.4 Circuit breakers and associated protection.

.5 Control functions.

.6 Switchboard metering instruments.

.7 Instrument transformers.

.8 Lightning and surge protection.

.9 Key Interlocks.

.10 Tools and accessories

2.4 Switchgear Enclosures

.1 The equipment shall be of modular, metal enclosed, floor mounted, dead-front free-standing type.

.1 Low voltage equipment shall be compartmentalized such that busbars, circuit side and controls equipment are housed within separate enclosures. Grounded steel barriers shall be provided between each section. No access to busbar shall be possible from circuit side or controls compartments.

.2 Accessible from front and rear.

.3 Relays, control circuits and their power supplies shall be housed in separate low voltage and controls section for each panel within the switchgear line-up, safely accessible without exposure to high voltages and without equipment shutdown.

.1 Control switches, lamps and protection relays shall be mounted on the low voltage compartment door.

.4 Use noncorrosive bolts and hardware.

.5 100mm steel channel sills for base mounting in single length common to multi-cubicle switchboard. Sills shall have removable lifting points.

.6 Access doors to have hinges on left side, open at least 90º with stops and shall be secured using multi point latches with the provision for multiple padlocking.

.7 Viewing window of transparent shatterproof material for visual verification of disconnector, circuit breaker and contactor positions.

.8 Each shipping section shall be provided with lifting lugs adequately sized for the equipment.

.9 Arc Venting:

.1 Plenums shall be provided on the top of the assembly for containment and directing of material and gases caused by arcs or explosion.

.2 Provide all necessary ducts, transitions and mounting accessories to connect plenums to exterior wall vents.

.3 Plenum vents suitable for the application shall be provided for exterior wall transitions. Arc vents shall be Explovent or equal with a core insulation rating of R-16.

.10 Each set of three-phase cable terminations shall be infrared scannable by means of a crystalline sight-glass with guard cover installed in the rear cover, minimum 75 mm diameter.

.1 Acceptable manufacturer:

.1 Fluke (Hawk IR International Inc.)

.2 Or approved equivalent.

.2 All fuse-blocks and fuses shall be installed within the applicable compartment.

.11 The incoming supply equipment to be provided in a section which is dedicated for this purpose, i.e., no additional equipment other than the main breaker, and the incoming metering and control.

2.5 Busbars

.1 All bus bars shall be tin-plated copper. All joints shall be secured with vibration proof lock washers.

.2 The main bus shall be rated per Final Design and shall extend through all units. All bus bars on the load and on bus side of each breaker shall be rated the same as the breaker.

.3 Bus bars and insulation shall be designed and braced to withstand the momentary and short time current ratings of the highest rated breaker in the switchgear assembly, without charring, ageing, melting or permanent deformation.

2.6 Ground Bus

.1 A copper ground bus, minimum 6 x 50 mm in cross section, shall extend the entire length of the switchgear assembly and be bolted to all units. Also, a copper ground bus extension of the same size shall be provided in all high voltage cable termination compartments. All non-current carrying metallic parts and all instrument transformer circuits shall be bonded to this ground bus.

2.7 Meters and Instruments:

.1 Details provided in Section 16291 – Power Measurement and Metering Equipment.

2.8 Future Equipment:

.1 There shall be provision for future extension on both sides of the switchboard.

.2 In each location where space for future equipment is indicated, leave such space clean. Install conduit, wiring and other work in such a manner that necessary connections can be made in future without dismantling existing equipment, raceways or wiring. Bus Conductors and Insulation.

2.9 Control Panels

.1 Enclosures are to be completely dead front type with flush panel mounted equipment having back connection terminals.

.2 Cut-outs for panel-mounted equipment are to be neatly cut, properly aligned and sized so that the hole is completely covered by the front bezel. Equipment and instrument cases are to be preferably held in place by rear connected fittings. Any front fixing required is to be only by means of chrome plated machine screws.

.3 Equipment is to be mounted to ensure adequate clearance between door mounted and backplane mounted components with the panel door closed. Relay base and terminal block rails are to be located square to the backplane. Door mounted instruments are to align horizontally and vertically on edges or centrelines as generally indicated. All internally mounted equipment is to be arranged for ease of access and removal when necessary.

.4 Group components symmetrically on panel face and backplanes into logical groups.

.5 Indicator Lights:

.1 Indicator lights are to be heavy duty oil-tight type with back mounted screw terminals with a 30.5 mm face, 120V AC, LED lamp with push-to-test function.

.6 Pushbuttons and Control Switches:

.1 Pushbuttons and control switches are to be heavy duty, oil-tight type with multi-element stackable contact blocks with side wired screw terminals.

.2 Pushbutton operators are to be momentary contact type, flush head construction, black in colour.

.3 Rotary operators are to be two, three or four position, wing type, with maintained contacts.

.4 Illuminated operators are to have clear wing style operator toggles, with internal indicating lamp.

.5 Pushbuttons and control operators are to be generally provided as follows:

.1 Pushbuttons to be 30.5 mm full-face operator type.

.2 Control Switches to be a 30.5 mm two or three-position multi-pole as required.

.7 Wiring and Terminal Blocks:

.1 The switchgear assembly shall be completely wired and documented using Manufacturer produced schematic diagrams showing all supplied equipment, devices and details. Wiring between units shall be included and, at shipping splits, shall be disconnected, tagged and pulled back into an adjacent unit.

.2 Each control panel shall be neatly arranged using plastic wiring duct for routing of internal wiring, and for field wiring to be terminated.

.3 Wiring harnesses for connection to door-mounted equipment shall be protected with nylon or polyethylene spiral wrap. Provide sufficient cable slack so that cables are not stressed. Protect wiring from any sharp edges using grommets. Fasten wire harnesses using nylon tie-wraps.

.4 Terminal blocks shall be provided for control interfaces using screw compression type terminals. Control wires leaving the cubicle of origin must first terminate on a terminal block. No control wire may leave a cubicle directly from any other device.

.5 All control wiring shall be without splices, stranded copper, minimum 14 AWG, non-flammable, 600 V (or higher). Vinyl or nylon insulated lugs shall be used for terminating wiring at all terminal blocks and at all other points of connection. Spare terminal blocks, minimum twelve (12) extra points, shall be provided in each unit for future circuits.

.6 All terminal blocks shall be identified and marked with the wire numbers. Sleeve type plastic wire markers shall be used at both ends of all wires, with the wire number machine imprinted on the sleeve.

.8 DC Control Circuits:

.1 Auxiliary power supply for control and protection purposes shall be 125 VDC and shall include a two pole miniature circuit breaker, 125 VDC, complete with Form C auxiliary alarm contact, for protection and complete isolation from all power sources.

.2 Close and trip circuits shall be separately fused. Fuse blocks shall be dead front, pullout type that provides the means of disconnecting the control power.

.9 Communications:

.1 Ethernet communication ports of all protection relays shall be connected to an Ethernet switch in the LV Switchgear controls compartment.

.2 Provide a Modbus TCP/IP interface for all intelligent control relays and metering with plant PCS.

2.10 Finishes

.1 Painting:

.1 All metal surfaces shall be thoroughly cleaned and primed to protect against corrosion, and finished with a final coat of ASA No. 61, light gray enamel.

.2 All paint shall be rated for indoor duty in a damp, corrosive atmosphere.

.3 For each type and colour of paint, supply one (1) 1 litre can and one (1) non-CFC aerosol can every four (4) units.

2.11 Identification

.1 Nameplates:

.1 Provide equipment identification nameplates on each item of instrumentation and equipment.

.2 Identification nameplates shall be included on the front door of all breaker compartments. A Switchgear identification nameplate shall also be included on the front door of each Incoming Metering and Control Compartment.

2.12 Accessories:

.1 A full set of maintenance tools.

.2 100 mm (4 inch) IR window for each breaker allowing view of cable connections.

2.13 Factory Acceptance Testing:

.1 The entire Switchgear assembly shall go through a quality inspection before shipment, verifying the equipment to the factory shop drawings.

.2 Physical inspection and verification of:

- .1 Structure including verification of all bolted connections.
- .2 Electrical conductors, including:
  - .1 Bussing including verification of all bolted connections.
  - .2 Wiring.
  - .3 Unit compartments.

.3 Electrical tests include:

- .1 Power circuit phasing.
- .2 Control circuit wiring and verification of satisfactory operation of all relays and other devices.
- .3 Instrument transformers.
- .4 Meters.
- .5 Ground fault system.
- .6 Device electrical operation.
- .7 AC dielectric tests shall be performed on the power circuit.

.4 Markings/Labels, include:

- .1 Instructional and warning type labels.
- .2 Plates with ratings and markings.
- .3 Inspector’s stamps.

.5 Lubricate all moving and working parts.

.6 The Manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the switchgear meets operating Specifications.

.7 Initial tests shall be completed by Manufacturer to verify proper system operation free of grounds, open, and short circuits.

.8 Point-to-point tests of all wiring shall be completed to verify correct connections, continuity and dielectric integrity.

.9 Verify the correct operation of all circuit breakers, interlocks and auxiliary contacts, control switches and push buttons, ground fault protection, relays, metering, automatic and manually initiated transfer, synchronizing circuit breaker transfer, HMI display and UPS.

.10 Following the above tests, provide full Ethernet configuration and factory acceptance testing of switchgear equipment at the switchgear factory prior to equipment shipment.

.11 Configure Ethernet addressing into each unit at the factory in accordance with City Ethernet Programming and Documentation Standards.

.12 Ethernet control and monitoring shall be factory tested for operations under normal and adverse conditions. Adverse conditions include, but are not limited to, simulated electrical faults including short circuit and line power supply voltage variations up to 10% above and below nominal.

.13 Configure all Ethernet input and output data assemblies in accordance with City's Standards.

.14 The above intent is to verify that all Switchgear circuit breakers and other Ethernet components for Ethernet control and monitoring functions, will communicate correctly.

.15 The Manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the switchgear meets operating Specifications.

.16 Supply, configure and transport all external control devices required for Ethernet control and functionality verification tests, in advance of the factory acceptance testing, to prevent delays to the factory acceptance testing.

.17 Prepare check-out sheets covering all test requirements and verifications, detailing all tested points and functionality. The sheet shall be completed during testing to verify compliance and functionality per Switchgear component and certified by a qualified professional. Provide for review, check-out sheets and procedures. Incorporate any modified or additional procedures and checks.

.18 Provide hardcopy and electronic copies of the final factory settings of all equipment. This and the signed check-out sheets shall be part of the test results to be submitted under this Section. Submit a certified test report of all standard equipment production tests at time of Factory Acceptance Testing. Equipment that is shipped without evidence of the required tests being performed to verify satisfactory operation will be subject to non-acceptance.

2.14 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

  .1 One (1) complete set of spare fuses used for each switchgear.

  .2 Ten (10) spare fuses of each size used for each power supply.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

3.2 Installation

.1 Perform tests/validations in accordance with Division 16, and the Manufacturer's instructions.

.2 Provision of all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks and written system verification reports to provide a complete line-up that is ready for commissioning and start-up.

  .1 Submit all test/validation results a minimum of 4 weeks prior to commissioning. Once all building and plant commissioning activities have been completed, submit all changes and all commissioning data/results.

.3 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

.4 Properly set and level channel sills.

.5 With all sections inter-wired permanently and with control power applied, perform:

  .1 Insulation resistance testing on power and control wiring, free from grounds, open and short circuits.

  .2 Functional testing of control circuits. Simulate field contacts; where necessary provide Hand-Off switch pre-wired to a terminal block or harness for easy plug and test.

  .3 Functional testing of Ethernet communication, monitoring, protection, display, interlocking and synchronizing systems.

  .4 Submit a certified test report of all standard equipment production tests to the Contract Administrator.

.6 Furnish complete, clear, and concise instructions for installation, operation, and maintenance of the equipment.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of distribution panelboards.

1.2 Standards

.1 Canadian Standards Association (CSA):

   .1 CSA C22.1 - Canadian Electrical Code Part I (CEC) as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

   .2 C22.2 No.29 - Panelboards and Enclosed Panelboards.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 – Electrical General Requirements and the following:

   .1 Manufacturer's descriptive literature for materials.

.2 Include electrical details of panel branch breaker type, quantity, ampacity, and enclosure dimension.

2. PRODUCTS

2.1 Manufacturers and Products

.1 All panelboards shall be the product of a single Manufacturer, with the exception of Standardized Goods as per Appendix 18E - Standardized Goods.

.2 Acceptable Manufacturers:

   .1 Eaton.

   .2 General Electric.

   .3 Siemens.

   .4 Schneider Canada.

   .5 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Panelboards:

   .1 Rating: 120V/ 208V, 3 phase, 4 wire, solidly grounded.

.2 Panelboards: bus and breakers rated for minimum 10,000 A symmetrical of interrupting capacity or as set out in the Final Design.

.3 Sequence phase busing with odd numbered breakers on left and even on right, with each breaker identification as to circuit number and phase.

.4 Panelboards: mains, voltages, number of circuits and number and size of branch circuit breakers as set out in the Final Design.

.5 Hinged door with two keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as main.

.7 Mains: suitable for bolt-on breakers.

.8 Trim and door finish: as per Section 16010 – Electrical General Requirements.

.9 Provide a main circuit breaker in all panelboards that are not in the same room as their associated upstream overcurrent protection device.

.10 Provide NEMA 4X type panelboards located in process or wet areas, complete with drip covers. In electrical rooms provide NEMA 12.

.11 Panelboard Manufacturer's nameplate to include all CSA requirements and show withstand short circuit current rating of the complete assembly.

.2 Breakers:

.1 Breakers shall be bolt-on type.

.2 Provide thermal and magnetic tripping type circuit breakers.

.3 Provide ground fault (GFCI) breakers in panelboards as set out in the Final Design.

.4 Provide arc fault (AFCI) breakers in panelboards as set out in the Final Design.

.5 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position will open breaker.

2.3 Identification

.1 Complete circuit directory with machine-printed legend showing location and load of each circuit.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Perform tests in accordance with Section 16020 – Electrical Testing.

.3 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.4 Connect all loads to branch circuits.

.5 Connect neutral conductor from transformer, or source panelboard if sub-fed, to common neutral bus with respective neutral identified.

.6 Panelboards shall not be installed in hazardous or corrosive locations. Panelboards are to be installed in electrical rooms as far as practicable. Other controlled environments will be considered on a case by case basis.

.7 Separate panelboards shall be utilized for process loads and building systems.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of lighting equipment and luminaires complete with all necessary accessories and components.

1.2 Standards

.1 American National Standards Institute (ANSI):

  .1 ANSI C78.377 - Chromaticity of Solid-State Lighting Products.

  .2 ANSI C81.10 - Electric Lamp Bases and Holders, Screw-Shell Types.

.2 Canadian Electrical Code (CEC):

  .1 C22.1 - Canadian Electrical Code Part I (CEC), as amended by provincial, territorial or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

  .2 C22.2 No. 9 - General Requirements for Luminaires.

  .3 C22.2 No. 141 - Emergency Lighting Equipment.

  .4 C22.2 No. 250.13 - Light Emitting Diode (LED) Equipment for Lighting Applications.

  .5 C860, Performance of Internally Lighted Exit Signs.

.3 Design Lights Consortium (DLC).

.4 National Fire Protection Association (NFPA):

  .1 101, Life Safety Code.

.5 Underwriters' Laboratories (UL):

  .1 773, Standard for Plug-In Locking Type Photo Controls for use with Area Lighting.

  .2 773A, Nonindustrial Photo Electric Switches for Lighting Control.

  .3 844, Standard for Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.

  .4 924, Standard for Emergency Lighting and Power Equipment.

  .5 1598, UL Standard for Safety Luminaires.

  .6 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.

.6 Illuminating Engineering Society of North America (IESNA or IES):

.1 LM-79, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.

.2 LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.

.3 TM-21, Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources.

.7 City of Winnipeg Electrical Design Guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 – Submittals and 16010 - Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Complete list of the types of lighting luminaires, lamps, ballasts and accessories.

.3 Mounting details to include design of pole bases and fixing the luminaires to handrails, precast panels and similar structures.

.2 Submit complete photometric data prepared by independent testing laboratory for specified luminaires and accessories.

.3 Photometric data to include:

.1 Total input watts.

.2 Candlepower summary.

.3 Candela distribution zonal lumen summary.

.4 Luminaire efficiency.

.5 CIE type.

.6 Coefficient of utilization.

.7 Lamp type and lumen rating in accordance with IES testing procedures.

.8 For floodlights: vertical and horizontal beam spread, beam lumens, beam efficiency and complete photometric data. Computer print-out for aiming angles.

.4 Samples:

.1 Provide samples of luminaires, lamps, ballasts and accessories as required per Final Design.

.5 Lighting Study.

2. PRODUCTS

2.1 Performance Criteria

.1 LED luminaires are required for all indoor and outdoor lighting.

.2 Luminaries shall be CSA certified.

.3 Provide commercially available luminaires and poles meeting the requirements specified in this Section and list them in a luminaires schedule.

   .1 Different luminaires and lamps may be supplied by different Manufacturers.

   .2 Similar luminaires and lamps shall be supplied by a single Manufacturer.

.4 For recessed luminaires supply pre-wired type with the junction box and the ballast forming an integral part of the assembly. Provide unit complete with plaster rings and supports as required to provide satisfactory access.

.5 Where applicable, use acrylic lenses with pattern as specified or as selected by Final Design.

.6 Use self-aligning ball joint hangers for stem suspended luminaires.

.7 Use aligning channels approved as fixture raceway for mounting suspended continuous-row luminaires in dry areas.

.8 Provide mounting hardware for recessed luminaires which is designed for the specified ceiling system.

.9 Luminaire bodies for corrosive areas shall be non-metallic or epoxy-coated in the same manner as PRA conduit, specified in Section 16106 - Conduit Systems.

.10 Hinges, latches and other exposed hardware shall be non-metallic or 316 stainless steel for corrosion-resistant luminaires. Use 316 stainless steel chains for suspension of corrosion-resistant luminaires.

.11 Luminaires for hazardous locations shall be certified for the hazardous area classification shown or specified.

.12 Emergency Lighting:

   .1 Emergency lighting shall be in accordance with Section 16536 – Unit Equipment for Emergency Lighting.

2.2 Configuration, Components and Features

.1 LED Lamps:

.1 Supply voltage and wattage as set out in the Final Design.

.2 Ballast electronic, integral.

.3 Rated life minimum 100,000 hours.

.4 CRI not less than 80.

.5 Colour temperature 2700 K.

.6 Maximum indoor lighting voltages shall be 120 VAC.

.2 LED Luminaires:

.1 Heavy-duty industrial-type housing designed for the environmental classification specified or shown.

.2 Luminaire construction shall include protective glass lens when used with LED lamps.

.3 Provide gasketing, stops and barriers to prevent light leaks.

.4 Luminaires subject to vibration shall be configured to securely hold their lamps in place.

.5 Ballasts:

.1 Regulated output, maintains light output over a range of plus or minus 10 percent of input voltage.

.2 Starting current less than operating current.

.3 95 percent or better power factor.

.3 Exit Lights, Non-process Areas:

.1 Housing: High-impact polycarbonate housing or aluminum.

.2 Faceplates: Gasketed polycarbonate clear faceplate.

.3 High-brightness LED.

.4 Designed for twenty-five (25) years of continuous operation without replacing LED.

.5 Approximately 150 mm high x 13 mm wide red letters.

.6 Emergency operation 120 VAC input.

.7 Single faceplate to remain captive for re-lamping.

.8 CSA C860 certified.

.9 Single- or double-face mounting.

.10 Snap-out directional chevrons.

.11 For installation in the following non-process areas:

.1 Electrical Rooms, Control Rooms, Computer Rooms, and Offices.

.12 Arrow right, left or both directions, as required.

.13 Wall end to wall and ceiling mounting as required.

.4 Exit Lights, Process Areas:

.1 As specified in Clause 2.3.4 in this Section with the following exceptions:

.1 Housing: Water-tight fibreglass housing with polycarbonate lens.

.2 Faceplate: Clear scratch-resistant polycarbonate lens.

.3 NEMA 4X enclosure.

.4 CSA C860 certified and CSA 22.2 No. 141 performance certified.

.5 Hazardous classification rating: as set out in the Final Design.

.5 Outdoor Floodlights:

.1 Outdoor weatherproof floodlight with die-cast aluminum housing. Integral watertight entrance bushing with rubber gland. Aluminum yoke with bolt hole for mounting accessories. Degree-marked vertical pre-aiming quadrants with repositioning stop to automatically return fixture to original setting after servicing. Anodised aluminum lens ring, gasket, and complete with stainless steel pressure clamps. Lens assembly captive to reflector by hinge or chain. Cast aluminum rear re-lamping knob.

.2 Lens: clear heat-tempered, shock-and impact-resistant.

.6 Safe Swivel:

.1 Provide safe switch or swivel pole for station mounted luminaires.

.2 Safe swivel pole shall be Type 316 stainless steel.

.7 Outdoor Area Luminaires:

.1 Weatherproof luminaire with one-piece, precision-cast aluminum housing.

.2 Optical assembly for LED lamps:

.1 Reflector: sheet aluminum chemically-brightened finish.

.2 Refractor: one-piece prismatic glass.

.3 Gasket: seal between refractor and housing.

.3 Filter to prevent entrance of dust.

.4 Light distribution: IES distribution type shall be achieved by adjusting position of lamp socket.

.5 Self-locking latches of stainless steel and aluminum.

.6 Twist-lock type receptacle for photoelectric controller to Section 16571 – Lighting Control Equipment.

.7 Adjustable slip-fitter with tightening bolts on outside of fixture.

.8 Factory wired, including integral ballast with electrical disconnect terminals on removable door or with quick-release screws.

.8 Steel Poles:

.1 To NEMA SH5, hot-dipped galvanized steel, designed for underground wiring and for mounting on concrete anchor base.

.2 Style: Monotube round, square or octagonal, straight or tapered, wall thickness to suit luminaire(s) and specified wind load, but not less than 3 mm, complete with pole cap.

.3 Single sweep davit arm to match pole shaft, for one or two luminaire(s) with tenon suitable for mounting of luminaire.

.4 Strength: Pole and bracket to withstand 160 km/h wind without deformation with luminaire mounted.

.5 Access hand-hole 450 mm above pole base for wiring connections, with welded-on reinforcing frame, bolted-on weatherproof cover and grounding lug.

.6 Height: as set out in Final Design.

.7 Finish: factory-applied hot-dipped galvanized.

.9 Aluminum Poles:

.1 To NEMA SH5, manufactured from 6063-T6 aluminum and designed for underground wiring and mounting on concrete anchor base.

.2 Style: Monotube round or square, straight or tapered wall thickness to suit luminaire(s) and specified wind load, but not less than 4.7 mm, complete with pole cap.

.3 Single-sweep davit arm to match pole shaft, for one or two luminaire(s) with tenon suitable for mounting of luminaire.

.4 Strength: pole and bracket to withstand 160 km/h wind without deformation with luminaire mounted.

.5 Access handhole 450 mm above pole base for wiring connections, with welded-on reinforcing frames, hex-head bolted-on weatherproof cover and grounding lug.

.6 Height: as set out in Final Design.

.7 Finish: Anodized.

.10 Luminaire Pole-Mount Brackets:

.1 Mounting brackets steel or aluminum for luminaires shown or specified.

.2 Provide all single and twin brackets.

.3 Arm extension length: as set out in Final Design.

.4 Provide single- or double-tapered davit-type bracket with underbrace and with hardware for clamping to pole shaft.

.5 Acceptable Product: Same Manufacturer as light poles.

.11 Concrete Pole Bases:

.1 Pole bases may be cast-in-place or precast to CSA-A23.1 or CSA-A23.4.

2.3 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Lamps and ballasts.

.2 Manufacturer's recommended # of spare lamps.

.3 Manufacturer's recommended # of spare ballasts.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Install recessed luminaires in T-bar or plaster ceilings to permit removal from below to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with 14 AWG conductors) may be used but if so, shall be independently supported, (i.e., not from the connectors), and have anti-shorts installed. For either method, the length of the flexible connection shall not to exceed 1.5 m per CEC.

.4 When luminaires are installed in valances with solid lens, provide adequate ventilation of openings into ceiling space to dissipate heat.

.5 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

.6 Apply protective coat of bituminous paint to surfaces of recessed luminaires in contact with concrete.

.7 For remotely-mounted ballasts, supply mounting boards and space ballasts in accordance with Manufacturer's instructions. Size wiring from ballast to remote luminaires to meet Manufacturer's requirements.

.8 Completely clean all luminaires, including lenses, lamps, hangers and interiors at completion of Work and before Handover.

.9 Luminaire Supports:

- .1 Support luminaires level, plumb, and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly and adjust to a neat flush fit with mounting surface.
- .2 Hang and mount luminaires to prevent distorting frame, housing, sides or lens.
- .3 Support luminaires independently of suspended ceiling.
- .4 In dry locations, support luminaires mounted in continuous rows from an approved lighting fixture raceway.

.10 Luminaire Alignment:

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

.11 Suspended Luminaire Connections:

- .1 Connect suspended luminaires to junction box through a length of flexible conduit.

.12 Branch Circuit Wiring:

- .1 Minimum conductor size is 12 AWG or as otherwise specified.
- .2 Size conduits in accordance with CEC requirements for the wire count installed. Minimum conduit size shall be is 21 mm.

.13 Exit Lights:

- .1 Lock exit light circuit breakers in ON position.
- .2 Do not use RPVC conduit for exit light branch circuit wiring.

.14 Floodlights and Area Lights:

.1 Install brackets on poles.

.2 Erect poles on foundations, true and plumb using shims as required and securely anchor standards to anchor bolts. Touch up all chips and scratches on poles upon completion. Under no circumstances bend or hammer anchor bolts into position to suit the pole flange. In case of mismatches, replace pole base with correct-dimensioned anchor bolts.

.3 Install luminaires on pole brackets or davits, as applicable, and connect to pole wiring and install lamps.

.4 Pole wrap: all poles shall be individually wrapped at factory. Wrapping shall be removed after erection.

.5 Align and aim energized floodlights and area lights during hours of darkness and in presence of a qualified professional.

.6 Lock floodlights in final aiming position.

.7 Connect pole wiring to underground branch circuit in handhole at pole bases.

.15 Pole Bases:

.1 Install concrete bases for pole with top of base 70 mm above grade unless shown otherwise required by the Final Design. Provide chamfered edges.

.2 Provide template for positioning of anchor bolts for poles. Extend anchor bolts 75 mm above top of bases.

.3 Restore area around pole base to match finish grade and material of surrounding area.

.16 Coordination:

.1 Confirm compatibility and interface of other materials with luminaire and ceiling system.

.2 Any conflicts between luminaries, supports and fitting, and mechanical or structural building elements shall be fully resolved without leaving any impairment of the functionality, structural integrity or the aesthetics of the work.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Confirm illumination measurement results meet the City of Winnipeg design guides and provide record of measurements to the Contract Administrator.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of unit equipment for emergency lighting.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 CSA C22.2 No. 141 - Emergency Lighting Equipment.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Data to indicate system components, unit capacity, mounting method, source of power and special attachments.
- .3 Mounting details which bear the stamp of a qualified professional.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

- .1 Cooper Lighting.
- .2 Lithonia.
- .3 Thomas & Betts.
- .4 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Control Unit:

- .1 Supply voltage: 120 VAC.
- .2 Output voltage: 12 or 24 VDC.
- .3 Operating time: thirty (30) minutes minimum.
- .4 Battery: sealed, maintenance free with 50 percent spare capacity to allow for connection of future additional light heads.

.5 Charger: solid-state, multi-rate, voltage and current regulated, inverse temperature compensated, short circuit protected. Capable of restoring battery to full charge within twelve (12) hours after a discharge of not more than thirty (30) minutes at rated load.

.6 Solid state transfer.

.7 Low-voltage disconnect: solid state, modular, to operate at 80 percent battery output voltage.

.8 Signal lights: solid state, life expectancy 100,000 hours minimum, for 'AC Power ON' and 'High Charge'.

.9 Cabinet: NEMA 4X. Wall or shelf mounting as applicable, with provision for wiring entry.

.10 Ready access to battery.

.11 With integral lamp heads and provision for remote heads.

.12 Auxiliary equipment:

.1 Test switch.

.2 Time delay relay upon return of normal power.

.3 AC input and DC output terminal blocks inside cabinet.

.4 Shelf or bracket as required.

.5 Cord and single plug connection for AC connection.

.6 RFI suppressors.

.2 Lamp Heads:

.1 Swivel-type integral on unit, 360˚ horizontal, 180˚ vertical adjustment.

.2 Remote-type for installation on surface mounted box, with swivel-type adjustment.

.3 Remote gimbal-type for recessed mounting.

.4 Enclosure type suitable for area classification.

.5 Lamp type: LED, sealed-beam not less than 3 W.

.3 Wiring:

.1 All DC wiring shall be 10 AWG minimum, except where wiring to be larger as required to limit voltage drop.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16020 – Electrical Testing.

.2 Confirm illumination measurement results meet the City of Winnipeg design guides and provide record of measurements to the Contract Administrator.

.3 Confirm emergency lights are on at all times, and that they operate on battery power for a minimum of 30 minutes on either loss of system power or the associating lighting circuit breaker trips.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of lighting control equipment complete with the necessary accessories and components.

1.2 Standards

.1 Canadian Standards Association (CSA):

  .1 CSA C22.2 No.184 - Solid-State Dimming Controls.

.2 City of Winnipeg Electrical Design Guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

  .1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

  .1 Lutron.

  .2 Wattstopper.

  .3 Douglas Lighting.

  .4 Or approved equivalent.

2.2 Configuration, Components and Features

.1 Photoelectric Lighting Control:

  .1 Capable of switching lighting at 120 V.

  .2 Voltage variation: plus, or minus 10 percent.

  .3 Temperature range: minus 40°C to plus 40°C.

  .4 Adjustable light sensitivity from 20 to 500 lx.

  .5 Rated for 5000 operations.

.6 Required options:

.1 Lightning arrester.

.2 Fail-safe circuit completed when relay de-energized.

.3 Twist-lock type receptacle/plug.

.4 Integral terminal strip.

.7 Switching time delay of thirty (30) seconds.

.8 Wall mounting.

.9 Colour coded leads.

.2 Lighting Contactors:

.1 Provide NEMA rated lighting contactor(s), 20 A, 120 VAC coil, and number of poles as set out in the Final Design.

.3 Occupancy Sensors:

.1 Occupancy sensors shall be either passive infra-red or ultrasonic technology. Dual technology (passive infra-red and ultrasonic) occupancy sensors shall be used where required in administration area (washrooms, storage rooms, mechanical rooms and in control room).

.2 Photo sensors and/or occupancy sensors and electronic timers shall be provided with manual overrides in some areas so that the end users can easily switch the spaces they are occupying manually.

.3 Capable of switching lighting at 120 V.

.4 Equipment Identification:

.1 Provide nameplate/ lamacoids per City Identification standard.

.2 Nameplate showing information in accordance with CSA C2.1 - 06.

.5 Provide lighting contactor panels, motion (occupancy) sensors, daylight (photo sensors) sensors, electronic timers and or dimming control wall switches in accordance with Final Design and lighting schedules.

.6 Lighting control system components and sensors must be easy to understand and operate and shall have provision for connection to the automation system.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Perform tests in accordance with Section 16020 – Electrical Testing.

.4 Outdoor photo sensors will be mounted on the north face of the facility building, away from direct sunlight. Indoor photo sensors shall be mounted near the north window, away from direct sunlight.

.5 Provide lighting fixtures support for ceiling and wall mount luminaries.

.6 Lighting Contactors:

  .1 Install lighting contactors and connect auxiliary control devices.

.7 Assemble multiple contactors into a lighting control panel, complete with terminal blocks for all external wiring.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of complete and fully operated fire alarm systems, including but not limited to:

- .1 Fire alarm control panels.
- .2 Transponders or slave panels.
- .3 Annunciators.
- .4 Field devices including heat and smoke detectors, manual pull-stations, visual and audible signalling devices, control relays, and ancillary devices.

.2 Coordinate with City fire department to identify and create zones and access routes for fire department.

1.2 Standards

.1 Canadian Standards Association (CSA).

.2 Electrical Equipment Manufacturers Association of Canada (EEMAC).

.3 Factory Mutual Engineering.

.4 Underwriters Laboratories of Canada (ULC):

- .1 CAN/ULC-S524 - Installation of Fire Alarm Systems.
- .2 CAN/ULC-S525 - Audible Signal Appliances for Fire Alarm and Signaling Systems.
- .3 CAN/ULC-S526 - Visual Signal Devices for Fire Alarm and Signaling Systems.
- .4 CAN/ULC-S527 - Control Units for Fire Alarm Systems.
- .5 CAN/ULC-S528 - Manual Pull Stations for Fire Alarm Systems.
- .6 CAN/ULC-S529 - Smoke Detectors for Fire Alarm Systems.
- .7 CAN/ULC-S530 - Heat Actuated Fire Detectors for Fire Alarm Systems.
- .8 CAN/ULC-S531 - Smoke Alarms.
- .9 CAN/ULC-S536 - Inspection and Testing of Fire Alarm Systems.
- .10 ULC-S525 - Audible Signal Appliances for Fire Alarm and Signaling Systems.
- .11 CAN/ULC-S537 - Verification of Fire Alarm Systems.

.5 National Fire Protection Association (NFPA):

.1 NFPA 70 Article 760 - Fire Alarm Systems.

.2 NFPA 72 - National Fire Alarm Code F.M. Data Sheet 5-48, Automatic Fire Detectors.

.6 Manitoba Building Code.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Detail assembly and internal wiring diagrams for control units.

.3 Overall system riser: Identify control equipment, initiating zones, signaling circuits and identify terminations, terminal numbers, conductors and raceways. Identify terminals and provide interconnections with plant process and third-party monitoring.

.4 Details for devices.

.5 Details and performance Specifications for control, annunciation and peripherals with item-by-item cross reference to Specification for compliance.

.6 Graphic panel display layout, internal layout and wiring diagrams.

.7 Site plan identifying locations for instruments, devices, components, panels etc.

.8 Step-by-step operating sequence.

.9 Include review by the Authority of Jurisdiction (AHJ) and their approval of submittals required by this Section. Submit to Authority of Jurisdiction one (1) set of approved submittals and drawings immediately after approval but no later than fifteen (15) working days to prior to final inspection.

.2 Submittals shall include design, supply, installation, testing and verification of the Fire Alarm and detection system, signed, and sealed by a qualified professional.

.3 Submittals after Testing:

.1 Provide operation and maintenance (O&M) data for fire alarm system for incorporation into manual specified in Appendix 18F – Operation and Maintenance Information.

.2 Include:

.1 Instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Technical data – illustrated parts lists with parts catalogue numbers.

.3 Copy of approved Shop Drawings with corrections completed and marks removed except for review stamps.

.4 List of recommended spare parts for system.

.5 The Manufacturer’s written instructions for repair and servicing procedures, include name of original installer and contact information.

.6 Data for all fire alarm equipment and components.

.7 Includes Quality-control reports (Fire Alarm system test and verification report, and Certificate of Verification) covering all components, equipment, wiring methods, signalling, indication/sounding, and zones in accordance with CAN/ULC-S537.

.1 Test reports for Projected beam smoke detector if applicable.

.2 Test reports for Open-area 2-wire smoke detectors.

.8 Provide updated As-Built Riser Diagram, facility routing, and all other design and installation drawings.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 CHUBB Edwards.

.2 Siemens (Cerberus / Pyrotronics).

.3 Or approved equivalent.

2.2 Performance Criteria

.1 General:

.1 All materials supplied shall be new and listed for the intended use.

.2 Except as specifically identified herein, all fire alarm system equipment and components shall be by a single Manufacturer.

.3 Provide any components required to compete and functioning fire alarm system.

.2 Special Conditions:

.1 Coordinate the fire alarm system in accordance with Section 16010 – Electrical General Requirements for all conduit routes, equipment locations and field device locations. Coordinate detector locations with other equipment, piping, cable trays, and lighting.

.2 All installed devices and equipment installed shall be accessible and that clearances have been provided for the automatic detectors and equipment as set out in the standards.

.3 The installation shall be compatible with the equipment supplied and that the fire alarm system is complete and operational.

.4 Any devices installed in classified (hazardous) areas shall be listed as suitable for the classification of the area in which they are installed (i.e.: Class 1, Zone 1, Group IIA).

.3 Regulatory Agencies:

.1 System components shall be listed by ULC and comply with applicable provisions of Manitoba Building Code and meet requirements of local authority having jurisdiction.

.2 The installation will comply with the acceptance of the regulatory agencies in accordance the following:

.1 Winnipeg Fire Department (for annunciator, zone designation and zone map graphics only).

.4 Fire Alarm System Requirements:

.1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.

.2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signaling to monitoring agency.

.3 Zoned, non-coded single stage.

.4 Modular in design to allow for future expansion.

.5 Operation of system shall be simple and not require personnel with special training.

.6 System shall include:

.1 Central Control Unit (CCU) in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.

.2 Addressable relays for sprinklers, fire pumps and its LCP, and existing fire alarm monitoring.

.3 Power supplies.

.4 Initiating/input circuits.

.5 Output circuits.

.6 Auxiliary circuits.

.7 Wiring.

.8 Manual and automatic initiating devices.

.9 Audible and visual signalling devices.

.10 End-of-line resistors.

.11 Local and remote annunciators.

.12 Event log memory chip.

.13 Testing mode capability.

.7 For general requirements, refer to Section 16010 – Electrical General Requirements.

.8 The fire alarm system shall operate in accordance with the following event sequences:

.1 Alarm: Upon activation of a manual pull station, a heat detector or sprinkler flow alarm switch shall:

.1 Generate an alarm signal (including strobe lights) throughout the alarm initiating ZONE and an alert signal throughout the premises and cause the remote fire department connection relay to close.

.2 Upon activation of a subsequent heat, smoke, sprinkler or manual pull station within the same ZONE, sound an alarm signal throughout the premises and cause the remote fire department connection relay to close.

.3 Activation of any field devices shall be annunciated at all main and slave control panels and all annunciators. The annunciation will include the type of the field device, the ZONE, the SUBZONE, the device address, time and date of alarm and the user text description.

.4 Alarm and alert signals shall be automatically transmitted through individual Form-C contact relay outputs to the Facility automation system on a ZONE or BUILDING indication basis.

.5 Possible to silence signals by "alarm silence" switch at control unit, after 60s period of operation.

.6 Alarm, trouble and initiating zone information shall be communicated to automation system based on Final Design i.e., Modbus TCP/ Ethernet.

2.3 Configuration, Components and Features

.1 Power Supply Units:

.1 Power supply units shall be provided for each self-contained unit including:

.1 Main control panels.

.2 Slave control panels.

.3 Main fire alarm system annunciator.

.4 Secondary fire alarm system annunciators.

.5 Each power supply unit shall contain suitable over-voltage protection to prevent any malfunction or damage due to power line surges (e.g. lightning).

.6 Each power supply unit shall be equipped with a built-in standby battery of nominally 24 VDC, rated to maintain fire alarm system operation for twelve (12) hours. In addition, the battery shall be capable of operating field indicators, including horns and strobe lights, for at least thirty (30) minutes. The field indicators shall be turned off by the fire alarm system after thirty (30) minutes of operation, during a particular power failure, to enable the battery to attain operating the fire alarm system for a minimum of twelve (12) hours. The power supply and the standby battery shall be sized for 50 percent spare capacity for future expansion.

.7 Upon loss of primary 110 VAC power, the power supply unit shall automatically revert to battery power, and the fire alarm system shall remain fully operational.

.8 When a fire alarm system control panel is operating on battery power, an equipment trouble indication shall be provided on the fire alarm system main control panel.

.9 The load shall be automatically switched off when the voltage drops below 19 V, to protect battery cells from being damaged by complete discharge, and equipment trouble indication shall be provided on the fire alarm system main control panel.

.10 When the AC power is restored, the power supply unit shall automatically revert to normal operation without requiring any manual restoring procedure.

.11 The power supply battery unit shall automatically be maintained in charged condition by a built-in short-circuit proof charger.

.12 During normal operation, if the battery voltage drops below 20 VDC of nominally 24 VDC, an equipment trouble indication shall be provided on the fire alarm system main control panel.

.13 Batteries shall be completely sealed gel type.

.14 Each power supply unit and charger circuit, including all fuses, shall be supervised. Any malfunction or blown or missing fuse shall result in a fault indication on the Main Control Panel.

.15 The primary power per Final Design.

.2 Field Devices and Ancillary Devices:

.1 Manual Pull Stations:

.1 All manual pull stations shall be addressable.

.2 Manual pull stations shall be single-stage, pull-down lever type.

.3 Colour red with white typeface.

.4 Surface or flush mount.

.2 Explosion Proof Manual Pull Stations:

.1 The explosion-proof (XP) manual pull station shall be suitable for installation in hazardous locations classified in accordance with Section 18 of the Canadian Electrical Code CSA C22.1.

.3 Addressable Input Module:

.1 The addressable input module shall be capable of connecting at least 20 parallel field devices into an addressable detection loop of the standard range of control units produced by the Manufacturer.

.2 The addressable input module shall connect to the control unit via a fully supervised two-wire circuit. Separate power line shall not be required.

.3 Each addressable input module shall represent one address on the control unit.

.4 The detector line connected to the addressable input module shall be supervised against open and short circuits.

.5 The addressable input module shall be equipped with a built-in alarm LED as a response indicator for parallel detectors and/or contacts connected.

.6 The addressable input module shall be able to activate the corresponding alarm response indicator on the parallel connected detectors.

.4 Addressable Control Module – Signal:

.1 The addressable control module shall be designed to supervise and operate 24 VDC strobe lights.

.2 The output contact of the addressable control module shall be rated for at least 1.5 A at 24 VDC and 0.5 A at 110 VAC.

.3 The module shall be fully supervised and shall have provisions for a connection of an external contact to provide a confirmation signal shall be sent back to the Control Unit via the detection line after the control function has been carried out.

.4 The module shall have a built-in response LED to flash during alarm activation.

.5 The control module function shall be programmable at the Control Unit.

.5 Addressable Heat Detectors:

.1 Heat detectors shall be combination fixed-temperature and rate-of-rise type. The fixed temperature rating shall be set at 57˚C.

.2 Heat detectors shall be addressable analogue type.

.3 Heat detectors shall be self-restoring type.

.4 Where the heat detector outlet box is surface mounted, provide either a detector base skirt ring or a finished surface mount outlet box to suit the installation.

.6 Addressable Explosion-Proof Heat Detectors:

.1 Explosion-proof heat detectors shall be combination fixed temperature and rate of rise type.

.2 Explosion-proof heat detectors shall be self-restoring type.

.3 Explosion-proof heat detectors shall be provided for high-humidity locations.

.4 Explosion-proof heat detectors shall be provided for installation in Class I and Class II Hazardous Locations in accordance with Section 18 of the Canadian Electrical Code, CSA C22.1.

.5 Explosion-proof heat detector connections shall be standard Class A supervised Fire Alarm circuit.

.7 Addressable Smoke Detectors:

.1 Addressable smoke detectors shall be photoelectric type.

.2 Addressable smoke detectors shall be automatic adjusting intelligent type sensor.

.3 Addressable smoke detectors shall operate at ambient temperature from minus 25˚C to plus 75˚C and at relative humidity up to 80 percent.

.4 Addressable smoke detectors shall operate on 24 VDC power.

.5 Addressable smoke detectors and/or detector bases shall be addressable so that each smoke detector can be annunciated individually.

.6 Addressable smoke detectors shall have an LED indicating light.

.7 Addressable smoke detectors shall have interchangeable bases.

.8 Where the addressable smoke detector outlet box is surface mounted, provide either a detector base skirt ring or a finished surface mount outlet box to suit the installation.

.8 Intrinsically Safe Smoke Detectors:

.1 Intrinsically safe smoke detectors shall be either photoelectric or ionization type.

.2 Intrinsically safe smoke detectors shall meet the requirements of Section 18 of the Canadian Electrical Code CSA C22.1.

.3 Provide intrinsically safe smoke detectors connections with intrinsically safe module via standard Class A supervised alarm circuit.

.9 Intrinsically Safe Heat Detectors:

.1 Intrinsically safe heat detectors shall be combination fixed temperature and rate of rise type.

.2 Intrinsically safe heat detectors shall be self-restoring type.

.3 Provide intrinsically safe heat detectors connections with intrinsically safe module via standard Class A supervised alarm circuit.

.10 Intrinsically Safe Modules:

.1 Intrinsically safe modules shall comply with the requirements of Section 18 of the Canadian Electrical Code, CSA C22.1.

.2 Intrinsically safe modules shall be enclosed in a separate cabinet.

.3 Intrinsically safe modules shall have the required interface so that the module shall either be located in a Main or Slave Control Panel or may be connected to an addressable loop.

.11 End-of-Line Devices (Addressable):

.1 End-of-Line devices shall control supervisory current in alarm circuits and signalling circuits and shall be sized to provide correct supervisory current for each circuit. Open, short and ground fault in any circuit shall alter supervisory current in that circuit, producing audible and visible alarm at main control panel.

.12 Photoelectric Detectors (Addressable):

.1 Plug-in type.

.2 Adjustable photo-electric sensitivity.

.3 Wire-in base assembly with integral red alarm LED.

.13 Signaling Devices:

.1 Horn

.1 The horn shall have the following features:

.1 Multitone capability with three separate prioritized inputs that will activate three isolated signals.

.2 Two power taps to allow field adjustments.

.3 Polarized inputs.

.4 Tone selection shall include Horn, Bell, March Time Horn, Code-3 Horn, Code-3 Tone, Slow Whoop, Siren, High/Low, Vibrating Chime.

.5 Operate on 24 VDC power.

.6 Combination Horn and Strobe Light

.2 In addition to the horn, the unit shall have the following:

.1 Strobe light using a xenon flashtube with 15 rated candels.

.2 Strobe and horn shall be powered either collectively or separately.

.3 Strobe light shall have clear translucent lens with 12 mm high "FIRE" lettering on at least two sides.

.4 Operate on 24 VDC power.

.5 Explosion Proof Horn

.6 The horn shall be vibrating type.

.7 Explosion-proof horn shall be provided in Class I Hazardous Locations.

.8 Operate on 24 VDC power.

.3 Bells:

.1 Vibrating type gongs of special alloy steel, 24 VDC, 250 mm, 92 dB at 3 m. For outdoor application, the bells shall be enclosed in a weatherproof box,

.14 Isolated Loop Circuit Protector:

.1 Isolated loop circuit protectors shall be installed with detector addressable loops.

.2 Isolated loop circuit protectors shall have circuit protection against open, short and ground conditions.

.3 Isolated loop circuit protectors’ response time shall be less than one (1) nanosecond.

.4 Isolated loop circuit protectors shall be rated for a maximum current of 2000 A, line to line and line to earth.

.5 Isolated loop circuit protectors shall be rated for a maximum current of 5000 A, shield to earth.

.6 Isolated loop circuit protectors shall be mounted in an approved enclosure.

.3 Conduit, Junction Boxes and Outlet Boxes:

.1 Conduits, Conduit Fastenings, and Conduit Fittings

.1 Conduits, conduit fastenings, and conduit fittings shall be in compliance with Section 16106 – Conduit Systems.

.2 All addressable loops, initiating device circuits and audible, visual signalling circuits shall be installed in:

.1 EMT conduit in above grade non-process areas.

.2 Rigid aluminium conduit (RA) for lower level areas.

.2 Junction and Outlet Boxes

.1 Junction and outlet boxes shall comply with Section 16131 - Junction Boxes, Splitters and Pull Boxes and 16141 Outlet Boxes, Receptacles and Switches.

.2 Where fire alarm devices are installed on surface mounted outlet boxes, the outlet box shall be flush with the device base.

.3 Use explosion proof junction and outlet boxes in hazardous areas except where intrinsically safe devices are used.

.4 Conductors, Wires and Cable:

.1 Wires and cables shall have solid copper conductors with 600 V, RW90 XLPE insulation, minimum 90˚C rating or per the Final Design.

.2 Conductor size shall be in accordance with the requirements of the Fire Alarm equipment supplier.

.3 Conductors shall be twisted and/or shielded as required by the Fire Alarm equipment supplier.

.4 Conductors colour code:

.1 AC Line, DC Positive: Black.

.2 AC Neutral, DC Negative: White.

.3 Ground: Green.

.4 Signal Circuits: Red & Black.

.5 Detection Circuits: Blue & White.

.6 Intrinsically Safe Wiring: Blue.

.7 Primary Communication Wiring: Use same colour code throughout.

2.4 Equipment and System Controls

.1 Control Panels:

.1 Design and Construction:

.1 The fire alarm control panel shall be modular in construction, with solid-state multi-tasking microprocessor-based technology.

.2 All components shall be housed either in a surface- or flush-mounted approved metal enclosure behind a cylinder-locked or housed behind a removable hinge door with a view window of clear Plexiglass. Opening the door shall not expose live components and wiring. Live components and wiring shall ONLY be accessible after opening the cover plate behind the hinged door.

.3 All fire alarm and annunciator panel locks shall be keyed alike.

.4 Panel modular layout shall provide space for wiring to be run in either bundles or ribbons in an orderly fashion.

.2 Basic Components:

.1 The fire alarm panel shall have the following skeleton components:

.1 Power supply unit.

.2 System display unit including access and programming keys.

.3 Fire alarm system CPU, Master Controller Module complete with RS232 and Ethernet ports for connection to laptop computer for programming purposes.

.4 Fire alarm system network communication modules for Style 7 network interface.

.5 Initiating device circuit modules.

.6 Signalling device circuit modules.

.7 Output relay modules as required for automation system interface.

.8 Memory modules for logging all fire alarm system activities.

.9 IO modules and interface modules.

.3 Fire Alarm Panel and Annunciator Display:

.1 Design, supply and install LED graphic annunciator. Connect and integrate the annunciator to the Fire Alarm panel.

.2 The annunciator location per the Final Design.

.3 The fire alarm system panels and annunciator units will contain the following:

.1 Minimum eighty (80) character backlit alphanumeric LCD display. The display shall indicate fire alarm system status and history log (i.e. system normal, system trouble and system alarm with specific identification of the Zone, Subzone or addressable device which initiated the status change), including time and date of event occurrence.

.2 Mounted integral to the LCD display shall be a zoning diagram of size 280 by 430 mm (11 x 17 inch) mounted under a clear plexiglass frame.

.3 Alarm indicating LED and Alarm Acknowledgement button.

.4 Trouble Signal indicating LED and Trouble Acknowledgement button. This is for a priority 3 type of alarm including valve limit switches and auxiliary functions.

.5 Fire alarm system hardware trouble-indicating LED and Acknowledgement button. This is for indicating sensor faults, low battery, and panel and system faults.

.6 Signal-silence indicating LED and button. This is for silencing the panel beeper and the horns without acknowledgement. Acknowledgement infers action has been or will be taken to remedy the problem. The LED illuminates and audible alarms are silenced when the silence button is pressed.

.7 Fire alarm system power-on indicating LED.

.8 Fire alarm system reset button.

.9 Items specified in clauses 1 to 8 above shall be visible through the view window of the display unit and be accessible only by opening the enclosure door with a key.

.10 Programmable function buttons.

.11 Operator key pad and menu function key pad.

.12 Items specified in clauses 9, to 11 above shall be mounted behind a hinged door not normally visible through the view window.

.13 Includes Zone indication(s) and listing(s).

.4 Fire Alarm System Performance:

.1 The fire alarm system shall be field programmable from a laptop PC and through the system display panel. All programmed information shall be stored in non-volatile memory after downloading into the control panel. No special programming and EPROM burning shall be required and the fire alarm system shall remain in operation during reprogramming.

.2 The fire alarm system shall follow latest password protection strategies.

.3 The fire alarm system shall have the capacity of at least forty (40) passwords.

.4 Network response time shall not exceed two (2) seconds.

.5 Fire alarm system history data bank shall retain at least the last 600 alarm events and 600 trouble events and shall be downloadable to external drives.

.6 The authorized personnel shall be able to make minor program changes including re-labelling of address points, temporary disabling and bypassing some address points without the need for a Manufacturer's authorized representative.

.7 Provide the fire alarm system operating sequence as described in this Section of the Specification. When there is a change of fire alarm system status, sound an alert at the panel. This sound alert shall be silenced after the appropriate acknowledgement switch has been activated. When activated.

.8 The fire alarm system shall be able to test all addressable devices at one panel location to satisfy the requirement for field device testing by CAN/ULC-S536-M86, Inspection and Testing of fire alarm systems.

.9 The fire alarm system shall enable adjustment of all addressable fire detector sensitivity at the system display panel.

.10 When any individual fire alarm control panel is disconnected from the fire alarm system primary communication network, it shall be capable of functioning as a stand-alone fire alarm unit.

2.5 Identification

.1 All equipment and wiring shall be to be tagged in accordance with WWD – Identification Standard and City of Winnipeg fire department.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Control Panels:

.1 Addressable Loops: twenty (20) percent spare modules.

.2 Signaling Circuits: twenty (20) percent spare circuits.

.3 Addressable Relay Contacts: twenty (20) percent spare circuits.

.2 Addressable Loops:

.1 Twenty (20) percent spare capacity for all addressable loops. Include device address for these spare points.

.3 Power Supply Units:

.1 Power supply units, including batteries sized for the capacities provided by each panel.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Perform tests in accordance with Section 16020 - Electrical Testing, and CAN/ULCS537. All testing results and reports shall be submitted to the Contract Administrator and included in the O&M.

3.2 Installation

.1 Fire alarm and detection devices shall be installed in accordance with CAN/ULC-S524M - Installation of Fire Alarm Systems, and with the Manufacturer's instructions.

.2 Interface with the existing fire alarm panel to annunciate the alarm and trouble signals from the existing facilities.

.3 Field Device Installations:

.1 General:

.1 All field device installations shall be in accordance with ULC S-524 with respect to minimum clearance for smoke detectors, minimum and maximum installation heights of manual pull stations and end-of-line devices.

.2 Intrinsically Safe Module:

.1 Where intrinsically safe modules are used, a limit of not more than fifteen (15) detectors connected to one module shall not be exceeded.

.2 The end-of-line device shall be installed in the same enclosure as the module. Mounting height of the enclosure shall be the same as the mounting height of an end-of-line device. Wiring will leave the module and return to it as well.

.3 Intrinsically safe modules shall be installed outside the hazardous locations.

.3 Addressable Input Module:

.1 The end-of-line device shall be installed in the same enclosure as the module. Mounting height of the enclosure shall be the same as the mounting height of an end-of-line device.

.4 Strobe Lights:

.1 Strobe lights shall be mounted at a height between 2 to 2.4 m and clearly visible from the floor in all directions.

.5 Isolated Loop Circuit Protectors:

.1 Isolated loop circuit protectors shall be installed at an interval of not more than twenty (20) addresses on an addressable loop and at the start of any T-tab connections. Any addressable line connected to a T-tab shall not serve more than twenty (20) addresses.

.6 Gaskets:

.1 All field devices at the tunnel level shall be installed with a gasket at the detector base.

.7 Fire Department Annunciator:

.1 Provide and install fire department annunciator within proximity to facilities main employee entrance.

.2 The final location shall be per Final Design and shall be approved by fire department.

.3 All cables from facility annunciators shall be installed in conduit.

.4 Maintenance:

.1 Provide maintenance in accordance with CAN/ULC-S536 for one year after Substantial Completion of each portion of the fire alarm system. Submit inspection reports to the City.

.2 Provide all maintenance requirements of the fire alarm system until facility handover.

END OF SECTION

PUBLIC ADDRESS SYSTEM

1. GENERAL

1.1 Summary

.1 This Section describes the requirements of a public address (PA) system that shall service both the interior and exterior of the Facility.

.2 The system shall consist of a centrally located Power Amplifier/Mixer that shall be installed in the Electrical Room In-Plant Radio Rack Cabinet, connected to a series of indoor and outdoor horns with adjustable impedance taps.

.3 In addition to the basic microphone input, the PA system shall be interfaced with an alarm annunciator that maps process control alarms to pre-recorded voice messages.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 CSA Z107.56 - Measurement of Noise Exposure.

.2 Safe Work Manitoba.

.3 City of Winnipeg Electrical Design Guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings shall include the following information, diagrams and drawings:

- .1 Equipment models, Specifications, operation, and installation details.
- .2 Power supply make, model, Specifications, operation and installation details.
- .3 Riser diagram and drawing standards showing all devices, cabling and cable numbers, interconnection to fire alarm and access control systems.
- .4 Site plan identifying locations for instruments, devices, components, panels etc.
- .5 Wiring diagrams showing how various devices are connected to the external wiring.
- .6 Cable details, including type and electrical characteristics.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

  .1 TOA Canada.

  .2 Or approved equivalent.

2.2 Configuration, Components and Features

.1 General:

  .1 System for areas covered by this project shall be integrated with existing NEWPCC public address systems, where used.

  .2 All equipment shall be rack mountable and powered with 120 VAC rack cabinet power supply.

.2 Public Address Amplifier/Mixer:

  .1 Supply and install integrated power amplifier and mixer of sufficient output to drive the required number of horn speakers.

.3 Public Address Speakers:

  .1 Supply and install outdoor rated speakers to ensure full exterior coverage of the infrastructure.

  .2 Supply and install indoor speakers to ensuring sufficient audible coverage while under normal plant operation.

  .3 At minimum the speakers spacing shall provide at least 83 dBA at 1m for an assumed loss of 6 dB every time the distance from the source doubles, with a minimum setting of 10-15 dB above ambient noise to allow for speech comprehension. The designs speaker size and spacing for speech intelligibility shall also be based on speech quality sound transmission and intelligibility. Outdoors the speech intelligibility shall be sufficient anywhere within 10m from the facilities perimeter.

.4 Microphone:

  .1 Supply and install a local microphone at each PA system.

.5 Interconnecting Cable:

  .1 Supply and install FT4 rated speaker interconnection cable between all speakers and PA amplifier. Cables shall be properly supported and either installed in rigid conduit.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.1 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.2 PA system shall be connected to UPS power.

.3 Layout both interior and exterior speaker placement to maximize audible area to minimize the number of speakers required while ensuring there are no spots of inappropriate (excessive) noise. Ensure that speaker placement yields satisfactory speech intelligibility when the Facility is in full operation. In order to assure uniform apparent speed intelligibility, a "zoned" volume adjustment for areas of the Facility that are significantly louder than others shall be provided as necessary.

    .1 Conduct noise assessment and speaker adjustments in accordance with Safe Work Manitoba and CSA Z107.56.

.4 Perform tests in accordance with Section 16020 – Electrical Testing.

END OF SECTION

FACILITY TELEPHONE EQUIPMENT

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of telephone systems and equipment.

1.2 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Shop Drawings of the layout drawings for the telephone system.
- .3 Wiring diagrams.

2. PRODUCTS

2.1 Performance / Design Criteria

.1 Telephone System:

- .1 New facilities shall include an IP based telephone system.
- .2 Equipment and configuration of new systems shall be consistent with existing systems, where appropriate.
- .3 Provide complete analog telephone system for connection to MTS with the capability to convert to a future digital telephone system. The telephone system shall include, but is not limited to following:
  - .1 Telephone Termination Backboard.
  - .2 Routers and Switching Equipment.
  - .3 Grounding.
  - .4 Power Supply for connection to UPS Backup Power.
  - .5 Cables and Raceways, wall sockets.
  - .6 Telephones, strobes and sounders and other hardware as required.

.2 Telephone Termination Backboard:

- .1 Material: Fire-rated plywood.
- .2 Size: minimum 1.2 m x 1.2 m (4 x 4 feet), and 2 cm (¾ inch) thick.

.3 Grounding:

.1 Provide wall mounted ground bus for telecommunication grounding.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.1 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.2 Coordinate with the City to assign and update registry for telephone services.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section covers system requirements for the Automated Access Control & Intrusion Detection System for the Work. Coordinate with the *NEWPCC Access Control Guideline* found in Appendix 18D.

.2 Provide , install, test, commission, and start-up the Automated Access Control & Intrusion Detection System.

.3 The security systems specialist company and its lead designer shall have a minimum of ten years' experience in design, supply and installation of access control and intrusion detection security system.

1.2 Standards

.1 Canadian Standards Association (CSA):

  .1 CSA C22.2 No. 41 - Bonding & Grounding of Electrical Equipment.

  .2 CSA C22.2 No. 205 - Signal Equipment.

.2 Underwriters Laboratories of Canada (ULC):

  .1 CAN/ULC 60839-11-1 – Standard for Alarm and Electronic Security Systems – Part 11-1: Electronic Access Control Systems.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

  .1 Manufacturer's descriptive literature for materials.

  .2 Shop Drawings shall be submitted as outlined herein and contain all items within one complete submission.

  .3 Shop Drawings shall include a complete material list with Manufacturer, style, model number and quantity.

  .4 Shop Drawings shall indicate materials, methods of construction, methods for attachment/ anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of the Project.

  .5 Shop Drawings shall be submitted complete with all necessary drawings, interconnection diagrams and details with an index in appropriate binder and digital folder. Diagrams, layouts and detail drawings shall be of professional quality drafting.

.6 Site plan identifying locations for instruments, devices, components, panels etc. The Site plan shall demonstrate sufficient floor coverage and monitoring points to achieve the desired level of security for the premises.

.2 Submittals after Testing:

.1 Provide operation and maintenance (O&M) data for fire alarm system for incorporation into manual specified in Appendix 18F – Operation and Maintenance Information.

.2 Include:

.1 Technical data – illustrated parts lists with parts catalogue numbers.

.2 Copy of approved Shop Drawings with corrections completed and marks removed except for review stamps.

.3 List of recommended spare parts for system.

.4 The Manufacturer's written instructions for repair and servicing procedures, include name of original installer and contact information.

.5 Data for all equipment and components.

.6 Includes Quality-control reports (testing and verification) covering all components, equipment, wiring methods, signalling, indication/sounding, and zones.

.7 Provide updated diagrams, facility routing, and all other design and installation drawings.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Refer to the NEWPCC Access Control Guideline found in Appendix 18D.

2.2 Performance / Design Criteria

.1 System Description and General Requirements

.1 The system shall be integrated with the PCS Historian Server.

.2 The designed, supplied and installed security system shall comply with the requirements detailed in this Section. This Section specifies specific system requirements and regardless of use within the installed system and indicated in the supplied equipment schedule.

.3 Design, supply and install a complete access control/security monitoring system as required and specified herein. Include all permit, testing and verification requirements. System will include the following:

.1 Buildings Access Control System.

.2 Intrusion Detection System.

.3 Integration with Digital Video Management System (CCTV).

.4 Interface with Fire Alarm and Detection System.

.4 System shall be complete with all necessary components needed for fully functioning system. Custom designed units shall only be considered for those items that are not currently available in the commercial market.

.5 The system, when complete, shall be free of all interference from cross-talk, hum, switch and relay noise. All wiring shall be terminated on terminal strips or blocks, and shall be neatly installed, laced, with wiring markers and cable tags . All terminals in terminal panels and junction boxes shall be provided with solderless connectors to Weidmuller (or approved equivalent) terminal blocks with a separate terminal for each conductor.

.6 All components for the system shall be provided and installed by the qualified security contractor.

.7 All door rough-in, associated door hardware, pull and junction boxes, cables, wiring, and conduits shall be provided.

.8 Coordinate, review, and verify the type of doors and mechanical door hardware that is being installed and ensure that it is compatible with the security system requirements.

.9 Access control functions shall include, validation based on time of day, day of week, holiday scheduling, site code verification, automatic and manual retrieval of cardholder photographs, and access validation based on positive verification of card and code. An interface between the Access Control System and the Intercom System (hard wired relays) shall be provided to allow for the control of designated doors based on operator or reception REX type initiation sequenced through the security system to either provide access or deny access based on an assigned schedule.

.10 The system programming shall be user-friendly graphical-user-interface (GUI) using a Windows environment and allow mouse control of key functions.

.11 The system shall be capable of expansion through an Ethernet communications network to accommodate future expansion.

.12 The system shall be easily scalable and expandable with the addition of appropriate hardware and software.

.13 Supply a licensed copy of all software programs being supplied in the system. All licenses shall be turned over to the City for backup purposes.

.14 Provide all programming for the system for alarm schedules, report schedules and reader/control functions.

.15 Provide the following as the minimum system performance requirements:

.1 Doors to unlock from valid read in less than 1 second.

.2 Doors to lockdown after-hours in less than 2 seconds from command initiation.

.3 Downloads of new user or system configuration to take less than 2 minutes.

.4 Report generation of built-in reports to take less than 2 minutes from the time of initiation.

.5 Status to be supplied back to host in less than 5 seconds on any change of state of system.

.6 System will have redundant server architecture. The redundant server shall be able to reside in any location network, allowing for continued operation of the system in the event the primary server fails and is shut down for maintenance. (The redundant server is not required at this time).

.16 Provide training of City’s Representatives on the use of the card access system in advance of commissioning the system at site. This will familiarize the operators with the software and programming functions in advance of actual field use.

.2 System Requirements:

.1 Software application program shall lock and unlock specified door(s) via valid ID cards, manual requests, by software time schedules, exit pushbuttons and provide status of each specified door.

.2 Integrate the following functions with the PCS:

.1 Secure door(s).

.2 Monitor door status.

.3 Release selected door(s) under fire conditions.

.4 Release door(s) when valid id card is presented to card reader.

.5 Place door(s) in a secure or unsecured mode automatically from software time schedule.

.6 Place door(s) in a secure or unsecured mode via the terminal keyboard.

.7 Manually release door(s) for exiting. The use of manual release to be controlled by the system schedules.

.8 Verify valid id cards, unlock door, display entry on crts and provide hard copy of all events.

.9 Monitor security alarms.

.10 Prioritize alarm conditions.

.11 Annunciate alarm points, door status and monitor points.

.12 Display complete personnel files with text information.

.13 Produce photo identification badges.

.14 Maintain an event log containing a record of all system transactions including but not limited to:

.1 Operator Sign On.

.2 Operator Commands.

.3 All card access events.

.4 System alarms.

.15 Provide synchronization between any access control or security point and the Digital Video Management System. Any point in the system can initiate a repositioning of an associated PTZ Camera and start a recording. The event shall be stored in the event log with a camera icon associated with the event which shall contain the recorded video information.

.3 Power Fail Restart:

.1 Provide an uninterruptible power supply in accordance with the NEWPCC Access Control Guideline found in Appendix 18D.

2.3 Configuration, Components and Features

.1 Intelligent Field Controllers:

.1 Unit shall be listed by Underwriters Laboratories as meeting the requirements of UL 294 for access control and UL 1076 for Alarm Monitoring for Canada. Unit will have dedicated processor to ensure fast response. Unit shall be able to operate completely stand alone with all functionality of system without host PC except on-line monitoring and downloading files. Unit shall store all transactions in buffer when host PC is not connected and immediately download to host upon reconnection. Unit shall be capable of storing a minimum of 1000 transactions in memory.

.2 The Networked Intelligent Controllers shall provide completely intelligent, local processing capability with downloaded data base processing including the following capabilities and features:

.1 Microprocessor-based for true distributed intelligent local processing.

.2 Minimum 512K processing RAM, expandable to 4-MB, with on board flash RAM and battery backup to retain the stored data in memory for a minimum of 168 hours.

.3 Full local storage of a minimum of 100,000 cardholder records with PIN assignments, area authorizations, time zones and activation/deactivation dates.

.4 Full local storage of a minimum of 5,000 Event Transactions, stored if the Controller loses communication with a SMA (Security Manager Application) server. Transactions will then be automatically uploaded to the host when communication is restored.

.5 The unit shall also incorporate an on board direct LAN connection with minimum 10 MBaud capability.

.6 Complete control and monitoring of up to twenty card readers, with or without keypads, connected utilizing two RS-485 multi-drop communication channels.

.7 Monitoring and control of a minimum of twenty-four fully supervised alarm inputs points, expandable to 255 (total) alarm inputs through the addition of Remote Input Modules.

.8 Control of a minimum of four auxiliary relay outputs, expandable to 96 (total) with the addition of Remote Relay Modules.

.9 Input power for 120 VAC, 50/60 Hz.

.10 The controller shall support the card reader specified in the NEWPCC Access Control Guideline found in Appendix 18D.

.3 Units shall control access for card readers, monitor points and auxiliary relays. Unit shall provide control relays to unlock door-locking mechanism, activate alarm output, activate alarm shunt, activate power failure alarm, low battery alarm, and communication failure alarm. Alarms shall be LED annunciated locally to indicate status of the unit. All panels in common location shall be mounted in security cabinets sized to suite application. Cabinets shall be fully enclosed painted metal with ventilated hinged locking door complete with handle and tamper switch connected to access system. Provide terminal strips in panels for all field wiring.

.4 Provide all required interface ports, input/output points and control relays to form a fully operational system.

.2 Card Readers:

.1 Card readers shall be solid-state microprocessor based electronic devices utilizing proximity field effect technology, capable of reading binary data from specially encoded PVC identification cards and transmitting that data to an access control unit. Indicating LED's to show access accepted or denied status. An audible acknowledgement beep is required.

.2 Presenting a card to the reader shall initiate a signal read. Thereafter the card shall be removed from the reader's field and re-presented before it is again read by the system.

.3 The multi-coloured LED shall indicate the status of the door as follows:

.1 Red status shall indicate that the door is secure (locked).

.2 Green status shall indicate that the door is unsecured (unlocked).

.3 Yellow status shall indicate that the reader is not functioning (offline/trouble), is processing a read request, or has denied access.

.4 The card reader shall produce an audible beep tone to indicate to the user:

.1 The card was read and/or access was denied.

.2 The door is being held open and needs to be closed.

.5 Readers shall be made from sturdy construction materials, capable of withstanding heavy usage and be highly resistant to tampering and vandalism. Indoor readers shall have at minimum 150 mm read range (passive).

.6 Card readers provided on the exterior doors shall be approved for outdoor use and be mounted on gasketed watertight boxes. Exterior mounted readers shall be weatherproof and have a minimum 300 mm read range (passive).

.7 All readers shall be wired back to the access control unit directly.

.8 Each card reader and/or reader electronics shall be powered directly from the Access Controller. External or local power supplies shall not be required unless the reader electronics is located more than 300 m from the controller.

.9 Location of card readers shall be shown on the Fire Alarm & Communication & Security plan drawings.

.10 Supply all the card readers for installation of the system. Provide compatible card readers (with similar characteristics) with the Lenel System or approved equivalent.

.3 Cards:

.1 The access card shall be dual technology proximity access control card type.

.2 All cards for the system shall be encoded with same facility code. All card ID numbers shall be unique to a single card and will not be duplicated.

.3 Cards shall be highly resistive to wear and environmental deterioration and shall have a lifetime warranty and photo ID systems shall be compatible with them. Photo identification and other desired information shall be capable of being directly applied to both sides of the card forming a tamper resistive identification badge.

.4 The access card shall be "Passive" (non-battery operated) proximity technology and shall be compatible with Lenel Prox (or approved equivalent) card reader technology.

.5 The read range of the access card shall be extremely consistent, and not affected by body shielding or variable environmental conditions. Expected card reader range is 150-200 mm.

.6 Cards shall be vertical or horizontal mounted and to accept straps and clips for attaching the badge to clothing. Card size shall be nominal 86 mm x 54 mm x 0.89 mm.

.4 Door Control Power Supply:

.1 Door control power supply shall provide 24 VDC with automatic battery charging output circuit to maintain standby batteries. Power supply shall have integral transient over voltage protection and surge suppression complete with ground fault detection and alarm. Power supplies shall be located in field control panels or in separate cabinets beside field control panel.

.2 Door control power supply shall provide power to the following:

.1 Door security control including all door hardware, card readers, LED's control circuits and supervisory equipment. Power supplies shall interface with Fire Alarm release relay to release doors equipped with electric strikes or magnetic locks.

.2 Power supplies shall be rated at 125% of total capacity of load connected.

.5 Electric Door Hardware:

.1 Provide all electric door and gate hardware. Hardware supplied shall include electric door operators, with either electric locks or electric strikes, complete with latch monitor switch, electric butt hinges, exit PIR, and door closed contacts.

.2 Install all Card Readers and associated proximity cards and supply and install exit PIR motion sensors, glass break detectors in windowed doors and on all ground floor windows.

.3 Coordinate with the supplier and installer for the door and window, door and window frame, and door and window installation to ensure that the proposed electronic door and window hardware is suitable for the security system.

.6 Software Updates:

.1 Maintenance updates and patches to the software package shall be provided for the lifetime of the system. These shall include all revisions and enhancements to the original software package. The latest version of the security and access control system shall be installed at start of commissioning.

.7 Wire and Cable:

.1 All wiring and cable installed and connected to any piece of equipment that forms part of the security system shall be electrically supervised and shall indicate a fault or tampering (open, ground) and provide a unique display of circuit trouble in the system on the display screen.

.8 Materials and Fasteners:

.1 Furnish hardware with all necessary fasteners, mounting brackets, and special tools required for the proper installation as recommended by the Manufacturer. Fastening devices shall be of the same material and finish as the item to which it is fastened. Any wood screws shall be threaded to the head. Provide either hex bolts or through bolts on rated mineral core doors.

2.4 Equipment and System Controls

.1 Software:

.1 System software shall run on the latest version of Windows Server and shall have these features to enable user to perform the following tasks:

.1 Modify database files.

.2 Process alarms.

.3 Print files and reports.

.4 Input and output shunting.

.5 Program system.

.6 Customized report capability.

.7 Operator password levels to restrict access from sensitive program areas.

.8 History report generation and printing.

.9 Automatically logs all transactions to the hard disk.

.10 Limit access by time, date and holiday.

.11 Monitor hardware groups, hardware zones and access groups/access zones.

.12 Journal all transactions.

.13 Ability to acknowledge, cancel or reset an alarm.

.14 Have prioritized alarm capabilities allowing higher priority alarms to annunciate before lower priority or during a lower priority alarm.

.15 Operator sign on duress feature which will alert other operator that guard is signing on under duress.

2.5 Identification

.1 All equipment units shall be identified following City of Winnipeg Electrical Design Guide and identification Standard.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Components not available locally within a 24-hour period.

3. EXECUTION

3.1 Installation

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 All system wiring shall be installed in rigid conduit where the exposed wiring could be subject to mechanical damage except cabling between CPU, keyboard, VDT, and printer. Cable in ceiling spaces shall be run in either EMT conduit or armoured cable and secured above the T-Bar tiles. Label all system wiring at both ends.

.4 All doors equipped with electric locks shall be inter-connected to Fire Alarm System. Latches and electric strikes for all doors shall be released on Fire Alarm. Intelligent controllers shall remain powered and operational and continue to monitor all alarm points and report the same to the security control room in the gatehouse.

.5 Coordinate with Fire Alarm supplier for exact connection of fire release relays. Include Fire Alarm release hardware and verification testing by the Fire Alarm supplier.

.6 Programming of the system shall begin as soon as practical. Provide schedule of proposed meetings and information requests to the City. Submit information request questionnaires to the City 28 Business Days in advance to obtain information required to program the system.

.7 Coordination:

  .1 Coordinate installation of access control system with:

    .1 Fire alarm and detection system.

    .2 CCTV system.

    .3 PCS System.

3.2 Equipment Checkout

.1 Testing, Start-up and Adjustments:

  .1 Upon completion of system installation, tests shall be conducted to determine system conformity to the requirements of the Specifications, proper operation and programming, and in accordance with Section 16020 - Electrical Testing.

.2 Check List:

  .1 Sufficient working space in front of the security panels to perform maintenance.

  .2 Readers or other access devices located where they are accessible.

.3 Security sensor are located, aimed, directed, coordinated and confirmed to provide optimal operation efficiencies.

.4 Confirm adequate floor coverage and monitoring points have been provided for the provided security detection devices to achieve the desired level of security for the premises.

.5 Emergency power backup circuits for security system components are in place and functioning.

.6 Interfacing between the security system and the PCS has been done.

.7 All devices and panels are tagged and identified.

.8 Individual conductors are tagged and identified and terminals and terminal strips are tagged and identified.

.9 Raceways, junction boxes and termination cabinets are identified with colour-coded bands or other approved means.

.10 Equipment is ULC approved.

.11 Confirm Spare parts for security system are present at the Facility.

.12 All equipment is free of scratches, dents, cracks, paint and damage.

.13 Equipment is bonded to ground.

END OF SECTION

CCTV SYSTEM

1. GENERAL

1.1 Summary

.1 This Section covers supply and installation of LAN based video recording and management system for the Work.

.2 All cameras complete with digital video steamers shall be wired to connect back to the designed camera server located in the main server room.

.3 The Digital Video Recording and Management System shall include:

- .1 PC based storage server and client software.
- .2 Ability to integrate with the security system.
- .3 Operator stations.
- .4 Cameras.
- .5 Camera power supplies.
- .6 Network connected cameras with digital video streamers.
- .7 Network switching infrastructure with appropriate copper and fibre media converter interfaces.
- .8 Mounting brackets, cables, and miscellaneous components.
- .9 Supply and install all control and video cabling for the CCTV systems.
- .10 Utility Rack enclosures shall house rack mounted servers, video streamers, Ethernet components and power supplies.

.4 CCTV System shall form a total integrated digital CCTV video surveillance system incorporating all cameras within the Facility.

1.2 Submittals

.1 Provide submittals in accordance with Sections 01300 - Submittals and 16010 - Electrical General Requirements and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Shop Drawings shall be submitted as outlined herein and contain all items within one complete submission.
- .3 Shop Drawings shall include a complete material list with Manufacturer, style, model number and quantity.

.4 Shop Drawings shall indicate materials, methods of construction, methods for attachment/ anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of the Project.

.5 Shop Drawings shall be submitted complete with all necessary drawings, interconnection diagrams and details with an index in appropriate binder and digital folder. Diagrams, layout and detail drawings shall be of professional quality drafting.

.6 Site plan identifying locations for instruments, devices, components, panels etc. The Site plan shall demonstrate sufficient floor coverage and monitoring points to achieve the desired level of security for the premises.

.2 Submittals after Testing:

.1 Provide operation and maintenance (O&M) data for fire alarm system for incorporation into manual specified in Appendix 18F – Operation and Maintenance Information.

.2 Include:

.1 Technical data – illustrated parts lists with parts catalogue numbers.

.2 Copy of approved Shop Drawings with corrections completed and marks removed except for review stamps.

.3 List of recommended spare parts for system.

.4 The Manufacturer's written instructions for repair and servicing procedures, include name of original installer and contact information.

.5 Data for all equipment and components.

.6 Includes Quality-control reports (testing and verification) covering all components, equipment, wiring methods, signalling, indication/sounding, and zones.

.7 Provide updated diagrams, facility routing, and all other design and installation drawings.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Samsung: QNV 7080R.

.2 Hanging Mount: SBP301HM2.

.3 Wall Mount: SBP300WM or SBP300B.

.4 Or approved equivalent.

2.2 Performance / Design Criteria

.1 System shall be complete with all necessary components to provide a functional operating system. All components shall be readily available off the shelf type. Custom designed units will only be considered for those items that are not currently available on the commercial market and subject to review through the submittal/submission activities.

.2 Supply and install all conduits, pull boxes, junction boxes, and terminal panels that are required to provide a complete conduit system. Pull wires to be installed in all conduit runs. The CCTV system shall be a complete and working system.

.3 The system, when complete, shall be free of all interference from cross-talk, hum and ground loops. All wiring shall be terminated in terminal panels, on devices and on terminal strips and shall be tagged. All cabling shall be installed without splices.

2.3 Configuration, Components and Features

.1 Outdoor Cameras:

  .1 Outdoor cameras shall be tamper resistant with a variable focusing lens and able to adjust for changes in ambient lighting levels.

  .2 Outdoor camera coverage shall be sufficient to monitor the grounds anywhere within 10 m from the facilities perimeter, and including all doorways and ground floor windows.

.2 Indoor Cameras:

  .1 Indoor cameras shall be tamper resistant with a variable focusing lens and able to adjust for changes in ambient lighting levels.

  .2 Indoor camera coverage shall be sufficient to monitor hallways, access doors, and the process areas.

2.4 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

  .1 Components not available locally within a 24-hour period.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Installation

.1 Install all security CCTV camera system as set out in the Final Design. Coordinate phasing of the system with all other trades.

.2 All system cable shall be supplied and installed in conduit raceways.

.3 Video connectors shall be crimp type installed with proper crimping tool. Twist on connectors are not permitted.

.4 Confirm all camera-mounting locations with the Contract Administrator and City.

.5 All cables shall be labelled at both ends with termination location.

.6 All cables shall be pulled in one continuous run. Splicing of cables are not permitted.

.7 Provide additional bracing or structural support necessary for camera and hardware mounting.

.8 Dress cables for installation into equipment enclosures and rack assemblies.

.9 Coordinate installation of CCTV System with Section 16735 - Card Access System and other Divisions.

END OF SECTION