## Part 1 General

### 1.1 GENERAL CONDITIONS

.1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.

.2 Refer to all other Sections of the Specifications and these Documents to determine their effect upon the work of this Section.

### 1.2 SCOPE

.1 A brief but not necessarily all inclusive list of work to be performed under this contract is given herein.

.2 The Contractor shall supply all labor, material, equipment, transportation, services and facilities necessary to make, test and place into operation a complete electrical installation as shown on the drawings and/or as specified herein.

.3 Where the term "provide" is used herein, it shall mean "supply, install, adjust, test and place into operation".

.4 All systems shall be completely assembled, adjusted, tested and demonstrated to be ready for operation to the satisfaction of the Contract Administrator.

.5 The Contractor shall carefully examine the drawings and specifications and shall fully inform himself as to all existing conditions and limitations, including all laws, ordinances and regulations affecting the contract and the work and shall include in his tender all items implied or required to complete the work of this contract.

.6 The Contractor shall satisfy himself as to working space, storage space, access facilities and all other conditions pertaining to the site, relating to the conduct of his operations, by the inspection of the site and examination of the drawings.

.7 Provide all labor and materials as necessary to install, wire, connect and put into satisfactory operation the following control panels and mechanical equipment supplied under Sections 23 and 44:

- .1 Electric motors and actuated valves
- .2 Motor starters, contactors, and interlocks where specified as components of "packaged" equipment.
- .3 UV disinfection system power distribution and monitoring panels.
- .4 Miscellaneous plumbing and HVAC equipment including fans, hot water tank, etc.

## 1.3 EXTENT OF WORK

.1 This work shall consist of furnishing of all labor, material, equipment and all incidentals required for the new Hauled Wastewater Receiving Facilities at the NEWPCC and SEWPCC.

.2 Work at the NEWPCC Hauled Wastewater Receiving Facility shall include, but not be limited to:

- .1 Provision of new Hauled Wastewater System comprising:
  - .1 New Gate Access Control System.
  - .2 New Process and instrumentation equipment.
  - .3 Electrical Services for new Wastewater Building
- .2 Provision of new Leachate Receiving System comprising:
  - .1 New Gate Access Control System
  - .2 New Process and instrumentation equipment.
  - .3 Two new Leachate Pumps
  - .4 Electrical Services for new Leachate Building
- .3 Modifications to existing Digester Facility comprising:
  - .1 New Process and instrumentation equipment.
  - .2 Three new Leachate Pumps
- .4 Upgrade to existing security system comprising:
  - .1 New security cameras.
  - .2 Additional area lighting.

.3 Work at the SEWPCC Hauled Wastewater Receiving Facility shall include, but not be limited to:

- .1 Provision of new Hauled Wastewater System comprising:
  - .1 New Gate Access Control System.
  - .2 New Process and instrumentation equipment.
  - .3 Electrical Services for new Wastewater Building
- .2 Upgrade to existing security system comprising:
  - .1 New security cameras.
  - .2 Additional area lighting.

.4 Wire to and make connections to, all electrical power and control items required, including motors, controls, etc.

## 1.4 EXAMINATION OF DRAWINGS

.1 The electrical drawings do not show all architectural, mechanical and structural details. All electrical schematics are shown diagrammatically unless otherwise noted. The Contractor shall review the mechanical and structural drawings to obtain building dimensions and details. Verify dimensions accurately by measurements.

.2 To change the location of electrical equipment, submit a request in writing to the Contract Administrator for approval. If approved, such changes are to be made at no additional cost to the City.

.3 No extra will be allowed for any additional labor or materials required for relocation of equipment due to interference with equipment of other trades, beams, joists, walls, etc., unless the conflict has been submitted to the Contract Administrator in accordance with B15 Enquiries.

## 1.5 APPROVED DESIGN AND INSTALLATION

.1 Equipment and material to be of approved design and manufactured in accordance with all governing regulations such as "Canadian Standards Association", "Canadian Electrical Code", "Provincial Department of Labor", "Underwriters Laboratory", etc. Equipment and material must bear applicable acceptance labels of all associations and governing bodies recognized by the municipal, provincial and federal authorities.

.2 Install equipment in strict accordance with manufacturer's recommendations and governing rules, regulations and codes.

.3 Where requirement conflict occurs, install all materials in accordance with the most severe requirements.

.4 Material installed under this Section to be new and of uniform construction.

.5 All installation to ensure maximum headroom, minimum interference with free use of surrounding areas, and best access to equipment.

.6 To deviate major service runs from the location shown on the drawings, submit to the Contract Administrator suitable drawings showing such deviations together with reasons for deviations and obtain approval from the Contract Administrator before proceeding with the installation.

## 1.6 CODES AND STANDARDS

.1 Do complete installation in accordance with the latest edition of the Canadian Electrical Code, Provincial, Municipal, and other codes, rules and regulations and requirements of local authorities having jurisdiction.

.2 Perform all work in accordance with drawings, specifications, applicable municipal and provincial regulations, and any pertinent inspection bulletins issued by the electrical inspection authority having jurisdiction over the installation. In no instance shall the standard established by the drawings and specifications be reduced.

.3 Provide a copy of all standards referred to in this Section for use on site.

## 1.7 PERMITS, FEES AND INSPECTION

.1 Submit to City of Winnipeg the necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Pay associated fees.

.3 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.

.4 Furnish Certificates of Acceptance from authorities having jurisdiction on completion of work to Contract Administrator.

## 1.8 ABBREVIATIONS

.1 Abbreviations for electrical terms shall be to CSA Z85 1983.

.2 Names used throughout these specifications are:

.1 EEMAC: Electrical & Electronic Manufacturers Association of Canada (formerly CEMA)
.2 CSA: Canadian Standards Association
.3 FM: Factory Mutual
.4 NEMA: National Electrical Manufacturers Association (U.S.)
.5 JIC: Joint Industry Conference
.6 IPCEA: Insulated Power Cable Engineers Association
.7 ISA: Instrument Society of America
.8 CEC: Canadian Electrical Code
.9 IEEE: Institute of Electrical and Electronic Engineers
.10 IES: Illuminating Engineering Society
.11 NBC: National Building Code
.12 ANSI: American National Standards Institute

## 1.9 SHOP DRAWINGS

.1 Submit shop drawings in accordance with E4.

.2 Submit shop drawings for all equipment as indicated with the exception of conduit, standard conduit fittings and low voltage wiring.

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

.4 Where applicable, include wiring, single line and schematic diagrams.

.5 Wiring drawings showing interconnection with work or other sections are required.

.6 Indicate the number or letter used as an identification symbol on product data for panelboards, lighting fixtures and other equipment.

**1.10 OPERATION AND MAINTENANCE MANUALS**

.1 Include in the manuals information based on following requirements:

.1 Operation and maintenance instructions to be sufficiently detailed with respect to design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.

.2 Technical data to be in form of approved shop drawings, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists.

.3 Advertising or sales literature is not acceptable.

.4 Provide wiring and schematic diagrams and performance curves.

.5 Include names and addresses of local suppliers for all items included in the operation and maintenance manuals.

.2 Submit six (6) complete copies of manuals and "as-constructed" drawings to the Contract Administrator for review. Revise initial manual as required by the Contract Administrator prior to final submission.

**1.11 RECORD DRAWINGS**

.1 Submit record drawings in accordance with Section 01 78 00 - Closeout Submittals.

.2 The Contractor shall record all changes made during construction and provide record drawings to the City upon completion of the work.

.3 At the completion of the project, the Contractor shall submit one (1) set of record drawings on disk, accurately recording all changes, deviations and relocations necessitated by job conditions and equipment approved shop drawings all done on CADD using AutoCAD Release 2004 or later.

.4 Include with the record drawings a list for each motor indicating motor or equipment number and name, nameplate voltage, horsepower and current, the size of overload and breaker or fuse protection provided.

**1.12 SINGLE LINE DIAGRAM**

.1 At the completion of the project, the Contractor shall submit one (1) copy of revised plant single line diagram on disk, accurately recording all changes, deviations and relocations necessitated by job conditions done on CADD using AutoCAD Release 2004 or later.

**1.13 PROCESS & INSTRUMENTATION DIAGRAM**

.1 At the completion of the project, the Contractor shall submit one (1) copy of revised plant process and instrumentation diagram on disk, accurately recording all changes, deviations

and relocations necessitated by job conditions done on CADD using AutoCAD Release 2004 or later.

**1.14 DEFINITIONS**

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

.1 "Inspection Authority" means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical work on site.

.2 “Supply Authority" means electrical power company or commission responsible for delivery of electrical power to project.

.3 "Electrical Code" means Canadian Electrical Code C22.1 or code in force at project location.

.4 "Indicated" means as shown on contract drawings or noted in contract documents.

.2 Refer to CSA C22.2 No.0 for "Definitions and General Requirements".

**1.15 COOPERATION AND COORDINATION**

.1 Schedule expediting of all materials and execution of work with associated work specified in other Sections.

.2 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 galvanized steel pipe, sized for free passage of conduit, and protruding 50 mm (2").

.3 Cables, conduits and fittings to be embedded or plastered over neatly and close to building structure so furring can be kept to a minimum.

.4 Arrange for holes through exterior walls and roof to be flashed and made weatherproof.

**1.16 SOURCE QUALITYCONTROL**

.1 Arrange for a plant inspection by Contract Administrator where specified.

.2 Inform Contract Administrator of manufacturing progress and arrange inspections at appropriate times.

.3 Action required by factory inspection shall not be construed as final acceptance.

.4 Obtain a Certificate of Acceptance from the inspection authority on completion of work and hand it to the Contract Administrator.

.5 The Contract Administrator may carry out inspections and prepare deficiency lists for action by the Contractor, during and on completion of project.

**1.17 CARE, OPERATION AND START-UP**

.1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

**1.18 APPROVAL OF ALTERNATE MATERIALS**

.1 Bid Opportunity shall be based on the materials, products, and manufacturers specified.

.2 Alternates to materials, products, and manufacturers specified shall be in accordance with Section 1.

.3 Supply and install all motor power wiring and conduit, all control wiring and conduit, all local and remote control devices, and all motor starters and contactors except where specified as components of "packaged" equipment.

## Part 2 Products

**2.1 GENERAL**

.1 All materials shall be fully approved by the Canadian Standards Association (CSA) for use as installed and meet the requirements of this specification in all respects.

.2 Where there is no alternative to supplying equipment which does not have CSA approval, submit such equipment to Provincial Hydro Inspection Authorities for special inspection and obtain approval. Pay all associated fees.

.3 Materials and equipment shall be of Canadian manufacture except where specified otherwise or where Canadian made materials or equipment do not exist.

.4 Where two or more units of the same class or type of equipment are required, the units shall be the product of a single manufacturer, although components of equipment need not be products of the same manufacturer.

.5 Use material and equipment available from regular production of manufacturer.

.6 Control panels and component assemblies to be shop manufactured.

**2.2 FINISH**

.1 Finish metal enclosure surfaces by removing rust and scale, cleaning, and applying rust resistant primer inside and outside with at least two coats of finish enamel.

.2 Paint all outdoor electrical equipment "equipment green" finish to EEMAC Y1.

.3 Paint all indoor switchgear and distribution enclosure "light grey" to ASA 61 grey.

.4 Clean, prime and paint exposed hangers, racks, fastenings, etc., to prevent rusting.

**2.3 VOLTAGE RATINGS**

.1 Operating voltages: to CAN3-C235-83.

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

**2.4 MATERIALS AND EQUIPMENT**

.1 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.

.2 Factory assemble control panels and component assemblies.

**2.5 WIRING**

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

**2.6 ENCLOSURES**

.1 Minimum enclosure type to be used is EEMAC 12 for ordinary environments, EEMAC 4X for corrosive environments or EEMAC 3R for outdoor installations unless otherwise specified.

**2.7 MANUFACTURERS AND CSA LABELS**

.1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed.

**2.8 WARNING SIGNS**

.1 Provide warning signs with suitable background color and lettering as required to meet requirements of inspection authorities and Contract Administrator. Use decal signs, minimum size 178 mm x 250 mm.

## 2.9 PLYWOOD MOUNTING BOARDS

.1 Surface wall mounted panelboards and other electrical equipment shall be installed on plywood mounting boards. Boards shall be provided under this section of the specifications, sized to suit equipment indicated and/or implied.

.2 Plywood mounting boards shall consist of 20 mm fir plywood fastened securely to wall.

.3 Plywood mounting boards, strapping and trim shall be treated with wood preservative prior to installation and painted with one coat of primer and two coats of grey enamel ASA61. Painting shall be completed before any electrical equipment is mounted on the plywood.

.4 Service entrance equipment shall be spaced from the plywood mounting boards to the satisfaction of the inspection authorities.

## 2.10 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Contractor and Sub-Contractor responsibility is indicated in Equipment Schedules on mechanical drawings 1-0101A-M0012-001 and 1-0102A-M0007-001.

.2 Control wiring and conduit is specified in Sections 26 05 21 and 26 05 34 except for conduit, wiring and connections below 50 V which are related to control systems and shown on mechanical drawings.

## 2.11 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamacoid 3 mm thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.

NAMEPLATE SIZES

| | | | |
|---|---|---|---|
| Size 1 | 10 x 50 mm | 1 line | 3 mm high letters |
| Size 2 | 12 x 70 mm | 1 line | 5 mm high letters |
| Size 3 | 12 x 70 mm | 2 lines | 3 mm high letters |
| Size 4 | 20 x 90 mm | 1 line | 8 mm high letters |
| Size 5 | 20 x 90 mm | 2 lines | 5 mm high letters |
| Size 6 | 25 x 100 mm | 1 line | 12 mm high letters |
| Size 7 | 25 x 100 mm | 2 lines | 6 mm high letters |

.3 Allow for average of twenty-five (25) letters per nameplate.

.4 Identification to be English.

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

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

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

## 2.12 WIRING IDENTIFICATION

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

.2 Maintain phase sequence and color coding throughout.

.3 Color code: to CSA C22.1.

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

## 2.13 LOCATION OF OUTLETS

.1 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

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

.3 Locate light switches on latch side of doors.

## 2.14 MOUNTING HEIGHTS

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

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

.3 Install electrical equipment at following heights unless indicated otherwise.

- .1 Local switches: 1400 mm.
- .2 Wall receptacles:
  - .1 General: 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 rooms: 1400 mm.
- .3 Panelboards: as required by Code or as indicated.
- .4 Voice and data communication outlets: same height as nearest receptacle.
- .5 Fire alarm stations: 1500 mm.
- .6 Fire alarm audible devices: 2100 mm above floor or 300 below ceiling, whichever is lower.

## 2.15 LOAD BALANCE

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

## 2.16 CONDUIT AND CABLE INSTALLATION

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

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

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

## 2.17 FIELD QUALITY CONTROL

.1 All electrical work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.

.2 The work of this section to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province that the work is being constructed.

.3 Conduct and pay for following tests:

- .1 Power distribution system including phasing, voltage, grounding and load balancing.
- .2 Circuits originating from branch distribution panels.
- .3 Lighting and its control.
- .4 Emergency lighting.
- .5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .6 Systems: fire alarm system, access control, CCTV.

.4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.5 Insulation resistance testing.

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

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

.7 Submit test results for Contract Administrator's review.

**2.18 CO-ORDINATION OF PROTECTIVE DEVICES**

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

.2 Select and adjust protective devices as required to ensure suitable coordination.

.3 Provide a coordination study report demonstrating selective tripping and proper functionality of the power distribution system with the devices and settings as installed.

**2.19 ARC FLASH SAFETY LABELING**

.1 Provide arc flash safety labeling on electrical equipment in accordance with CSA - Z462.

**Part 3 Execution**

**3.1 WORKMANSHIP**

.1 All work to be carried out by qualified journeymen of the related trades.

.2 Where sheet metal enclosures are not provided with knockouts, Greenlee punches shall be used in all cases. Cutting torches shall not be used for making holes.

**3.2 INSTALLATION**

.1 Determine manufacturers' recommendations regarding storage and installation of equipment and adhere to these recommendations.

.2 Check all factory joints and tighten where necessary to ensure continuity.

.3 Coordinate the work of this Section with the installation of the equipment specified in the relevant Sections of Sections 11 and 15 and shown on the Mechanical and Electrical drawings.

.4 Perform all work in compliance with the relevant sections of this Section.

## 3.3 SPECIAL PROTECTION

.1 Accept the responsibility to protect those working on the project from any physical danger due to exposed electrically energized equipment such as panel mains, outlet wiring, etc. Shield and mark all live parts "LIVE 600 VOLTS" or with the appropriate voltage.

.2 Arrange for the installation of temporary doors, barriers, etc., for all electrical equipment. Keep these doors locked at all times except when under direct supervision.

## 3.4 FIREPROOFING

.1 Where sleeves or openings are installed in walls, floors, roof or partitions to accommodate raceways, cables or bus duct, provide all necessary seals, fittings, barriers and fire resistant materials to restore the installation to its original fire rating to the satisfaction of the Contract Administrator.

## 3.5 TOUCH-UP PAINTING

.1 Be responsible for field touch up painting of all shop painted electrical equipment installed in this Contract.

.2 All surfaces to be painted shall be dry, clean, and free from dust, dirt, grease, frost, rust, loose crystals or extraneous matter, tool and machine marks. Feather out edges of scratch marks to make patch inconspicuous.

.3 Apply one or more coats of paint until the damaged surface has been restored to original finish condition. Do not apply succeeding coats until preceding coat is dry and hard. Sand lightly between coats with No. 00 sandpaper.

.4 Be responsible for obtaining the necessary touch up paint of the original type and quality from the equipment manufacturer.

.5 Supervise priming and finish painting of all electrical equipment and material not shop painted.

## 3.6 SLEEVES AND OPENINGS

.1 Provide sleeves and openings for exposed conduits, busways, and wireways, where they pass through walls or floors conforming to relevant fire codes where applicable.

.2 Sleeves for individual conduits shall be galvanized steel in ordinary areas or stainless steel in corrosive environments.

.3 Pack or fill sleeves and openings after the completed work is in place. Filling shall provide a waterproof seal to prevent leakage of water or other liquids through the sleeve or opening.

.4 Sleeves and openings shall not displace reinforcing steel, and shall receive approval of the Contract Administrator prior to placement.

## 3.7 CUTTING AND PATCHING

.1 Do all drilling, cutting, fitting and patching necessary for the running and securing of conduits, wireways, and other electrical equipment.

.2 Provide supports necessary for same.

.3 Provide bracing and anchorage of work subject to Contract Administrator's approval.

.4 No cutting of the structural members or of the fireproofing shall be done without the written consent of the Contract Administrator.

.5 Caulk and flash all conduits passing through walls, roofs or other surfaces exposed to weather or as indicated on the drawings to prevent the passage of water and/or sewer gases.

## 3.8 HANGERS AND SUPPORTS

.1 Provide hangers, angles, channels, and other supports necessitated by field conditions to install all items of electrical equipment. Design of supports and methods of fastening to building structures shall be subject to the Contract Administrator's approval.

.2 All local motor control devices are to be grouped and mounted on a free-standing frame of stainless steel construction easily accessible and as close to the motor as possible.

.3 Provide weight-distribution facilities, where required, so as not to exceed the load-bearing capacities of floors or walls that bear the weight of, or support, electrical items.

.4 Paint all exposed parts of hangers and supports with an anti rust inhibiting primer.

.5 Equipment shall not be held in place by its own weight. Provide base anchor fasteners in each case.

## 3.9 PROTECTION OF EQUIPMENT

.1 Protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps.

.2 Fixtures, materials, equipment, or devices damaged prior to final acceptance of the work shall be restored to their original condition or replaced by the Contractor.

## 3.10 TESTING OF ELECTRICAL SYSTEMS GENERAL

.1 Prior to the Contract Administrator's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Contract Administrator to ensure that the operation of the system and components satisfy the requirements of the Specifications.

.2 Ensure that the system and its components are ready prior to the inspection and test for acceptance.

.3 All testing shall be conducted by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Contract Administrator. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the City. Submit six copies of the test certificates to the Contract Administrator. Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.

.4 Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.

.5 Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.

.6 In addition to tests on purely electrical systems, supply the necessary labor and equipment for operational tests required by other Sections where electrical services are involved and make final adjustments to the electrical controls at no additional cost to the City.

.7 Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.

.8 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.

.9 Supply all instruments, meters and personnel required for the tests.

## 3.11 CABLE AND WIRE 1000 VOLT AND BELOW

.1 Tests on cables in this voltage range shall be limited to insulation resistance measurements using a 500V megger for systems up to 350V and a 1000V megger for 351 600V systems.

.2 Record all test results in a log book and submit to the Contract Administrator for reference. Replace or repair all circuits, which do not meet minimum requirements specified in the CEC, Table 24. Insulation resistance of the following circuits shall be measured:

- .1 Power, lighting and motor feeders (with equipment disconnected): phase to phase, phase to neutral and phase to ground.
- .2 Control circuits: measure to ground only.
- .3 Do not perform megger tests on control circuits containing transistorized or solid state components.
- .4 Where power factor correction equipment is installed, it may be necessary to disconnect the capacitors from the system prior to testing to avoid overvoltage.

## 3.12 GROUNDING SYSTEM

.1 Test the grounding system efficacy for compliance with CSA Standard C22.1 and Supply Authority requirements. Verify that the ohmic resistance values specified therein are not exceeded.

.2 Notify Contract Administrator that they may be present to witness Contractor testing.

## 3.13 TRAINING

.1 Provide for the training of the Contract Administrator in the operation, maintenance and testing of all systems and equipment including the provision of qualified manufacturer's technical representatives for specialized systems.

.2 Provide these services for such period, and for as many visits as necessary to put installation in working order, and to ensure that operating personnel are conversant with all aspects of its care and operation.

## 3.14 DELIVERY AND STORAGE

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

.2 Ship channel bases and anchor stencils in advance of equipment.

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

.4 Block moving parts when necessary to prevent damage during movement and shipment of equipment. Instructions to remove blocking before putting equipment in service to be clearly and conspicuously displayed.

.5 Store all electrical equipment indoors. Temperature sensitive equipment to be stored in heated spaces.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 Preparation of harmonics study of the proposed electrical installation.

### 1.2 QUALIFICATIONS

.1 The Contractor shall have the harmonics study prepared by qualified sub-contractor of an independent consultant. The consultant shall be a licensed Professional Engineer who has at least ten (10) years of experience and specializes in performing power system studies.

.2 The harmonics study shall be performed utilizing the SKM PowerTools for Windows computer software package.

### 1.3 SUBMITTALS

.1 The Contractor shall submit the harmonics study within 30 days after the electrical equipment submittals have been received for review by the Contract Administrator. The electrical submittals will be reviewed but not approved until the harmonics study has been received and approved.

.2 Submit three (3) copies of the harmonics study.

## Part 2 Products

### 2.1 DESCRIPTION

.1 Provide a harmonics study for the electrical distribution system. The intent of the study is to verify that the specified and supplied electrical equipment will operate properly when correctly installed in the system and will not adversely impact the operation of other equipment, whether existing or new.

.2 The harmonics study shall include all portions of the electrical distribution system , from the normal and alternate sources of power down to each load shown on the single line diagram. The harmonics study shall consider operation during normal conditions, alternate operational configurations, emergency power conditions and any other operations which could result in harmonic distortion exceeding proscribed standards.

.3 The harmonics study shall be in written form and shall include analysis of the harmonic voltages and currents which are likely to be produced on the power distribution system by operation of plant equipment.

.4 The study shall include the “worst case” situation that is likely to be produced. The worst case is defined as that combination of equipment which is deemed most likely to create the highest level of total harmonic voltage distortion and total current demand distortion at a given point.

.5 The study shall include all plant equipment likely to influence the results of the study. This shall include, but is not limited to:

.1 Feeder circuits attached to the same distribution transformer;
.2 Conventional loads on those feeders;
.3 Non-linear loads;
.4 Reactors;
.5 Capacitors ;
.6 Filters

.6 All non-linear loads shall be modeled with the spectrum produced at full load.

## 2.2 ANALYSIS

.1 Analyze the harmonic calculations and discuss the results at the following locations:

.1 The primary side of each unit substation (normal power)
.2 The bus of each switchboard (normal and alternate power)
.3 Each alternate power source (including generators)
.4 The point of common coupling

.2 The point of common coupling shall be taken at the utility metering point (primary side if not primary metered). In the case of multiple primary metering points, the point of common coupling shall correspond to that defined in ANSI/IEEE std 519 (latest version).

.3 Include recommendations for mitigating the total harmonic voltage distortion or total current demand distortion on the system if the combination of loads exceeds or violates the limits of the electric utility or ANSI/IEEE 519 (latest revision).

.4 Include recommendations for mitigating the impact of the harmonic distortion on plant equipment or processes if the levels are such that equipment or processes may be impaired.

.5 If diversity factors are used, include discussion on affected units, the loading assumed on each load and the multiplying factor used for each load.

.6 Include discussion of verification measurements and how they compare with calculated results. Account for any discrepancies, adjust model and recalculate values, if necessary.

## 2.3 VERIFICATION

.1 The consulting firm performing the harmonic study shall perform the following verifications.

.2 Measure the harmonic voltages at the following locations:

.1 The primary side of each unit substation (normal power)
.2 The bus of each switchboard (normal and alternate power)
.3 Each alternate power source (including generators)
.4 The point of common coupling

.3 Measure the harmonic current at the following locations:

.1 The feeder from the secondary of the unit substation to the associated switchboard (normal power)

.2 The feeders to all other switchboards (normal and alternate power)

.3 The feeder from the alternate power source to the associated switchboard (alternate power)

.4 If operation from the normal source of power includes more than one operating configuration, measurements shall be taken when plant is operating under the configuration that is calculated to produce the highest distortion.

## Part 3 Execution

### 3.1 REPORT FORMAT

.1 The results of the harmonics study shall be summarized in a final report. The report shall include the following attributes:

.1 Introduction and executive summary sections which include assumptions and recommendations. Reiterate assumptions stated elsewhere in the report.

.2 Copy of the project single line drawing(s).

.3 Printouts from SKM PowerTools for Windows software package of calculated harmonic currents and voltages. Include input data. Provide separate section for each scenario studied.

.4 Printouts from SKM PowerTools for Windows software package of calculated voltage waveforms at all significant buses and current waveforms on all significant circuits. Provide separate section for each scenario studied.

.5 Copies of manufacturer data on harmonic spectrum produced by each non-linear load in the system.

.6 All sections shall be clearly tabulated and shall include an index page for easy reference.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 Materials and installation for wire and box connectors.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.2 CSA C22.2No.65, Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.3 National Electrical Manufacturers Association (NEMA)

## Part 2 Products

### 2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of suitable material sized to fit conductors as required.

.2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

.3 Clamps or connectors as required to: CAN/CSA-C22.2No.18.

## Part 3 Execution

### 3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

**END OF SECTION**

## Part 1 General

### 1.1 RELATED SECTIONS

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

### 1.2 REFERENCES

.1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.

## Part 2 Products

### 2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

### 2.2 TECK CABLE

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

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Type: ethylene propylene rubber.

.2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: polyvinyl chloride material.

.7 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables.

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

.8 Connectors:

.1 Watertight, approved for TECK cable.

## 2.3 ALUMINUM SHEATHED CABLE

.1 Conductors: copper, size as indicated.

.2 Insulation: type RA90 rated 600 V.

.3 Sheath: aluminum applied to form continuous corrugated sheath.

.4 Outer jacket of PVC applied over sheath.

.5 Fastenings for aluminum sheathed cable:

.1 One hole steel straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm.

.2 Channel type supports for two or more cables.

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

## 2.4 FIBRE OPTIC CABLE

.1 Multimode fibre cable.

.2 Construction:

.1 Central strength member: Dielectric epoxy glass rod.

.2 Fibres: 250μm diameter buffer

.3 Buffer tubes: Polymer loose tubes c/w super absorbent polymer.

.4 Cable core: components cabled around a central strength member.

.5 Core separator: super absorbent tape between cable core and outer strength member.

.6 Outer strength member: torque balanced contra helical aramid yarn.

.7 Cable jacket: black, flame retardant, UV and moisture resistant polymer c/w ripcord applied under the jacket.

.8 Armour: aluminum interlocking armour.

.9 Armour jacket: flame retardant riser rated PVC.

.3 Fibre connectors to be ST type (twist style).

## 2.5 WIRING ACCESSORIES

.1 Wire markers, black letters on white background, shall be heat shrink type as manufactured by Critchley.

.2 Cable markers for cables or conductors greater than 13 mm diameter, shall be strap on type, rigid PVC, black letters on white background, with PVC covered aluminum straps, as manufactured by Electrovert Cat. No. 510.

.3 Terminal blocks shall be minimum 600 volt rated, modular, sized to accommodate conductor size used, as manufactured by Weidmuller, Phoenix, Allen-Bradley.

.4 Where screw type terminals are provided on equipment, field wiring shall be terminated with insulated fork tongue terminals, as manufactured by Thomas & Betts, Sta-Kon.

.5 Splice connectors for wire sizes #14 10 AWG inclusive, shall be of the compression spring type, as manufactured by Ideal Waterproof Type DP.

.6 Splice connectors for wire sizes #8 AWG and larger shall be split bolt type, sized to suit number and size of conductors, as manufactured by Burndy Servit Type KS.

.7 Cable ties shall be nylon, one piece, self locking type, as manufactured by Thomas & Betts, Burndy, Electrovert.

.8 Electrical insulating tape as manufactured by 3M Scotch 88.

.9 Cable grips shall be provided for all vertical and catenary cable suspension installations to reduce cable tension at connectors or at cable bends. The cable grips shall be selected to accommodate the type and geometry of cable supported and shall be of the single wave, variable mesh design, as manufactured by Kellems, Arrow-Hart.

.10 Cable pulling lubricant shall be compatible with cable covering and shall not cause damage and corrosion to conduits or ducts.

## Part 3 Execution

### 3.1 INSTALLATION – GENERAL

.1 Install all wire according to the drawings with a minimum size of #12 AWG unless indicated otherwise.

.2 Pull wire into ducts and conduits in accordance with the manufacturer's recommendations, using patented wire grips suitable for the type of wire or using pulling eyes to be installed directly onto the conductors.

.3 Limit pulling tensions to those recommended by the manufacturer to avoid overstressing wire.

.4 Utilize adequate lubricant when pulling wires through ducts and conduits to minimize wear on cable jackets.

.5 Make connections to equipment "pig tails" with mechanical, insulated, screw on connectors for wire sizes #14 10 AWG. For wire sizes #8 AWG and larger utilize split bolt connectors, taped with three layers minimum of insulating tape. For all terminations, wire through the conductor, apply joint compound anti-oxidant, and torque to lug manufacturer's recommended torque levels.

.6 No splices shall be permitted in cable or wiring runs without the written permission of the Contract administrator, and shall only be permitted in junction boxes.

.7 Neutral conductors shall be identified. Paint or other means of colouring the insulation shall not be used.

.8 Unless otherwise specified, make all wiring taps, splices and terminations with identified compression screw type terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Make connections for interior and exterior lighting circuits and 120 volt, 15 amp convenience receptacle circuits using screw on or split bolt connectors and insulating tape.

.9 Determine the exact length of cable required to avoid splices.

.10 Identify each conductor by specified markers at each termination indicating the circuit designation or wire number.

.11 Identify each cable by attaching a suitable marker, stamped or indelibly marked with the cable number, at each end of the cable and in all junction boxes and pull boxes.

## 3.2 INSTALLATION OF TECK CABLE 0 -1000 V

.1 Install cables.

.1 Group cables wherever possible on channels.

.2 Install cable in trenches in accordance with Section 26 05 44.

.3 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

## 3.3 INSTALLATION OF ALUMINUM SHEATHED CABLE

.1 Group cables wherever possible on channels.

.1 Install cable in trenches in accordance with Section 26 05 44.

.2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0-1000 V.

## 3.4 INSTALLATION OF FIBRE OPTIC CABLE

.1 Redundant fibre runs with each fibre in its own path as much as possible.

.2 New construction will have each fibre in separate conduit. Sharing fibre conduit with low voltage wiring shall be acceptable.

.3 Fibre quantities per cable shall be as follows:

.1 Two (2) fibres for transmit and receive for S800 I/O.

.2 One (1) fibre per four (4) video cameras. Video shall transmit over a four (4) channel single fibre multiplexer / demultiplexer pair. Acceptable manufacturer shall be Pelco No.FT8304 / FR8304.

.3 Two (2) fibres for transmit and receive for networking to the industrial PC.

.4 Four (4) spare fibres reserved for future networking.

.5 Two (2) fibres for connection to Public Address system. Confirm location of PA system panel in Dewatering Building Control Room at NEWPCC and Administration Building Control Room at SEWPCC.

.6 Two (2) fibres for connection to telephone system. Confirm location of PA system panel in Dewatering Building Control Room at NEWPCC and Administration Building Control Room at SEWPCC.

.7 Allocate minimum 50% spare quantity of fibre after total usage for I/O, networking, video, PA and telephone has been finalized.

**END OF SECTION**

## Part 1 General

### 1.1 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

### 1.2 REFERENCES

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

.2 Canadian Standards Association.

## Part 2 Products

### 2.1 EQUIPMENT

.1 Grounding conductors: bare stranded copper, soft annealed, sized to suit system amperage.

.2 Non-corroding accessories necessary for grounding system, type, size, material to suit equipment, including but not necessarily limited to:

- .1 Grounding and bonding bushings.
- .2 Protective type clamps.
- .3 Bolted type conductor connectors.
- .4 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.

## Part 3 Execution

### 3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including conductors, connectors, and accessories. Tie to station grounding grid.

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

.3 Protect exposed grounding conductors from mechanical injury.

.4 Make buried connections and connections to electrodes, using permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

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

.6 Soldered joints not permitted.

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

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

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

## 3.2 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of primary 600 V system, and secondary 208 V system.

## 3.3 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting.

## 3.4 COMMUNICATION SYSTEMS

.1 Install grounding connections for voice/data communication, fire alarm, and security systems in accordance with CEC and specific equipment manufacturer's recommendations.

## 3.5 FIELD QUALITY CONTROL

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

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Contract administrator and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator (where present) during tests.

**END OF SECTION**

## Part 1 General

### 1.1 SCOPE

.1 Refer to Section 26 05 01 for project electrical extent of work.

.2 Furnish all labour, materials, equipment and services specified, indicated or requested to install the electrical boxes specified herein and on the drawings.

## Part 2 Products

### 2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

### 2.2 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

### 2.3 CABINETS

.1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

.2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm plywood backboard for surface mounting.

## Part 3 Execution

### 3.1 SPLITTER INSTALLATION

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

### 3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor.

.3 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

## 3.3 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name voltage and phase.

**END OF SECTION**

## Part 1 General

### 1.1 REFERENCES

.1 CSA C22.1, Canadian Electrical Code, Part 1.

## Part 2 Products

### 2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

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

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

### 2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted conduit, minimum size 102 x 54 x 48 mm.

.3 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

### 2.3 MASONRY BOXES

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

### 2.4 CONCRETE BOXES

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

### 2.5 FLOOR BOXES

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to

accommodate short or long ear duplex receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.

**2.6 CONDUIT BOXES**

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

**2.7 FITTINGS - GENERAL**

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

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

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

**END OF SECTION**

## Part 1 General

### 1.1 SCOPE

.1 Refer to Section 26 05 01 for project electrical extent of work.

.2 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install a complete conduit raceway system. The raceway systems shall be comprised of the supply and installation of all conduits, fittings, supports, hangers and miscellaneous support materials and hardware required.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

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

.3 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

### 1.3 LOCATION OF CONDUIT

.1 The drawings do not show every specific conduit run. All wiring shall be surface and as run in the slab unless otherwise indicated in the specifications and/or shown on the drawings. All devices shall be surface mounted type except as shown.

## Part 2 Products

### 2.1 CONDUITS

.1 Conduit in ordinary areas and humid corrosive environments shall be Rigid P.V.C. Minimum size to be 19 mm.

.2 Conduit in hazardous areas shall be threaded rigid aluminium epoxy coated conduit with zinc coating and corrosion resistant epoxy finish inside and outside. Minimum size to be 12 mm.

.3 Liquid-tight flexible metal conduit for motor and equipment connections.

.4 EMT conduit shall not be utilized anywhere in the installation.

### 2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.

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

.3 Channel type supports for two or more conduits.

.4 Threaded rods, 6 mm dia., to support suspended channels.

**2.3 CONDUIT FITTINGS**

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90E bends are required for 25 mm and larger conduits.

**2.4 EXPANSION FITTINGS FOR CONDUIT**

.1 All conduits entering outlet boxes and devices that are located in walls subject to movement shall be terminated by means of liquid-tight flexible conduit, approximately 450 mm in length between the conduit and the outlet box or device which is being supplied. All conduits, bus duct, wireways, etc., passing through or across expansion joints of the building shall be installed with the use of approved expansion fittings.

**2.5 FISH CORD**

.1 Polypropylene.

**Part 3 Execution**

**3.1 INSTALLATION**

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

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.3 Use rigid pvc conduit unless otherwise noted.

.4 Use rigid pvc conduit underground and in cast concrete.

.5 Use flexible metal conduit for connection to motors.

.6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.7 Minimum conduit size: 19 mm.

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

.9 Mechanically bend steel conduit over 19 mm dia.

.10 Install fish cord in empty conduits.

.11 Run 2-50 mm spare conduits up to ceiling space and 2-50 mm spare conduits down to crawlspace from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.

.12 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.13 Dry conduits out before installing wire.

**3.2 SURFACE CONDUITS**

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended channels.

.5 Do not pass conduits through structural members except as permitted by the Contract Administrator

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

**3.3 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 or concrete toppings.

**3.4 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 Do not place conduits is slabs in which slab thickness is less than 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

## 3.5 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

**END OF SECTION**

## Part 1 General

### 1.1 GENERAL REQUIREMENTS

.1 All Sections of General Requirements form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.

.2 Refer to all other Sections of the Specifications and these Documents to determine their effect upon the work of this Section.

.3 All Sections of specification form part of the Contract Documents.

### 1.2 SCOPE

.1 Furnish all labour, materials, supervision, equipment and services specified, indicated of requested to provide all trenching and backfilling as necessary for the installation of all underground cables, etc, as indicated.

### 1.3 QUALITY ASSURANCE

.1 Installation of cables in trenches and ducts shall meet the requirements of CSA C22.1 – revised to date, Canadian Electrical Code.

## Part 2 Products

### 2.1 TRENCHING AND BACKFILLING

.1 Trenching shall be approximately 1000 mm in depth, width to suit proper installation

.2 Backfill for trenches for all direct buried cables, ducts, conduits, etc, shall consist of fine sand (minimum 100 mm below and above cables, etc.) and firmly compacted

.3 All direct buried cables, ducts, etc, crossing over each other or over/under other types of underground service shall be encased in wood planks treated with pentachlorophenol.

.4 Frozen earth, large lumps or boulders shall not be used for backfill material.

.5 Provide treated wood planks meeting City of Winnipeg approved wood treatment materials over all buried cables, etc, under existing or future roads and sidewalks.

.6 Provide sleeves under all parking, concrete and traffic areas for cables.

.7 Where cables enter building provide a vertical 100 x 250 mm white sign with black wording ELECTRICAL CABLES securely fastened to the building wall approximately 300 mm above finished grade.

### 2.2 CABLE PROTECTION

.1 Provide identification tape labeled as indicated showing location of direct buried cables.

## Part 3 Execution

### 3.1 DIRECT BURIAL OF CABLES

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

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

.3 Underground cable splices are not acceptable

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

.5 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossing.

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

## 3.2 FIELD QUALITY CONTROL

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

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

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

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

.5 Pre-acceptance tests:

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

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

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

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

.8 Contractor responsible for making all necessary repairs to installation resulting from improper backfilling, compactions, etc.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

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

### 1.2 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

### 1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

- .1 CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
- .2 CSA C9, Dry-Type Transformers.

.2 National Electrical Manufacturers Association (NEMA)

### 1.4 SUBMITTALS

.1 Submit shop drawings in accordance with E4. At a minimum shop drawings to include:

- .1 Voltage ranges and taps
- .2 KVA rating
- .3 Mounting configurations
- .4 Weight
- .5 Cable terminal sizes
- .6 Nameplate data.

.2 Include transformer literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results - Electrical.

## Part 2 Products

### 2.1 TRANSFORMERS

.1 Use transformers of one manufacturer throughout project.

.2 Design.

- .1 Type: Epoxy encapsulated
- .2 Three phase, 600V delta connected primary, 120/208V wye connected secondary
- .3 kVA rating as indicated on drawings
- .4 Operating frequency of 60 Hz
- .5 Winding insulation of 1000 V class, 115 degree temperature rise
- .6 Maximum impedance of 5%

.7 Sound rating of 40 dB

.8 Basic Impulse Level (BIL) is standard

.9 Hipot is standard

.10 Taps 4 - 2 1/2 percent FCAN, FCBN

.11 Air ventilated via louvres

.12 Termination at bottom of transformer

.13 Finish: in accordance with Section 26 05 01 - Common Work Results - Electrical.

**2.2 EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Label size: 7.

**2.3 MANUFACTURERS**

.1 Acceptable manufacturer is Hammond, Square "D", Bemag.

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Mount dry type transformers as indicated.

.2 Ensure adequate clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

.5 Loosen isolation pad bolts until no compression is visible.

.6 Make primary and secondary connections in accordance with wiring diagram.

.7 Energize transformers after installation is complete.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 Materials and installation for standard and custom breaker type panelboards.

### 1.2 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

.2 Section 26 28 21 - Moulded Case Circuit Breakers.

### 1.3 REFERENCES

.1 All equipment to CSA Standard C22.2 No. 29 M1989.

.2 Fault current ratings to be indicated on nameplates.

### 1.4 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

.2 Include panelboard literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

## Part 2 Products

### 2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2No.29 and product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 and 600 V panelboards: bus and breakers rated for 42,000 A (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.

.6 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.

.7 Panelboards to have flush doors. (Gasketted where required).

.8 Two keys for each panelboard and key panelboards alike.

.9 Provide "sprinkler-proof" design in areas where sprinkler fire protection is installed. In any event, all surface mounted enclosures to be complete with sprinkler drip cover.

.10 Copper bus with neutral of same ampere rating as mains.

.11 Mains: suitable for bolt-on breakers.

.12 Trim with concealed front bolts and hinges.

.13 Trim and door finish: baked grey enamel.

## 2.2 BREAKERS

.1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.

.2 All breakers to be bolt on type, moulded case, non adjustable and non interchangeable trip, single, two and three pole, 120/208 (240)V or 347/600V and with trip free position separate from "On" or "Off" positions.

.3 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard. Minimum interrupting rating of breakers to be as follows:

.1 347/600V panelboards - 14,000 Amps at 347 volts.

.2 120/208V panelboards - 10,000 Amps at 250 volts.

.4 Main breaker to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.5 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules.

.6 Provide at least 10% spare 15 Amp single pole breakers whether indicated or not.

.7 Provide GFI type breakers as indicated.

.8 Provide Lock-on devices as indicated and in any event for Fire Alarm circuits, Security equipment circuits, EXIT sign circuits and Emergency Battery equipment circuits.

.9 EEMAC 4X enclosure in corrosive environments, EEMAC 12 enclosure in ordinary areas.

## 2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Nameplate for each panelboard size 4 engraved.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

.5 Complete circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a "letter sized" paper copy of each directory in the project maintenance manual.

.6 Provide a plasticized typewritten information card fixed to the back of the each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a "letter sized" paper copy of each information card in the project maintenance manual.

## 2.4 STANDARD OF ACCEPTANCE

.1 Cutler Hammer, Type PRL. Door within door trim where indicated.

.2 Schneider, Type NQOD. Door within door trim where indicated.

# Part 3 Execution

## 3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.

.3 Mount panelboards to height specified in Section 26 05 01 - Common Work Results - Electrical or as indicated.

.4 Connect loads to circuits as indicated.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

.6 Install 4x27mm [1"] empty conduits (or equivalent) from each flush mounted panelboard single tub to ceiling space above and 2x27mm [1"] empty conduits (or equivalent) from each flush mounted panelboard single tub down to ceiling or space below where space exists. Refer also to Section 26 05 34 "Conduits, Conduits Fastenings And Conduit Fittings"

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 This section describes the supply and installation of additional sections in existing Digester Building motor control centres MCC 3D and MCC 4D.

### 1.2 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

.2 Section 26 28 21 - Circuit Breakers

.3 Section 26 29 10 - Motor Starters

.4 Section 26 29 11 - Variable Frequency Drives

.5 Section 26 43 13 – Surge Suppressors

### 1.3 QUALITY ASSURANCE

.1 Conduct equipment inspection at manufacturer's plant.

.2 Provide manufacturer's type test certificates.

.3 The Contract Administrator reserves the right to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

.4 Submit written test results to the Contract Administrator.

### 1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with E4. Indicate:

- .1 Outline dimensions.
- .2 Configuration of identified compartments.
- .3 Floor anchoring method and dimensioned foundation template.
- .4 Cable entry and exit locations.
- .5 Dimensioned position and size of busbars and details of provision for future extension.
- .6 Schematic and wiring diagrams

### 1.5 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for motor control centre for incorporation into the Operation and Maintenance Manual as specified in Section 26 05 01.

.2 Include data for each type and style of starter.

### 1.6 MAINTENANCE MATERIALS

.1 Provide maintenance materials in accordance with Section 26 05 01.

.2 Provide listed spare parts for each different size and type of starter:

- .1 2 sets of contacts, stationary
- .2 2 sets of contacts, movable
- .3 1 set of contact, auxiliary
- .4 1 control transformer for each VA rating
- .5 1 operating coil for each starter size supplied
- .6 2 fuses of each rating
- .7 4 indicating lamps for each type provided
- .8 2 relays for each type provided

### 1.7 CODES AND STANDARDS

.1 Materials and workmanship shall comply with codes and standards of the Province in which the work is located and local codes, regulation and standards.

.2 In addition the work shall conform to the latest editions and amendments of the applicable Codes and Standards of the following agencies:

- .1 EEMAC Standard ICS2-322.
- .2 CSA Standard C22.2 No. 14-M1987, "Industrial Control Equipment".
- .3 CSA Standard C22.1, Canadian Electrical Code, Part I plus Provincial supplements.
- .4 Applicable sections of ANSI (American National Standards Institute) Standards.
- .5 All equipment to be CSA approved.

### 1.8 GUARANTEE

.1 The performance of the motor control centre equipment shall be guaranteed throughout to perform the duty stated herein in accordance with General Conditions.

## Part 2 Products

### 2.1 SUPPLY CHARACTERISTICS

.1 Existing motor control centres MCC 3D and MCC 4D are rated 347/600 V, 60 Hz, 3 phase, 4 wire.

### 2.2 EXISTING MOTOR CONTROL CENTRES GENERAL DESCRIPTION

.1 Compartmentalized vertical sections with common power busbars.

.2 Floor mounting, free standing, enclosed dead front.

.3 Accommodating incoming cable to enter at bottom.

.4 Class 2, Type C.

.5 Motor circuit protector combination starters.

.6 Sprinkler proof EEMAC 12 enclosure.

**2.3 NEW VERTICAL SECTION CONSTRUCTION**

.1 Independent vertical sections fabricated from rolled flat steel sheets, bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 305 mm high.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.

.5 Vertical wireways for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.

.7 Provision for outgoing cables to exit via top and bottom.

.8 Removable lift means.

.9 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

**2.4 SILLS**

.1 Continuous 100 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

**2.5 BUSBARS**

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment insulated self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:

.1 Main horizontal busbars: match existing.

.2 Branch vertical busbars: match existing.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace bus-work to withstand effects of short-circuit current of 42 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

**2.6 GROUND BUS**

.1 Tin plated copper bus size 50mm x 6mm extending entire width of motor control centre, located at top.

**2.7 STARTER UNIT COMPARTMENTS**

.1 Units EEMAC size 4 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating silver plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Devices and components by one manufacturer to facilitate maintenance.

.7 All starters and contactors to have two N.O. and two N.C. spare contacts wired to terminal blocks.

**2.8 WIRING AND TERMINAL BLOCKS**

.1 The shop installed wiring arrangement shall be as indicated. For Type B wiring, all control connections to be brought to terminal blocks within each starter compartment. Provide a minimum of 10 spare terminal blocks for #12 AWG incoming control wiring.

.2 Incoming and outgoing power cables and conduits shall enter the MCC's from the top

.3 Provide internal power wiring from the line side of each starter to the bus stabs with a minimum of #12 AWG wire rated for 600 volt duty. Size wiring to accommodate the largest horsepower that the line starter is capable of switching.

.4 Control wiring shall be as 600 V rated, XLPE insulated, minimum #14 AWG size. Install wiring to panel doors utilizing extra flexible 49-strand conductors.

.5 All internal wiring shall employ stranded copper conductors.

.6 Identify all wiring by means of heat shrink type wire markers as manufactured by Critchley fixed to each conductor at both ends.

.7 Wires shall be colour coded as follows:

.1 Control circuits – Red

.2 Power circuits – Black

.8 Terminal blocks shall be of the compression type and shall be of modular pull-apart construction enabling unit wiring to be easily separated from the field wiring. Identify all terminal blocks with numbers identical to the wire numbers.

.9 No more than two wires shall be placed under each terminal screw.

## 2.9 INCOMING LINE TERMINATION

.1 Provide pressure type cable lugs and bus adapters or extensions suitable for terminating the main incoming cable conductors. The lugs shall accommodate the number and size of cables as indicated. Cable entry shall be from the top of the MCC.

## 2.10 SPACE FOR FUTURE UNITS

.1 Provide spaces for starters or switching units in the MCC's for equipment designated "Future". Fully equip these spaces with horizontal and vertical bus bars and all fittings necessary to accommodate the future equipment with a minimum of field alterations and additions. Provide bolted-on blank covers.

## 2.11 WIRING IDENTIFICATION

.1 Provide wiring identification in accordance with Section 26 05 01.

## 2.12 EQUIPMENT IDENTIFICATION

.1 Provide motor control centre main nameplate and individual compartment nameplates identification engraved in accordance with Section 26 05 01.

## 2.13 EXISTING MCC 3D NEW SECTION LAYOUT

.1 Leachate Pump LP-3:

.1 30A, 600V, 3P breaker

.2 Variable Speed Drive, 7.5HP, 575V, 3P, c/w line and load reactor

.3 1 – “Hand-Off-Auto” selector switch

.4 1 – Timer ON-Delay, time range 10min, adjustable

.5 2 – Control relays, coil 120VAC, 4PDT contacts 6A

.2 Leachate Pump LP-4:

.1 30A, 600V, 3P breaker
.2 Variable Speed Drive, 7.5HP, 575V, 3P, c/w line and load reactor
.3 1 – "Hand-Off-Auto" selector switch
.4 1 – Timer ON-Delay, time range 10min, adjustable
.5 2 – Control relays, coil 120VAC, 4PDT contacts 6A

.3 2 – Spaces

**2.14 EXISTING MCC 3D NEW SECTION LAYOUT**

.1 Leachate Pump LP-5:

.1 30A, 600V, 3P breaker
.2 Variable Speed Drive, 7.5HP, 575V, 3P, c/w line and load reactor
.3 1 – "Hand-Off-Auto" selector switch
.4 1 – Timer ON-Delay, time range 10min, adjustable
.5 2 – Control relays, coil 120VAC, 4PDT contacts 6A

.2 4 – Spaces

**2.15 FINISHES**

.1 Apply finishes in accordance with Section 26 05 01.

.2 Paint motor control centre exterior ASA 61 light grey enamel and interiors white.

**2.16 MANUFACTURER**

.1 New MCC sections to match existing Westinghouse 5 Star type MCC 3D and MCC 4D in Digester Building West Electrical Room. Fabrication of custom built MCC shall be by acceptable panel manufacturer as specified in Section 40 14 00.

## Part 3 Execution

**3.1 SHOP ASSEMBLY**

.1 Shop assembly shall be maximized, to minimize the on-site erection work. Equipment should thus be shipped in as few subassemblies as is practical and in accordance with overall erection schedule.

.2 Containers and components clearly identified for transportation and field assembly.

**3.2 PACKAGING AND SHIPPING.**

.1 Each item shall be packed, crated or otherwise protected so that it is not damaged in transit and arrives in serviceable condition at the site. In particular, measures shall be taken to prevent accumulation of water in equipment.

.2 Crates, boxes and cartons shall be clearly marked to indicate the purchase order number and the name of the equipment.

.3 Shipping invoice shall show the crate, box or carton number.

.4 All finished rubbing surfaces which are not assembled in the shop shall be adequately protected during shipment by wrapping with burlap or canvas or other means which shall be secured by wooden batts securely wired together.

## 3.3 INSTALLATION AND TESTING

.1 Install embedded floor channels where applicable.

.2 Set and secure MCC's in place, rigid, plumb and square, on channel bases.

.3 Interconnect MCC cubicles with bus bar and wiring connectors supplied by manufacturer.

.4 Check factory-made connections for mechanical security, electrical continuity, and current phasing.

.5 Make grounding connections between equipment ground busses and building grounding system.

.6 After finishing work, remove foreign material, including dust, before energizing equipment.

.7 Perform all tests in accordance with Section 26 05 01.

.8 Make all power and control field wiring connections.

.9 Check overload trip unit settings against drawings and motor nameplate data.

.10 Ensure moving and working parts are lubricated where required.

.11 Operate starters in sequence to provide satisfactory performance of motor control centre during 8 hour period.

## 3.4 COMMISSIONING

.1 The motor control manufacturer shall include for the testing and commissioning of the complete systems and instruct the City's personnel in the operation of the systems.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

### 1.2 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

### 1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.3 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

### 1.4 SUBMITTALS

.1 Submit shop drawings in accordance with E4.

.2 Include wiring devices literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results - Electrical.

## Part 2 Products

### 2.1 SWITCHES

.1 Extra heavy duty specification grade.

.2 20 A, 120 V or 347 V, single pole, double pole, three-way, four-way switches as indicated.

.3 Manually-operated general purpose ac switches as indicated and with following features:

.1 Terminal holes approved for No. 10 AWG wire.

.2 Silver alloy contacts.

.3 Urea or melamine moulding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 White toggle (red toggle for emergency power circuits).

.4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.5 Switches of one manufacturer throughout project.

.6 Standard of acceptance:

.1 Hubbell HBL.1221 20A series
.2 Leviton 1221-20A 120V series – 18221 347V
.3 Pass & Seymour PS20AC1 120V series – PS37201(3)0 347V

## 2.2 RECEPTACLES - GENERAL

.1 Extra heavy duty specification grade.

.2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:

.1 White nylon molded housing (red for emergency power circuits)
.2 Suitable for No. 10 AWG for back and side wiring.
.3 Break-off links for use as split receptacles.
.4 Eight back wired entrances, four side wiring screws.
.5 Triple wipe contacts and rivetted grounding contacts.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

.5 Standard of acceptance:

.1 Hubbell 5252 heavy duty, construction series
.2 Leviton 5262 series
.3 Pass & Seymour 5262 series

## 2.3 RECEPTACLES – PARTICULAR APPLICATION

.1 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button. Equal to:

.1 Hubbell GF8200A series
.2 Leviton 7599HG series
.3 Pass & Seymour HG1595 series (Décor)

.2 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.

**2.4 COVER PLATES**

.1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. For general interior flush mounted wiring devices and surface type FS or FD type boxes.Cover plates from one manufacturer throughout project.

.2 Nylon plates: Heavy duty, unbreakable and flush. All nylon plates to match wiring device color.

.3 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.

.4 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.

.5 All plates to be bevelled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.

.6 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.

.7 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Coverplates to fasten to box by four screws.

.8 Gaskets: resilient rubber or close cell foam urethane.

.9 Cover plates for all wiring devices to be from one manufacturer throughout project.

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.3 Mount toggle switches at height in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.

.3 Mount receptacles at height in accordance with Section 26 05 01 - Common Work Results - Electrical.

.3 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

## Part 1 General

### 1.1 RELATED SECTIONS

.1 Section 26 24 17 – Panelboards Breaker Type.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

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

### 1.3 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Include time-current characteristic curves for breakers.

.2 Include circuit breaker literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results - Electrical.

## Part 2 Products

### 2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers: to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Circuit breakers to have minimum interrupting capacity rating as indicated.

### 2.2 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

.2 Series rated breakers to be manufacturer tested and listed. Breakers to be applied following manufacturer's guidelines and accepted best practice.

## Part 3 Execution

### 3.1 INSTALLATION

.1 Install circuit breakers as indicated.

**END OF SECTION**

## Part 1 General

### 1.1 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4, Enclosed Switches.

.2 CSA C22.2 No.39, Fuseholder Assemblies.

### 1.3 SUBMITTALS

.1 Submit shop drawings in accordance with E4.

.2 Include circuit breaker literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

## Part 2 Products

### 2.1 DISCONNECT SWITCHES

.1 "Heavy Duty" class, enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4

.2 Fuseholder assemblies to CSA C22.2 No.39.

.3 Fusible and non-fusible disconnect switch in CSA enclosure.

.4 Provision for padlocking in off switch position.

.5 Fuses as indicated. Allow for Class J or L for general circuits, Class RK5 for transformer, motor or other high inrush current circuits

.6 Fuseholders in each switch suitable without adaptors, for type of fuse as indicated.

.7 Quick-make, quick-break action.

.8 ON-OFF switch position indication on switch enclosure cover.

.9 Weatherproof as required.

### 2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

**2.3 STANDARD OF ACCEPTANCE**

.1 Cutler Hammer – Heavy Duty

.2 Schneider - Heavy Duty

.3 Siemens - Heavy Duty

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Install disconnect switches complete with fuses where indicated or required.

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

**3.2 MOTOR PLUG/RECEPTACLE AND QUICK DISCONNECTS**

.1 Motor quick disconnects do not negate the requirement for a switched safety disconnect as specified in this Division. A separate disconnect is still required unless the Contract Administrator has given a special pre-approved circumstance.

**END OF SECTION**

## Part 1 General

### 1.1 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

.2 Section 26 24 19 - Motor Control Centre

### 1.2 REFERENCES

.1 International Electrotechnical Commission (IEC)

.1 IEC 947-4-1, Part 4: Contactors and motor-starters.

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with E4. Include:

.1 Mounting method and dimensions.
.2 Starter size and type.
.3 Layout of identified internal and front panel components.
.4 Enclosure types.
.5 Wiring diagram for each type of starter.
.6 Interconnection diagrams.

.2 Include motor starter literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

### 1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include operation and maintenance data for each type and style of starter.

### 1.5 EXTRA MATERIALS

.1 Provide listed spare parts for each different size and type of starter:

.1 3 contacts, stationary.
.2 3 contacts, movable.
.3 1 contact, auxiliary.
.4 1 control transformer.
.5 1 operating coil.
.6 2 fuses.
.7 10% indicating lamp bulbs used.

**Part 2 Products**

**2.1 MANUAL MOTOR STARTERS**

.1 Not Applicable.

**2.2 FULL VOLTAGE MAGNETIC STARTERS**

.1 Not Applicable.

**2.3 SOFT START MOTOR STARTERS**

.1 Solid-state "Soft Start" combination starters of size, type, and rating, with components as follows:

.1 Contractor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 MCP circuit breaker with operating lever on outside of enclosure to control motor current protector and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Locking in "ON" position.

.3 Independent locking of enclosure door.

.4 Provision for preventing switching to "ON" with enclosure door open.

.4 Thermistors type protection relay, to match sensors provided in the motor windings, c/w alarm pilot light and manual reset.

.5 Solid-state motor controller c/w interphase option and the following features:

.1 Soft start adjustable 2 to 30 seconds

.2 Soft stop adjustable 5 to 110 seconds

.3 Current limit

.6 Accessories:

.1 Pushbuttons and selectors switches: Standard heavy duty oil tight labelled as indicated.

.2 Indicating lights: Push-to-Test transformer heavy duty oil tight type and colour as indicated.

.3 2-N/O and 2-N/C spare auxiliary contact unless otherwise indicated.

.7 Terminal blocks to be Weidmuller SAK Series or approved equal.

.1 Power and control terminals

.2 Wiring and schematic diagram inside starter enclosure in a visible location.

**2.4 CONTROL TRANSFORMER**

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 100% spare capacity.

**2.5 FINISHES**

.1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results - Electrical.

**2.6 EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, size 1 engraved as indicated.

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Install starters, connect power and control as indicated.

.2 Install auxiliary contacts and connect wiring.

.3 Ensure correct MCP settings and overload devices elements installed.

.4 Manual motor starters shall be mounted 1500 mm above finished floor level to top of starter enclosure.

**3.2 FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 This section describes the supply and installation of all variable frequency drives.

### 1.2 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

.2 Section 26 24 19 - Motor Control Centre.

### 1.3 REFERENCES

.1 CSA C22.2 No. 14-M91—Industrial Control Equipment.

.2 IEC 529—Degrees of Protection Provided by Enclosure.

.3 NEMA ICS7—Industrial Control and Systems Adjustable Speed Drives.

.4 NEMA ICS 7.1—Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives.

.5 UL 508—UL Standard for Safety Industrial Control Equipment.

.6 UL 508C—UL Standard for Safety Power Conversion Equipment.

### 1.4 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Submittal to include standard catalogue sheets showing the following for each different Horsepower rated AC Drive provided:

- .1 Voltage.
- .2 Horsepower.
- .3 Maximum current ratings.
- .4 Recommended replacement parts with part numbers.

.2 Include VFD literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical

### 1.5 QUALITY ASSURANCE

.1 The AC Drive and all associated optional equipment shall be CSA certified. As verification, a CSA label shall be attached on the side of the drive controller.

## Part 2 Products

### 2.1 MANUFACTURER

.1 The AC Drive shall be provided by ABB Canada Inc., Type ACS800.

.2 Alternate control techniques other than sine wave by pulse width modulated (PWM) are not acceptable.

### 2.2 GENERAL DESCRIPTION

.1 The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined in the following sections.

.2 The input power section shall contain an integrated line reactor. The line reactor should provide a minimum of 4% impedance based on the drive operating at it's continuous output current rating.

.3 The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. This power section shall be insensitive to phase rotation of the AC line. The DC voltage shall be filtered.

.4 The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilize insulated gate bipolar transistors (IGBTs) or intelligent power modules (IPMs) as required by the current rating of the motor

### 2.3 MOTOR DATA

.1 The AC Drive shall be sized to operate the following AC motor :

.1 Motor Horsepower: as indicated.
.2 Motor RPM: 1800; 60Hz.
.3 Motor voltage: 575 VAC.
.4 Motor service factor: 1.15

### 2.4 APPLICATION DATA

.1 The AC Drive shall be sized to operate a constant torque load.

.2 The motor speed range shall be from a minimum speed of 1.0 Hertz to a maximum speed of 60 Hertz.

.3 The AC drive shall have, as a minimum, a 5:1 turndown ratio.

### 2.5 ENVIRONMENTAL RATINGS

.1 The AC Drive shall be of construction that allows operation in a pollution Degree 2 environment.

.2 The AC Drive shall be designed to operate in an ambient temperature from $-10^0$ to + $40^0$C.

.3 The storage temperature range shall be $-40^0$ to $+ 70^0$ C.

.4 The maximum relative humidity shall be 95% at $40^0$C, non-condensing.

.5 The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 ft. (1000m). For altitudes above 3,300 ft., derate the AC Drive by 1% for every 300 ft. (100 m).

**2.6 RATINGS**

.1 The AC Drive shall be designed to operate from an input voltage of 525 to 690 VAC +/- 10%.

.2 The AC Drive shall operate from an input voltage frequency range from 45 to 66 Hertz.

.3 The displacement power factor shall not be less than .96 lagging under any speed or load condition.

.4 The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.

.5 The constant torque rated AC Drive overcurrent capacity shall be not less than 150% for 1 minute.

.6 The output carrier frequency of the AC Drive shall be selectable from 1.0 to 6 KHZ depending on Drive rating. For low noise operation, derating may be required.

.7 The output frequency shall be from 0.1 to 320 Hertz.

.8 The AC drive will incorporate Sensorless Flux Vector control technology for increased starting torque and better dynamic speed control performance.

**2.7 PROTECTION**

.1 Upon power-up the AC Drive shall automatically test for valid operation of memory, dynamic brake failure, power and the pre-charge circuit.

.2 The Power Converter shall be protected against short circuits between, output phases, output phases and ground. The AC Drive shall safely shut down without damaging any power circuit devices.

.3 For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function should provide up to 10 programmable restart attempts with Lock-out after the last attempt. The programmable time delay before restart attempts will range from 1 to 60 seconds. This feature can be defeated if not required.

.4 The rotating motor auto start on power-up function could be enabled/disabled if required.

.5 The AC Drive shall be capable of running without a motor connected for setup and testing.

.6 The deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, emergency stop and DC injection braking.

.7 Upon a loss of the analog process follower reference signal, the AC drive shall fault and/or operate at a user defined speed set between software programmed low speed and high speed settings.

.8 The AC drive shall have solid state $I^2t$ protection that is UL listed and meets UL 508 as a Class 10 overload protection and meets IEC 947. The minimum adjustment range shall be from 50 to 110% of the current output of the AC Drive.

.9 There shall be a minimum of 2 skip frequency ranges that can each be programmed with a programmable bandwidth from 0 to 10Hz. The skip frequencies shall be programmed independently, back to back or overlapping.

.10 The AC Drive shall have an internal over temperature protection.

## 2.8 ADJUSTMENTS AND CONFIGURATIONS

.1 If required, a password should be available to allow the terminal keypad to be locked out from unauthorized personnel.

.2 The acceleration and deceleration ramp times shall be adjustable from 0.1 to 3000.0 seconds.

.3 The memory shall retain and record run status, operating time, fault type of the past 10 faults.

.4 Slip compensation shall be a software enabled function.

.5 The AC drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator continuously, at start and/or at stop. The level of current will be adjustable between 15-150% of rated current.

.6 As a minimum, the following parameters shall be accessible:

- .1 Maximum speed
- .2 Minimum speed
- .3 Current limit
- .4 Thermal overload
- .5 Restart limit
- .6 Skip frequency and bandwidth
- .7 Preset speed

## 2.9 OPERATOR INTERFACE

.1 The operator interface terminal should feature and alphanumeric display with seven indicators for speed controller status (Run, direction, ready stop, alarm, fault) and three

indicators for control (I/O terminal, keypad, bus/communication). There are also three LEDs indicators green/red/amber for Ready, Run, Fault. The terminal should allow the modification of AC drive adjustments via a keypad. All electrical values, configuration parameters, application and activity function access, faults, local control, adjustment storage will be in plain English.

.2 The display will be a high resolution, LCD backlighted screen capable of displaying two lines of alphanumeric characters. The use of coded or abbreviated displays shall not be acceptable.

.3 The following monitoring values shall be accessible and available when in the operating mode:

.1 Frequency (Hz) and/or motor speed (RPM)

.2 Motor current (A), motor voltage (V), motor torque (%), motor power (%)

.3 Drive temperature ($^{o}$C)

.4 Motor temperature (%)

.5 Values or status of analog I/O, digital I/O

.4 The operator terminal shall allow the user to display up to three user selectable monitoring values on the same screen at a time.

.5 The operator terminal shall offer a general menu consisting of parameter setting, fault history, and drive configuration. A software lock with password will limit access to the main menu or parameters.

.6 There will be function keys that allowing the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.

.7 A data entry key will allow the user to confirm a selected menu or numeric value.

.8 The following control functions shall be available on the keypad:

.1 Start

.2 Stop

.3 Select

.4 Reset

.5 Direction control

.9 A RESET key will allow a parameter to return the existing value if adjustment is not required and the value is displayed.

.10 The AC drive shall have a LED on the keypad to indicate RUN status of the drive.

## 2.10 CONTROL

.1 External pilot devices shall be able to be connected to a terminal strip for starting/stopping the AC Drive, speed control and displaying operating status. All outputs will be software assignable.

.2 The control power for the digital inputs and outputs shall be 24 VDC.

.3 There will be two (2) analog inputs. The analog inputs will be hardware selectable and consist of the following configurations: 0(4)–20 mA, 0-10V, or +/-10V.

.4 There will be six (6) digital input that shall be individually user assignable to perform the various control functions available.

.5 There will be one (1) software assignable analog output that can be selected and assigned in the software. The analog output assignments shall be programmable 0(4)-20 mA or 0-10V.

.6 Two form "C" configurable relay output contacts and an open collector output (24 VDC) to power a relay or pilot light, shall be provided. Each shall be programmable to indicate one of the following:

.1 Run
.2 Fault
.3 Ready
.4 At speed
.5 Current limit
.6 Follower present
.7 Auto speed mode
.8 Reverse indicator
.9 PID control active
.10 Over-temperature alarm

.7 There shall be available additional hardware input / output cards for incorporating alternate control signals including AC voltage logic inputs, PTC thermistor inputs and encoder feedback inputs.

## 2.11 COMMUNICATIONS

.1 The AC Drive shall include an interface to allow for addition of optional communication cards. The communication cards shall be available for the following protocols: Modbus and Ethernet IP.

# Part 3 Execution

## 3.1 INSPECTION

.1 Verify that the location is ready to receive work and the dimensions are as indicated.

.2 Do not install AC Drive until the building environment can be maintained with the service conditions required by the manufacturer.

## 3.2 PROTECTION

.1 Before and during the installation, the AC Drive equipment shall be protected from site contaminants.

## 3.3 INSTALLATION

.1 AC drives shall be installed in the motor control centre as indicated. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.

## 3.4 TRAINING

.1 An on-site training course of 1 day shall be provided by a representative of the AC Drive supplier to plant and / or maintenance personnel.

## 3.5 INSPECTION

.1 The supplier of AC Drive shall have a factory trained service representative available on site within 48 hours of notification. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 This section covers the supply and installation of all transient voltage surge suppressors.

### 1.2 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Include:

.1 Unit dimensions, mass, installation instruction details and wiring configuration.

.2 Clamping voltage test data, in a graph form, for a Category B3 ringwave and a Category B3 combination wave, as defined by ANSI/IEEE C62.41 and tested in accordance with ANSI/IEEE C62.45.

.3 Insertion loss test data, in a graph form, over a frequency bandwidth from 0 to 100 MHz and tested in accordance with MIL-STD 220A.

.4 A nameplate showing the electrical ratings, including UL 1449 surge suppression ratings and the UL and CSA monograms, shall be permanently affixed to the unit.

.2 Include surge suppressor literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

## Part 2 Products

### 2.1 GENERAL PRODUCT

.1 The transient voltage surge suppressors (TVSS) described by this specification are to be installed in the various panels as indicated.

.2 All TVSS devices shall be listed under UL 1449 and certified by CSA.

.3 TVSS device enclosure shall be rated EEMAC 12

### 2.2 SPECIFIC PRODUCT REQUIREMENTS

.1 TVSS device installed on the MCC shall be suitable for a Category C3 environment in accordance with ANSI/IEEE C62.41.

.2 TVSS device shall be wired in parallel into the electrical system.

.3 TVSS device shall feature full-cycle tracking clamping profiles that follow the AC sine wave contour for uniform transient voltage surge suppression regardless of phase angle.

.4 TVSS device circuit shall be a MOV-based, hybrid design; surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform shall be rated and internally fused to a

minimum of 100kA in relation to available interrupting capacity (AIC) per phase and provide equal impedance paths to each matched MOV bank. TVSS device design shall not be based on components such as gas tubes, which may crowbar the system.

.5 The maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage.

.6 TVSS devices shall protect against surges between phase and neutral (L-N) and neutral and ground (N-G) in wye configured systems (four-mode TVSS device). TVSS devices for branch panels shall protect against surges between phase and neutral (L-N), phase and ground (L-G) and neutral and ground (N-G) in wye configured systems (seven-mode TVSS device). All delta configured systems shall be protected between phases (L-L) and phase to ground (L-G).

.7 TVSS devices shall be capable of sustaining a single pulse transient current (based on a single pulse 8 x 20μs waveform specified in IEEE C62.45) of 150 kA in the L-N mode for wye configured systems, or L-L and L-G for delta configured systems, and 50kA in the N-G mode. TVSS devices for branch panels shall be capable of sustaining a single pulse transient current (based on a single pulse 8 x 20μs waveform specified in IEEE C62.45) of 90 kA in the L-N and L-G modes, or L-L and L-G for delta configured systems, and 50kA in the N-G mode.

.8 Maximum let through voltage shall not exceed the following UL 1449 Classification, for Category B3 ring and combination waves:

| Max. Let Through Voltage per Mode | L-N, N-G; L-G (when present) | L-L |
|---|---|---|
| 120/240 VAC, 1φ | 500 | - |
| 120Y/208 VAC | 500 | - |
| 220 VAC Delta | - | 500 |
| 220Y/380 VAC | 800 | - |
| 240 VAC Delta | - | 800 |
| 277Y/480 VAC | 1000 | - |
| 347Y/600 VAC | 1200 | - |
| 480 VAC Delta | - | 1500 |
| 600 VAC Delta | - | 2000 |

.9 MI/RFI rejection, measured in accordance with the 50 ohms insertion loss procedures outlined in MIL-STD 220A, shall reflect a minimum noise attenuation of 10 db over a frequency bandwidth from 20 kHz to 10 MHz.

.10 TVSS device endurance shall meet the UL Category C3 as an adjunct to its TVSS UL listing, consisting in the application of 1000 surges at 30-second intervals with 20 kV full peak voltage values for IEEE Category C3.

**2.3 SAFETY AND DIAGNOSTIC MONITORING**

.1 TVSS device shall have visual indicators and an audible alarm to advise that the system is active and functioning properly or that TVSS protection has been lost or damaged and that device maintenance or replacement is necessary.

.2 TVSS device shall include a set of 1 N.O. and 1 N.C. contacts for remote monitoring of device status and be capable of incorporating an optically-coupled sensing circuit option, which will permit monitoring of the TVSS device from a remote site.

.3 TVSS device shall include a test and diagnostic circuit to ensure proper functioning of the monitoring circuit.

**2.4 ACCEPTABLE MANUFACTURER**

.1 All TVSS devices shall be from the same manufacturer.

.2 Acceptable manufacturer for the TVSS devices shall be Leviton No.57120M3 (1Φ, 120V), No 57346-M3 (3Φ, 347/600 V).

**Part 3 Execution**

**3.1 WIRING REQUIREMENTS**

.1 All TVSS devices shall be installed in accordance with the applicable sections of the C.E.C. Part I and following the manufacturer's recommended practice. Conductor lead lengths to the TVSS device shall be kept as short as possible, without unnecessary bends. Conductors shall be twisted and tightly bound together. Refer to manufacturer's instructions for required size of conductors.

**3.2 EXTERNALLY MOUNTED TVSS**

.1 Provide a breaker sized in accordance with TVSS device manufacturer's instructions for connection of TVSS device into panel.

.2 Maximum conductor lead length between breaker and TVSS device shall not exceed 500mm.

## 3.3 INTEGRATED DISTRIBUTION PANEL INSTALLATION

.1 TVSS devices shall be factory installed into the distribution panels and/or MCC as indicated.

**END OF SECTION**

## Part 1 General

### 1.1 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C82.1, Electric Lamp Ballasts-Line Frequency Flourescent Lamp Ballast.

.2 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

.2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

### 1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with E4. Include complete photometric data prepared by independent testing laboratory for luminaires as follows:

.1 Total input watts.

.2 5 plane candlepower summary.

.3 Polar plot candela distribution.

.4 Zonal lumen summary.

.5 Luminaire efficiency.

.6 CIE type.

.7 Coefficient of utilization.

.8 Lamp type and lumen rating in accordance with IESNA testing procedures.

.9 Lens and louvre type and finish.

.10 Spacing criterion.

.2 Include lighting fixture literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

## Part 2 Products

### 2.1 LAMPS

.1 Include lamps for all fixtures.

### 2.2 BALLASTS

.1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic, dimmable where indicated.

.1 RFI/EMI suppression circuit to: FCC (CFR47) Part 18, sub-part C, Class A and Part 15, sub-part B, Class B.

.2 Totally encased and designed for 40C ambient temperature.

.3 Power factor: minimum 95 % with 95% of rated lamp lumens.

.4 Crest factor: 1.5 maximum current, 2.0 maximum voltage.

.5 Capacitor: thermally protected.

.6 Harmonics: 10 % maximum THD, including 49th.

.7 Operating frequency of electronic ballast: 21 khz minimum.

.8 Ballast Factor: greater than 0.90.

.9 Sound rated: Class A.

.10 Mounting: integral with luminaire.

.2 Metal halide ballast:

.1 Rating: 60 Hz, voltage as indicated, for use with metal halide lamp, wattage as indicated. Where requested, provide circuitry for standby light to provide light for starting and restart.

.2 Totally encased and designed for 40C ambient temperature.

.3 Power factor: minimum 95 % with 95% of rated lamp lumens.

.4 Input voltage range: plus or minus 10% of nominal.

.5 Minimum starting temperature: minus 29 EC at 90% line voltage.

.6 Mounting: integral with luminaire.

.7 Crest factor: 1.8 maximum current, 2.0 maximum voltage.

.3 High pressure sodium ballast: to ANSI C82.4.

.1 Rating: 60Hz, voltage as indicated, for use with high pressure sodium lamp, wattage as indicated.

.2 Totally encased and designed for 40C ambient temperature.

.3 Power factor: minimum 95 % with 95% of rated lamp lumens.

.4 Input voltage range: plus 10% to minus 10% of nominal.

.5 Minimum starting temperature: minus 34C at 90% line voltage.

.6 Mounting: integral with luminaire.

.7 Crest factor: 1.8 maximum current, 2.0 maximum voltage.

## 2.3 LUMINAIRES

.1 HPS. luminaire design

.1 Rating: 400 W, 347 V, HPS.

.2 Enclosed and gasketed weathertight high pressure sodium luminaire designed for outdoor pole mounting.

.3 Finish: baked enamel

.4 Housing: die cast aluminium

.5 Reflector: anodized aluminium

.6 Premium square area light with symmetric distribution

.7 Acceptable manufacturer shall be Lithonia KVE2 400S SYM

**2.4 POLES**

.1 Outdoor lighting poles

.1 9.14m height hinge pole.
.2 Baseplate minimum A-36 plate.
.3 Hand hole c/w cover and mounting hardware.
.4 Ground stud, 3 leveling shims, 2-piece bolt together base cover.
.5 4 anchor rods c/w nut and washer. Threaded portion shall be hot dip galvanized.
.6 Pole finish shall be galvanized power coated.
.7 Colour: Bronze.
.8 Top tenon suitable for two fixture mounting spaced 180 degrees.
.9 Acceptable manufacturer shall be West Coast Engineering No. 5SQP24

## Part 3 Execution

**3.1 INSTALLATION**

.1 Locate and install luminaires as indicated on electrical site plan drawings. Install video cameras on lighting poles (Refer to Section 28 23 00).

**3.2 WIRING**

.1 Connect luminaires to lighting circuits.

**3.3 LUMINAIRE SUPPORTS**

.1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.

**3.4 LUMINAIRE ALIGNMENT**

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**END OF SECTION**

## Part 1 General

### 1.1 SECTION INCLUDES

.1 Materials and installation for emergency lighting systems.

### 1.2 RELATED SECTIONS

.1 Section 26 05 21 - Wires and Cables (0-1000 V).

.2 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### 1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.141, Unit Equipment for Emergency Lighting.

### 1.4 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Include:

.1 System components.
.2 Mounting method.
.3 Source of power.
.4 Special attachments.

.2 Include emergency lighting literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical.

## Part 2 Products

### 2.1 EQUIPMENT

.1 Emergency lighting equipment: to CSA C22.2 No.141.

.2 Supply voltage: as indicated.

.3 Output voltage: 24 V dc.

.4 Operating time: 60 min or as indicated.

.5 Battery: sealed, maintenance free.

.6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.

.7 Solid state transfer circuit.

.8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.9 Signal lights: solid state.

.10 Lamp heads: remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: quartz halogen 20 W. In battery rooms luminaires to be suitable for explosion-proof, corrosion-resistant installations.

.11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.12 Finish: white.

.13 Auxiliary equipment:

.1 Test switch.
.2 Shelf or mounting bracket.
.3 Cord and plug connection for AC.

## 2.2 WIRING OF REMOTE HEADS

.1 Conduit: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Conductors: in accordance with Section 26 05 21 - Wires and Cables 0-1000 V, sized in accordance with manufacturer's recommendations.

# Part 3 Execution

## 3.1 INSTALLATION

.1 Install unit equipment and remote mounted fixtures.

.2 Direct heads.

.3 Connect exit lights to unit equipment.

**END OF SECTION**

## Part 1 General

### 1.1 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No.141, Unit Equipment for Emergency Lighting.

.2 CSA C860, Performance of Internally-Lighted Exit Signs.

.2 National Fire Protection Association (NFPA) requirements

### 1.2 SUBMITTALS

.1 Submit shop drawings in accordance with E4. Product data sheets for exit lights to include:

.1 Performance criteria.

.2 Physical size / dimension drawings

.3 Equipment finish.

.2 Include exit signs literature in electrical O&M manuals in accordance with Section 26 05 01 – Common Work Results – Electrical. Manufacturer's Instructions to indicate special handling criteria, installation sequence, cleaning and maintenance procedures.

## Part 2 Products

### 2.1 STANDARD UNITS

.1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.

.2 Housing: extruded aluminum housing, brush aluminum finish.

.3 Face and back plates: extruded aluminum.

.4 Lamps: LED.

.5 Operation: designed for 100,000 hours of continuous operation without relamping.

.6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red on aluminum face, reading EXIT.

.7 Downlight: translucent acrylic in bottom of unit.

.8 Face plate to remain captive for relamping.

## Part 3 Execution

### 3.1 INSTALLATION

.1 Install exit lights.

.2 Connect fixtures to exit light and emergency circuits.

.3 Ensure that exit light circuit breaker is locked in on position.

**END OF SECTION**