

Town of Kindersley

Lagoon and Waste Water Upgrades

Contract for Construction of

- Lagoon Expansion
- Lagoon Desludging
- Lagoon Aeration
- Lagoon Sewage and Effluent Pumping
- West Kindersley Trunk Main
- Rosedale SFM and Pumping Upgrades

Issued for Bid



SASKATOON, SK
MAY 2019
60595192 (450.11)

Notice to Bidders

Town of Kindersley

**Bid for:
Lagoon and Waste Water Upgrades**

Contract for Construction of Lagoon Expansion, Lagoon Desludging, Lagoon Aeration, Lagoon Sewage and Effluent Pumping, West Kindersley Trunk Main, Rosedale SFM and Pumping Upgrades

A Request to Pre-Qualify (RTP) for Prime Contractors and Underground Contractors process has been completed prior to issuance of these Bid Documents. Only Bids from the pre-qualified Prime contractors shall be opened. Any Bids received from companies that are not pre-qualified shall be returned to the Bidder unopened.

Sealed envelopes containing Bids clearly marked "Town of Kindersley – Contract for Construction of Lagoon and Waste Water Upgrades" and addressed to Town of Kindersley c/o AECOM Canada Ltd., shall be received at the office of AECOM, 200-2100 8th Street East, Saskatoon, SK, S7H 0V1 before 2:00:00 p.m., local time, on June 27, 2019 from successfully qualified bidders.

The Work generally comprises:

- Dual sanitary sewage and effluent pumping facility;
- Lagoon Expansion – construction of two (2) partial mix cells;
- Lagoon desludging of existing lagoon cells;
- Lagoon aeration in proposed partial mix cells;
- Gravity sanitary sewer trunk main;
- Effluent force main and two (2) sanitary sewer force mains;
- Constructing all works in accordance with the Contract (as herein defined).

Copies of the Bid Documents can be obtained from the offices of **AECOM Canada Ltd.**, 200 – 2100 8th Street East, Saskatoon, SK, S7H 0V1, on or after June 10, 2019 upon receipt and acceptance of Qualification Experience forms and a \$200.00 refundable deposit by cheque, made payable to AECOM Canada Ltd. if returned within seven (7) days after closing of Bids. Please request copies and allow one day to prepare the documents.

Bids should be accompanied by Bid Security in the amount of ten percent (10%) of the Bid Price, payable to the Town of Kindersley. Failure to provide Bid Security will be a factor taken into account when awarding the contract.

Inquiries regarding this Project shall be directed to:

AECOM Canada Ltd.
200 – 2100 8th Street East
Saskatoon, SK S7H 0V1
Attention: Trevor Woiden, P.Eng.
Telephone: (639) 398-6176

1.0 SCOPE

- .1 Division 16 and 17 work on this contract includes supply, installation and field verification of the equipment indicated by drawings and referenced by specification sections:
 - .1 Conduit, Fastenings and Fittings Section 16111
 - .2 Splitters, Junction Boxes, Pull Boxes and Cabinets Section 16131
 - .3 Outlet Boxes, Conduit Boxes, and Fittings Section 16132
 - .4 Cabletrays Section 16135
 - .5 Wiring Devices Section 16141
 - .6 Dry Type Transformers Section 16271
 - .7 Wire and Cable Section 16301
 - .8 Underground Services Section 16402
 - .9 Grounding - Secondary Section 16450
 - .10 Panelboard – Breaker Type Section 16471
 - .11 Molded Case Circuit Breakers Section 16477
 - .12 Telephone Systems Section 16740
 - .13 Motor Starters to 600 V Section 16811
 - .14 Motor Control Centres Section 16820
 - .15 System Analysis Section 16821
 - .16 Control Devices Section 16825
 - .17 Programmable Control Systems Section 16827
 - .18 Instrumentation Section 17010
- .2 The Division 16 Contractor is responsible for the supply, installation and testing of all field installed cabling and connections indicated by:
 - .1 Process mechanical P&ID drawings
 - .2 Division 16 electrical specifications drawings and schedules

- .3 Division 17 specifications, instrumentation and communications drawings and schedules.
- .3 Co-operate and coordinate with the requirements of other units of work specified in other sections.

2.0 SITE INVESTIGATION

- .1 Examine the site and local conditions affecting the work and be satisfied that the work under this division can be satisfactorily carried out in accordance with the plans and specifications without changes.
- .2 No allowances will be made nor extra paid for unanticipated expense required to complete the work through failure to make this examination.

3.0 CODES AND STANDARDS

- .1 Work shall be done in accordance with the regulations and requirements of CSA C22.1 including provincial amendments, Canadian Fire Underwriters' Association, the Inspection Authorities of Board or Department of Provincial Municipal or Civic Authority or Utility company having jurisdiction and the latest issues of the National Building Code.
- .2 Work shall be done by qualified electrical tradesman with a Journeyman Electrician supervising or doing the work.
- .3 Abbreviations for electrical terms: to CSA Z85.
- .4 These drawings and specifications shall govern where they are more stringent than code requirements.

4.0 LOCATION CLASSIFICATIONS

- .1 The main floor, with the exception of stairwells are ordinary locations
- .2 Dry wells and associated stairwells are a Zone 2 hazardous location, reduced to an ordinary location by use of continuous ventilation. All equipment and cabling systems shall be suitable for the Zone 2 hazardous classification such that operation can continue in the event that the ventilation system fails.
- .3 Dry wells and associated stairwells are category 1 corrosive location.
- .4 Wet wells and associated structures are Zone 1 hazardous location, and category 2 corrosive and wet location.
- .5 Rooms and areas containing pumps and similar process equipment are wet locations.

- .6 Equipment, installation and wiring methods in each area are to be in accordance with applicable sections of the Canadian Electrical Code.

5.0 PERMITS, FEES

- .1 Obtain and pay for all permits, licenses and certificates in force, required for the performance of the work.
- .2 Give required notices, and comply with local, provincial or federal laws, ordinances, rules, regulations, codes and orders relating to the work, which are or become in force during the performance of the work.
- .3 Submit to Electrical Inspection Department and Utility Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .4 Make reasonable changes and alterations required by the Inspection Authority without cost to the Engineer or Owner.

6.0 DRAWINGS AND SPECIFICATIONS

- .1 The drawings utilize standard symbols to indicate the general arrangement and location of outlets, switches, panels, controls, etc.
- .2 Since the drawings are largely schematic and do not show all the structural, architectural, equipment, etc., details, examine the drawings of other trades before beginning the work to ensure that the equipment may be installed as specified and indicated. Report to the Engineer any discrepancies or interferences which may occur.
- .3 Control and instrumentation system layouts shown on the Drawings are generally diagrammatic, and the locations of equipment are approximate. Exact routing of conduits, cables, wiring and tubing shall be governed by the mechanical, structural, and architectural conditions which prevail.
- .4 The Engineer reserves the right to change the location of any piece of equipment without extra payment therefore, providing only that the change is requested before installation and that the new location is within 3 m of the original location.

7.0 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- .1 Submit shop drawings and samples in accordance with Section 01300.
- .2 Each submittal shall include the following information, as applicable.
 - .1 Project No., name and location
 - .2 Equipment Tag Number

- .3 Equipment manufacturer and model number.
- .4 Manufacturer's name and description of item
- .5 Equipment capacity, duty and performance across the full operating range of the equipment including but not limited to:
 - .1 Voltages and voltage regulation
 - .2 Currents / ampacity
 - .3 Number of phases / wires
 - .4 Frequency and frequency regulation
 - .5 Power factor
 - .6 Harmonic content
 - .7 Temperature rise, thermal capacity, insulation class
 - .8 Efficiency
 - .9 Sound levels
 - .10 Agency approval and certification
 - .11 Single line, schematic, wiring and interconnection diagrams
 - .12 Functional block diagrams, logic diagrams, process flow charts
 - .13 HMI screenshots
 - .14 Bills of materials
 - .15 Details of construction materials, enclosure types, weights and dimensions, cable entry locations, position and size of components, busbars, foundations, drilling and mounting details
 - .16 Panel layouts, internal equipment layouts
 - .17 Catalogue cut sheets showing pertinent physical and operation characteristics of internal components
 - .18 Lighting illuminance plan of each location in pdf format referencing actual building layout and equipment locations
 - .19 Reports

- .20 Spare parts lists
- .21 Warranty, service and support information
- .3 Manufacturer shall not commence fabrication or material shall not be delivered to the site until Engineer reviewed shop drawings and catalogue data is in the hands of the Contractor.
- .4 The above shop drawings are for inclusion in the Operating and Maintenance Manuals.

8.0 OPERATION AND MAINTENANCE DATA

- .1 Shall be submitted as per Section 01730.
- .2 Include configuration setting tables for any applicable equipment, including, but not limited to the following:
 - .1 Instrument set-points
 - .2 Protection relay and control system set-points
 - .3 Circuit breaker, VFD, soft starter and motor starter settings

9.0 RECORD DRAWINGS

- .1 Record drawings shall be as per Section 01700.
- .2 Updates shall include relocation of equipment, changes to size, type, rating and addition, deletion or modification of cabling system.

10.0 UNITY OF MANUFACTURE

- .1 Repetitive items in general classifications including toggle switches, duplex receptacles, cover plates, branch circuit panels, safety switches, motor controllers and control stations, etc., shall be of the same manufacture and type through the project.

11.0 MANUFACTURER'S INSTRUCTIONS

- .1 The Contractor shall be responsible for the correct installation and assembly of all items of equipment. Manufacturer's instructions shall be carefully read and rigidly adhered to in the installation. Any damage resulting from failure to observe the manufacturer's instructions or as a result of proceeding with the work without complete knowledge of a particular component, will be the Contractor's responsibility. The contractor shall make good any loss or damage resulting from malpractice.

12.0 VOLTAGE RATINGS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

13.0 MATERIALS AND EQUIPMENT

- .1 Provide materials and equipment in accordance with this Section.
- .2 Equipment and material to be CSA certified, and manufactured to standard quoted.
- .3 Factory assemble control panels and component assemblies.

14.0 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Provide for interconnecting conduit, wiring and service connection of electrical equipment.
Provide for the supply and connection of service conduit and wiring to an equipment wiring termination box.
Wiring of equipment package controls and operators to the wiring termination box shall be provided by the equipment supplier.
Provide for connection of equipment package remote control devices specified elsewhere.
- .2 Installation of equipment by others which may affect the arrangement of conduits, and equipment. The Contractor shall notify other trades of all openings, anchors, hangers or other provisions for the installation of his work in ample time so that proper provision can be made. Failure to comply with this requirement will not relieve him of the cost of cutting openings, installing brackets, etc., at a later period and subsequent patching.
- .3 Provide feeders to, connection and testing of motors supplied and installed.
- .4 Confirm the motors connected have correct rotation.
- .5 Supply interconnecting 120 volt control wiring and conduits for control apparatus installed by others.
- .6 Provide disconnect switch at the motor where necessary to comply with the Canadian Electrical Code, provided the disconnect does not come as part of the equipment.

15.0 FINISHES

- .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955.
 - .2 Paint indoor switchgear and distribution enclosures light grey to ANSI-61.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean, prime, and paint exposed hangers, racks, fastenings to prevent rusting.
- .4 Existing equipment shall be touched-up or repainted as required to make a finished project.
- .5 Name plates shall be kept free of paint.
- .6 Panel backboards shall have one coat of primer paint and two coats of ASA-61 gray enamel.

16.0 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows.
- .2 Nameplates:
 - .1 Laminated 3 mm thick plastic engraving sheet, black face, white core, mechanically attached unless specified otherwise.

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	25 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 Nameplates as above, but showing white against red, shall be provided, as warning signs where rule 12-3036, and rule 36-006, Canadian Electrical Code applies.
- .4 Sign shall read "Warning Multi Voltage" or as required.

- .5 Dymo or similar adhesive labels will not be accepted.
- .6 Each motor shall be provided with a 3 mm thick, brass, engraved nametag with wording to match that on the corresponding control device. These tags shall be affixed onto the motor housing or case with nylon cable ties.
- .7 A main laminated plastic nameplate shall be provided on the electrical main service panel giving the name of the structure, name of the consulting firm, name of the electrical sub-contractor, date nameplate is installed.
- .8 Wording on nameplates and labels to be approved by Engineer prior to manufacture.
- .9 Allow for average of twenty five (25) letters per nameplate and labels.
- .10 Identification to be English.
- .11 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .12 Existing electrical equipment such as breakers, load centres, lighting panels, lighting contactor boxes, telephone cabinet, light control panel shall have nameplates installed.

17.0 MANUFACTURER'S AND CSA LABELS

- .1 Visible and legible after equipment is installed.

18.0 WARNING SIGNS

- .1 Provide warning signs, as specified and/or to meet requirements of Inspection Department and Engineer.
- .2 Use porcelain enamel signs, minimum 175 x 250 mm size.

19.0 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with this Section.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets or switches at no extra cost or credit, providing distance does not exceed 3 m, and information is given before installation.
- .4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

20.0 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not indicated verify before proceeding with installation.
- .3 Install electrical equipment at the 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 splash back: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and inter-phone outlets: 300 mm or as indicated.
 - .5 Wall mounted telephone and inter-phone outlets: 1500 mm.
 - .6 Thermal motor switches: 1525 mm.

21.0 FIELD QUALITY CONTROL

- .1 Complete installation checks, including those by manufacturers, in accordance with Section 01630 Equipment Installation.
- .2 Complete startup and commissioning of equipment in accordance with Section 01650 Facility Startup / Commissioning.
- .3 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of installation, check, adjust, balance and calibrate components.
- .4 Test equipment, materials and labor necessary to carry out the tests shall be provided.
- .5 Carry out pre-start-up, start-up and commissioning tests and submit results to the Engineer, including as applicable:
 - .1 Visual Inspection.
 - .2 Continuity tests:
 - .1 Check each circuit for continuity and short circuits.

- .2 Verify correct phase rotation and identify each phase conductor of each circuit.
- .3 Check neutral and grounding connections.
- .3 Insulation resistance tests:
 - .1 Megger circuits, feeders and equipment with operating voltages up to 208V with a 500V instrument.
 - .2 Megger circuits, feeders and equipment with operating voltages up to 600 V with a 1000V instrument.
 - .3 Megger circuits, feeders and equipment with operating voltages up to 5kV with a 5kV instrument.
 - .4 In all cases, ensure that resistance to ground is not less than required by code and manufacturer recommendations.
- .4 Hipot testing:
 - .1 Conduct hipot testing in accordance with manufacturer recommendations.
- .5 Functional tests:
 - .1 The Contractor shall test equipment to ensure that functionality of all installed equipment operates correctly in accordance with manufacturer drawings, manuals and Engineer specifications prior to power circuit energization.
 - .2 Verify correctness of connections and polarities of electrical supplies.
 - .3 Verify the ratios, polarities and vector groups of all transformers and instrument transformers prior to energization by way of primary injection.
 - .4 Implement settings for all programmable devices such as meters, relays, VFD's, monitoring instrument set-points and equipment communications systems. Control system I/O shall be loop checked for individual function and operation. Analog signals and set points shall be tested by means of signal injection from the field device.
 - .5 Perform overlapping functional tests to ensure end-end functionality of the system.
 - .6 Verifying correct implementation all other equipment ratings or settings as required to safely achieve a functional system.

Such ratings or settings include transformer tap selectors, fuse ratings and correct interlock functions.

- .7 Carry out further tests as recommended by equipment manufacturer literature
- .6 Start-up for electrical systems
 - .1 Energize the equipment in accordance with Contractor and Owner electrical safety rules and switching schedules.
 - .2 Following energization of equipment, carry out checks to demonstrate correct operation of equipment. Such tests include but are not limited to:
 - a) Verification of voltages, phase rotations, currents and frequency.
 - b) On-line testing of differential protection.
 - c) On-line testing of load transfer systems.
 - d) Discharge testing of UPS equipment including emergency lighting
 - e) Record baseline operating voltage, current, vibration and temperature data for each motor. Report any excessive readings and unbalance.
 - f) Measure phase current and voltage of each panelboard, motor control center and transformer with normal loads operating at time of acceptance. Measure phase voltages at loads and adjust transformer taps.
 - .3 Carry out further commissioning tests as recommended by equipment manufacturer literature.

22.0 CLEANING

- .1 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.
- .2 The interior and exterior of enclosures and boxes shall be cleaned of dust, dirt, and loose material, and if possible, shall be vacuum cleaned. All fastening screw holes provided in boxes and enclosures shall have a fastening screw installed.

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Conduits, Conduit Fastenings and Conduit Fittings.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Conduits

- .1 Conduit size and material as indicated and according to CEC requirements. Minimum conduit size shall be 21mm.
- .1 Rigid PVC conduits with non-threaded fittings.
- .2 Liquid-tight flexible non-metallic conduit.

2.2 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 53 mm and smaller. Two holes steel straps for conduits larger than 53 mm.

2.3 Conduit Fittings

- .1 Fittings for raceways for CSA C22.2 No. 18.
- .2 Fittings and bends manufactured for use with conduit specified.

3.0 EXECUTION

3.1 Installation

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conduits shall be PVC type, surface mounted, unless otherwise indicated on the drawings or in this section.
- .3 Use rigid PVC conduit underground and in corrosive areas.

- .4 Use liquid tight flexible non-metallic conduit for connection to instruments, motors, and HVAC equipment.
- .5 Install polypropylene fish cord in empty conduits.
- .6 Run ground wire in all conduits per CEC requirements.

3.2 Surface Conduits

- .1 Conduit is to be neatly installed parallel to building lines on channel supports.
- .2 Conduits shall have 1.5 m clearance (minimum) to infrared or gas fired heaters.
- .3 Group conduits wherever possible on surface channels.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Position conduits so that the markings on the conduit are facing the wall and are not visible.
- .6 Where cables, cable tray or conduits pass through floors and walls to hazardous areas and through fire rated walls, sealing shall be by approved fire sealants.

3.3 Conduits in Poured Concrete

- .1 Located to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete. Apply coating of silicon caulking over steel conduit for a length of + 150 mm where it stubs out of concrete, and install heat-shrink tubing over this area to prevent corrosion.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Encase conduits completely in concrete.

3.4 Conduits in Poured Slabs on Grade

- .1 Run conduits 27 mm and larger below slab and encased in 78 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Splitters, Junction Boxes, Pull Boxes and Cabinets.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Splitters

- .1 Utility service splitter in accordance with Utility requirements
 - .1 NEMA 3R, double door
 - .2 Approved Product
 - .1 Bel Products AMC Series or equal

2.2 Junction and Pull Boxes

- .1 NEMA 4X, fiberglass, watertight and corrosion resistant with gasketed, screw covers for surface mounting.
- .2 Explosion proof junction boxes for wet well and dry well locations.
- .3 Provide terminal block kit assembly for each junction box.

3.0 EXECUTION

3.1 Junction Boxes, Pull Boxes and Cabinets Installation

- .1 Install junction boxes and pull boxes in inconspicuous but accessible locations.

3.2 Identification

- .1 Install size 2 identification labels indicating voltage and phase in accordance with Section 16010.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Outlet Boxes, Conduit Boxes and Fittings.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Outlet and Conduit Boxes General**

- .1 Size boxes in accordance with CSA C22.1, Section 12.
- .2 102 mm square or large 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 Fittings - General

- .1 Connectors with nylon insulated throats.
- .2 Knock out filters to prevent entry of foreign materials.
- .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.

2.3 PVC Boxes

- .1 Use surface mounted PVC boxes in damp areas and wherever PVC conduit is used.

3.0 EXECUTION

3.1 Installation

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam similar approved material to prevent entry of construction material.
- .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 connectors. Reducing washers not allowed.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Standby Power Generation.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Cabletray**

- .1 Cable trays shall be rigid galvanized steel ladder type, Class C to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as indicated.
- .2 Elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from manufacturer.
- .3 Provide rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.
- .4 Barriers where different voltage systems or electrical systems are in the same cabletray, or as indicated.
- .5 Approved manufacturers:
 - .1 Thomas & Betts
 - .2 Approved equal

2.2 Supports

- .1 Provide rod hangers, rod hanger clamps and accessories as required.
- .2 Provide wall mounted support brackets, channel strut supports sized to suit cabletray width and loading.

3.0 EXECUTION

3.1 Installation

- .1 Provide a complete system of cable trays required to fully support cables indicated by drawings and specifications. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.
- .2 Suspend cabletrays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers.
- .3 Fasten hangers to channels securely mounted to the structure. Coordinate the location of the support channels so as not to interfere with other services.
- .4 Do not drill through wood ceiling trusses. Provide wood blocking on top of ceiling truss to anchor rod hangers and channels.
- .5 Provide minimum 150mm vertical clearance above the trays. Provide minimum 600 mm horizontal clearance on one side of cabletray throughout.
- .6 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.
- .7 Run trays parallel to building lines unless otherwise shown on the Drawings. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .8 Permanently cap the end of Unistruts, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .9 Use beam clamps to fasten support systems to structural steel. Do not weld, drill or cut structural steel without approval by the Engineer.
- .10 Extend a stranded tin plated bare, or green insulated, copper ground conductor the length of each tray route, and solidly connect sections of tray runs to the ground bus of the electrical room. Connect ground conductor to the tray every 15 m with approved grounding clamps suitable for connecting aluminum tray with copper conductor. Conductor size shall be in accordance with CEC.
- .11 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray Manufacturer.

- .12 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.
- .13 Size cabletrays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Engineer before installing the tray.
- .14 Where cables, cable tray or conduits pass through floors and walls to hazardous areas and through fire rated walls, sealing shall be by approved fire sealants.

3.2 Cables in Cabletray

- .1 Install cables individually.
- .2 Lay cables into cabletray. Use rollers when necessary to pull cables.
- .3 Secure cables in cabletray at 5 m centers, with nylon ties.
- .4 Identify cables with nameplates in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Wiring Devices.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Switches**

- .1 15 A, 120 V, single pole, double pole, three-way, four-way switches as indicated.

- .2 Manually operated industrial spec. grade switches as indicated and with following features:

.1 Brass Robertson large head screws.

.2 Silver alloy contacts.

.3 Urea or melamine molding.

.4 Suitable for back and side wiring.

.5 Ivory toggle.

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

- .4 Switches of one manufacturer throughout project.

- .5 Approved products:

.1 Arrow Hart No. 1201

.2 Leviton No. 1201

.3 Hubbell No. 1201

.4 Approved equal

- .6 Switches in dry well and stairwells to be suitable for zone 2, category 1 locations.

2.2 Receptacles

- .1 Duplex receptacles, industrial, CSA Type 5-15 R, 125 V, 15 A, U ground, with following features:
- .1 Nylon or Melamine base with impact resistant ivory nylon face.
 - .2 Suitable for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Brass Robertson large head screws.
 - .5 Double wipe contacts and riveted grounding contacts.
 - .6 Wrap-around mounting strap.
- .7 Approved Products:
- .1 Arrow Hart No. 5262,
 - .2 Leviton No. 5262,
 - .3 Hubbell No. 5252.
- .4 Approved equal
- .2 Receptacles in dry well and stairwells to be suitable for zone 2, category 1 locations.

2.3 Cover Plates

- .1 Cover plates for wiring devices: PVC.
- .2 Cover plates from one manufacturer throughout project.
- .3 For exterior receptacles, use weatherproof double lift spring loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated. Hubbell 5206WO or equal.
- .4 Use PVC cover plate for PVC outlet boxes.
- .5 Use NEMA 4X boxes and cover plates in Category 1 (wet) and Category 2 (corrosive) locations.

2.4 Local Disconnect Switches

- .1 *Heavy Duty non-fused disconnect*
- .2 600 V, 208 V, 120V rated as required

- .3 30A, 60A, 100A as indicated
- .4 Non-fused
- .5 NEMA 1 for indoor ordinary areas and NEMA 4X for outdoor applications. Provide explosion proof disconnect switches for Zone 1 and Zone 2 hazardous areas.
- .6 CSA / cUL listed
- .7 Approved product:
 - .1 Hubbell HBLDS
 - .2 Square D Heavy Duty Safety Switch
 - .3 Eaton Heavy Duty Safety Switch
 - .4 Pass & Seymour Non-Fusible Safety Switch

3.0 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 specified in Section 16010 or as indicated.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height specified, Section 16010 or as indicated.
 - .3 Install receptacle with ground pole "Down".

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Dry Type Transformers.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Transformers

- .1 600 V – 120 / 208 V Transformers

- .1 CSA certified
- .2 Type: ANN for indoor use
- .3 Rating: As indicated
- .4 Mounting: Floor mounted on housekeeping pad.
- .5 Primary Winding: 600 V configured in delta
- .6 Secondary Winding: 120 / 208 V wye, four wire with neutral brought out.
- .7 Winding Material: Copper
- .8 Voltage taps: 2 FCBN, 2 FCAN, in 2.5% increments.
- .9 Insulation: Class 220°C, 80°C temperature rise.
- .10 Efficiency: Meets NRCan 2019 efficiency levels.
- .11 Basic Impulse Level (BIL): 10kV
- .12 Average sound level: Standard
- .13 Impedance: Standard
- .14 Enclosure: NEMA 3R
- .15 Approved Product:
 - .1 Hammond Power Solutions Sentinel
 - .2 Delta C802.2 Distribution Transformer

- .3 Square D Three Phase Energy Efficient Transformer (NRCan)
- .4 Approved equal

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Provisions.
- .2 Label size: 7.

3.0 EXECUTION

3.1 Installation

- .1 Mount dry type transformers where indicated on the drawings.
- .2 Ensure adequate clearance around transformer for ventilation.
- .3 Install transformers in level upright position.
- .4 Make primary and secondary connections in accordance with wiring diagram.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Wire and Cable.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Materials**

- .1 Armored Power Cable (TECK90)

.1 CSA Teck90 armored power cable 1000 V.

.2 Copper conductors, quantity and size as indicated, bonding conductor

.3 1000 V XLPE Insulation

.4 Aluminum Interlocked armor

.5 PVC Jacket

.6 -40°C to +90°C

.7 Thomas & Betts Star-Teck connectors or approved equal.

.8 Provide Star Teck XP hazardous location series fittings for Teck cables in hazardous areas.

- .2 Armored Control Cable (AIA)

.1 CSA Teck90 armored control cable 600 V

.2 Copper conductors, quantity and size as indicated, bonding conductor

.3 600 V XLPE Insulation

.4 Aluminum Interlocked armor

.5 PVC Jacket

.6 Thomas & Betts Star-Teck connectors or approved equal.

- .7 Provide Star Teck XP hazardous location series fittings for Teck cables in hazardous areas.
- .3 Non-armored Power Cable (RW90)
 - .1 CSA single conductor, non-armored power cable.
 - .2 Copper conductors, size as indicated,
 - .3 1000 V and 600 V XLPE Insulation, as indicated, RW90
- .4 Armored Instrumentation Cable (ACIC)
 - .1 CSA ACIC multiconductor armored instrumentation cable.
 - .2 Copper conductors, quantity and size as indicated
 - .3 600 V XLPE Insulation
 - .4 Overall PVC Jacket
 - .5 Individual and overall shields, twisted pair #16 AWG
 - .6 Individual and overall shields, twisted triad #16 AWG
 - .7 Interlocked aluminum armor
 - .8 PVC Jacket
 - .9 Thomas & Betts Star-Teck connectors or approved equal.
 - .10 Provide Star Teck XP hazardous location series fittings for Teck cables in hazardous areas.
- .5 Ethernet Cables (Cat 6)
 - .1 Cat 6 cable for Ethernet connections to equipment as indicated.
 - .2 4 twisted pairs, 23AWG solid strand conductors.
 - .3 600V insulation for 600V MCC Ethernet connections. 300V insulation for other Ethernet connections.
 - .4 Interlocked aluminum armor
 - .5 PVC jacket.
 - .6 Thomas & Betts Star-Teck connectors or approved equal.

2.2 Wire Gauge

- .1 Where conductor sizes are not indicated on drawings, cable to be sized and installed or current carrying equal to or greater than the breaker or fuse protecting the cable. Size conductors for maximum 3% voltage drop.

3.0 EXECUTION**3.1 Installation**

- .1 Install non-armored cables in conduit systems in accordance with Section 16111.
- .2 Install armored cables in cable tray systems in accordance with Section 16135.
- .3 Install lugs, stress relief tubes, tapes and any other materials required for correct installation and termination in accordance with manufacturer instructions. All termination kits and accessories shall be the proper equipment for the intended cable as indicated by the cable manufacturer.
- .4 Cable bends shall be not less than manufacturer and CEC requirements.
- .5 Connect shield of instrument cable to ground at one end only, preferably in the control panel. Do not ground instrument with shield wire, instead run a bonding conductor in the conduit.
- .6 Identify cables with engraved stainless steel cable tags, on both ends of cables, tags per cable schedules.
- .7 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - .1 Maintain phase sequence and colour coding throughout.
 - .2 Colour code: to latest CSA C22.1.
 - .3 Use colour coded wires in communication cables, matched throughout system.
 - .4 Uniquely identify each control wire, using typed, heat shrink wire markers at each end.
- .8 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

END OF SECTION

1.0 GENERAL**1.1 Coordination with Supply Authority**

- .1 Coordinate with supply authority, the Owner, and the Engineer, to ensure availability of service when required.
- .2 Coordinate installation by SaskPower of Utility owned equipment required for the installation as indicated including but not limited to transformers, vault, poles, overhead lines and cable.
- .3 Complete installation is to comply with applicable SaskPower technical service requirements.

2.0 PRODUCTS

- .1 Service splitter, meter, and metering cabinet shall comply with applicable SaskPower Technical Service Requirements.
- .2 Metering instruments to be installed within MCC metering equipment enclosure as indicated.

3.0 EXECUTION**3.1 Installation**

- .1 Installation of service cables between transformer and service splitter shall be by SaskPower. Provide conduit sleeve to splitter to SaskPower's requirements.
- .2 Contractor is responsible for providing trenching and backfill for secondary cables if required by SaskPower.
- .3 Obtain inspection and approval from Electrical Authority having jurisdiction prior to energizing any equipment.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Grounding systems.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Materials**

- .1 Grounding equipment to: CSA C22.2 No. 41.
- .2 Copper grounding conductors to: ASA G7.1.

2.2 Equipment

- .1 Clamps for grounding conductor, size as required to electrically conductive underground water pipe.
- .2 Rod electrodes for ground grid: copper clad steel, 19 mm dia by 6 m long with threaded couplers.
- .3 Ground wells shall be polymer concrete construction, Eritech T416D or approved equal.
- .4 System, circuit, and equipment grounding conductors: bare stranded copper, tinned, soft annealed.
- .5 Ground bus: tinned steel, complete with insulated supports, fastenings, connectors.
- .6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.

- .4 Thermal welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.

2.3 Manufacturers

- .1 Acceptable manufacturers: Burndy Corp., Erico Inc or approved equal.

3.0 EXECUTION

3.1 Installation - General

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including electrodes, conductors, connectors, accessories, as indicated, to conform to requirements of Engineer, and local authority having jurisdiction over installation. Run ground wire in all conduits.
- .2 Install connectors to manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections and connections to conductive water main or electrodes, using copper welding by thermal process.
- .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 hub, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.

3.2 Electrodes

- .1 Install rod electrodes and make grounding connections using Hyground compression or exothermic welding methods.
- .2 Make ground connections to continuously conductive underground water pipe.

- .3 Make special provision for installing electrodes that will give less than 5 ohms resistance to ground value.

3.3 System and Circuit Grounding

- .1 Install system and circuit grounding connections.

3.4 Equipment Grounding

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to, the following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, generators, distribution panels.

3.1 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.
- .2 Perform ground continuity and resistance tests using 3-point fall of potential method. Report results to Engineer.
- .3 Perform tests before energizing electrical system.

END OF SECTION

1.0 GENERAL

1.1 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity, and enclosure dimension.

1.2 Plant Assembly

- .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 in withstand.

2.0 PRODUCTS

2.1 Panelboards

- .1 Panelboards: to CSA C22.2 No. 29.
- .2 Panelboards to be product of one manufacturer.
- .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.
- .4 Panelboards: mains, number of circuits, and number of size of branch circuit breakers as indicated.
- .5 Copper bus with full size neutral.
- .6 240 Volt panelboards shall have minimum interrupting capacity of 10 kA symmetrical RMS.

2.2 Breakers

- .1 Bolt-on breakers with thermal magnetic tripping in panelboards except as indicated otherwise.
- .2 Main breaker: separately mounted on top or bottom of panel to suit cable entry.

2.3 Equipment Identification

- .1 Provide equipment identification in accordance with Section 16010.
- .2 Nameplate for each panelboard size 4 engraved as indicated.

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

2.4 Approved Product:

- .1 Eaton PRL-1
- .2 Schneider NQ
- .3 Approved equal

3.0 EXECUTION

3.1 Installation

- .1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Connect loads to circuits as indicated.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Molded Case Circuit Breakers.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Molded Case Circuit Breakers

- .1 Molded case circuit breakers: to CSA C22.2 No. 5.
- .2 Molded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping under overload conditions and instantaneous magnetic tripping for short circuit protection.
- .3 Bolt-on molded case circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .4 Common-trip breakers with single handle for multi-pole applications.
- .5 Magnetic instantaneous trip elements in circuit breakers, to operate only when the value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-10 times current rating.
- .6 Circuit breakers with interchangeable trips as indicated.
- .7 Circuit breakers shall have a minimum symmetrical interrupting capacity of 42 kA. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to 42 kA, regardless of whether equipped with instantaneous trip protection or not.
- .8 Approved manufacturers:
 - .1 Eaton Electric,
 - .2 Siemens,

- .3 Square D,
- .4 General Electric.

3.0 EXECUTION

- .1 Install circuit breakers as indicated.

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of Telephone Systems.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Components

- .1 Conduit: as specified in Section 16111, of required type and size, complete with accessories/fittings.
- .2 Outlet, pull and junction boxes: as specified in Sections 16131 and 16132, of type to suit conduit being used and as required by wall type, complete with accessories/fittings.
- .3 Main telephone service duct: Provide new telephone service entrance
- .4 Telephone cable: Two pair 24 AWG solid copper with PVC jacket. Belden 9562 or equal.
- .5 Telephone jacks: Type 625B4 Flush mount jacks for concealed outlets, Leviton 40259-W or equal. Type 625C surface jacks for control panel outlets, Leviton 40237-I or equal.

3.0 EXECUTION

3.1 Coordinate with Telecommunications Utility

- .1 Coordinate with SaskTel and the Owner for relocation of telephone and data service connection.
- .2 Provide backboard for telecoms equipment within the Electrical Room per Utility requirements. (Equipment installed by others). Alternatively, an exterior wall mounted NID may be used at the discretion of the utility.
- .3 Make connections between telephone and data cable point of delivery to building telephone and data systems as indicated.

- .4 Complete data and telephone installation shall comply with Utility service requirements.

3.2 Installation

- .1 Install two dedicated phone lines and one Ethernet cable to telephone outlet locations shown on drawings.
- .2 Complete telephone system installation to be as indicated on drawings, specified herein, and to complete satisfaction of SaskTel.
- .3 Notify SaskTel well in advance regarding required date for telephone service installation.

END OF SECTION

1.0 GENERAL

1.1 Scope

- .1 This section covers work related to Section 16010 for the provision of motor starters to 600 Volts.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS

2.1 Variable Frequency Drives

- .1 Integrated into a Motor Control Centre in accordance with Section 16820.

- .2 Digitally controlled AC variable frequency drive (VFD)

- .1 Sensorless flux vector control

- .2 Minimum 6 pulse SCR input, IGBT output modules.

- .3 VFDs will be CSA / cUL approved, rated 690 V for operation with a nominal 600 V, 60 Hz, 3 phase supply

- .4 VFDs shall be rated for continuous operation of motor loads at the nominal motor HP rating indicated, with a continuous output current not less than identified by table 44 of the Canadian Electrical Code.

- .5 The VFD will be controlled with panel mounted 3 position H-O-A switch, potentiometer and a keypad / display unit.

- .1 Hand – Starts Motor and accelerates to speed set manually set by door mounted potentiometer.

- .2 Off – Ramps down and stops motor by decelerating according to ramp settings.

- .3 Auto control of VFD via hardwired I/O configured as indicated.

- .6 VFD Output: 0-60 Hz, with standard Volts/Hertz VFD curve, 3 phase. The drive shall be able to start into a spinning motor.

- .7 Operator interface and drive keypads installed on the MCC door, shall be mounted at a height taking into account the housekeeping pad height for ease of operator viewing.
- .8 Provide ventilation fans, vents, filters, and associated equipment to adequately cool the compartments.
- .9 Provide pad-lockable thermal-magnetic circuit breaker and/or semiconductor fuse short circuit protection as required by drive manufacturer for equipment approvals. Interlock doors for VFD to prevent access unless disconnect is open.
- .10 The VFD shall be configured to provide the following protection functions which will lock out the VFD until manually reset:
 - .1 Motor short circuit
 - .2 Motor thermal overload
 - .3 VFD Overtemperature
 - .4 VFD internal fault
 - .5 External signal trip
 - .6 Motor phase loss
 - .7 Motor stall protection
 - .8 Ground fault
- .11 The VFD shall be configured to provide the following auto-reset protection functions that allow return to operation following reinstatement of utility supply without manual reset:
 - .1 Input phase loss
 - .2 Undervoltage / overvoltage
- .12 Approved products:
 - .1 Allen Bradley Powerflex 750 series
 - .2 Square D Altivar 30
 - .3 Eaton SVX9000
- .13 Accessories:
 - .1 Provide line side line reactor within MCC enclosure.

- .2 Provide load side dV/dt filter within MCC enclosure.
- .3 Pushbuttons, selector switches: 22 mm, heavy duty, oil tight, labelled as indicated.
- .4 Indicating lights: 22 mm, heavy duty, oil tight, LED-type, push to test, and colour as indicated.
- .5 Control transformer, fused.

2.2 120V Manual Motor Starters

- .1 Single phase manual motor starter with starting and overload protection of fractional horsepower single phase fans and heaters as indicated.
- .2 NEMA type 1 enclosure.
- .3 Approved products:
 - .1 Allen Bradley Bulletin 600
 - .2 Eaton MST
 - .3 or equal.

2.3 Spare Parts

- .1 Provide maintenance materials in accordance with Section 01784 – Spare Parts and Maintenance Materials.
- .2 Include:
 - .1 Two spare pilot lamps for each type, voltage and colour used.
 - .2 Two spare relays for each type and voltage used
 - .3 Three spare fuses for each type and voltage used.
 - .4 One spare air filter for each section equipped with filters.

3.0 EXECUTION

3.1 Installation

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements and settings are suitable for the nameplate ratings of motors supplied.
- .3 Set the trip adjustment on the motor circuit protectors

- .4 Configure motor protection settings on reduced voltage starters to suit motor nameplates and as required to achieve stable operation of electrical and process functions.

3.1 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of Motor Control Centres.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

1.4 Related Work

- .1 Housekeeping Concrete Pad for Motor Control Centres: Division 3

- .2 Motor Starters to 600V Section 16811

2.0 PRODUCTS**2.1 Supply Characteristics**

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

2.2 Construction

- .1 Provide control centres with vertical sections assembled to form a rigid, free-standing assembly, having a common power bus and forming an enclosure to which additional sections may be readily added.
- .2 For each section or structure, provide a 3 phase horizontal bus rated 600 amperes and a 3 phase vertical bus rated minimum 300 amperes.
- .3 Provide fully rated neutral busbar extending entire width and height of motor control centre.
- .4 Copper ground bus extending entire width of motor control centre with dimensions of 0.25" x 1".
- .5 The MCC horizontal and vertical power bus bracing shall have a short circuit rating of 42,000 A rms symmetrical.
- .6 NEMA 1, gasketed, Type B, metal enclosed, free standing dead front, complete with all required accessories.

- .7 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.
- .8 Tin-plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section. Bus shall be tin plated copper.
- .9 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tie supports. Insulate wireways from horizontal and vertical bus.
- .10 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all bus work.
- .11 Incorporate starters, circuit breakers, etc., as indicated. Provide shop drawings for review before commencing fabrication. Provide plug-in type units.
- .12 Provide tin-plated copper bus bar stabs reinforced with strong spring steel to ensure high contact pressure.
- .13 Provide appropriate flanges and bus connections for incoming line and feeders.
- .14 Design unit doors to be locked in the 'OFF' position with from one to three padlocks. Provide door interlocks which prevent opening the unit when the breaker is in the 'ON' position. Provide a defeat mechanism. Provide lamicoid plates with lettering as indicated. See 'Identification' - Section 16010.
- .15 Provide all wireways, ducts, etc., required to feed the MCC. Install main lugs on vertical bus and make terminations in a dedicated fed cell as shown on drawings.
- .16 All joints and connections to be tin-plated, cadmium plate all bolts, nuts and lock washers to resist corrosion.
- .17 Equip control centres with VFDs, motor starters and contactors as specified in Section 16811 – 'Motor Starters to 600V'.
- .18 Provide indications to plant PLC systems as indicated.
- .19 Provide pull apart terminal block plug in each starter for all control connections, such that each starter unit may be easily removed. All terminals shall be identified in both starter unit and master terminal section.
- .20 Provide barriers to isolate all bus work to prevent accidental contact when starter units are removed or spaces are provided. Barriers shall also provide phase to phase isolation of the vertical bus.

- .21 Complete as-built control wiring diagrams for each starter with conductor identification clearly shown. Diagram shall be affixed to the interior cover of the starter section and provide a book of wiring diagrams for all starters and drives in each MCC.
- .22 Motor control centres shall be finished in ANSI #61 grey enamel and unit insert pans shall be finished in white enamel.

2.3 Manufacturers

- .1 Approved Products:
 - .1 Allen-Bradley Centreline 2100
 - .2 Square D Model 6.
 - .3 Eaton Freedom 2100
- .2 Qualifications
 - .1 The Vendor is required to notify the Engineer 7 days prior to close of bids should the physical size of the complete MCC line-up exceed the dimensions indicated.
 - .2 Use of corner sections, back to back installation or splitting of the MCC shall be subject to approval by the Engineer prior to close of bids.

2.4 Surge Protective Device

- .1 SPD type 1
- .2 Connection:
 - .1 MCC-600: 347 / 600 V, 3 phase, 4 wire wye connection, 60 Hz
 - .3 Nominal discharge current rating: 20 kA
 - .4 Short circuit current rating: 200 kA
 - .5 Voltage protection ratings: 1500 V L-G, 2500 V L-L
 - .6 UL 1449 3rd Edition approved, cUL Listed
- .7 Approved products:
 - .1 Eaton SPD
 - .2 Square D MCC SPD
 - .3 Approved equal

- .8 Mount unit in MCC section drawer with diagnostic panel mounted on door. Unit shall provide a form-C dry contact alarm status.

2.5 Automatic Transfer Switch

- .1 The automatic transfer switch shall be rated 400 A, 600 V, 3 phase, 60 Hz, 3 poles (solid neutral).
- .2 Programmed transition time delays.
- .3 Digital Meter to display voltage, current, frequency, and power for both sources.
- .4 LCD display & LED-indicated source status.
- .5 Programmable generator exerciser.
- .6 Two programmable outputs.
- .7 Adjustable Time delays.
- .8 The controls shall monitor utility voltages and if abnormal power conditions exist, start the generator and switch to standby power.
- .9 The switch shall protect the station from operating under phase-loss conditions, undervoltage, overvoltage, underfrequency, overfrequency, and voltage imbalance.
- .10 Open construction transfer switch to be mounted in Motor Control Centre.
- .11 Approved Product:
 - .1 Cummins OTPC
 - .2 Kohler KCP c/w MPAC 1500 controller
 - .3 Eaton ATS with ATC-300 controller

2.6 Spare Parts

- .1 Include:
 - .1 Two spare pilot lamps for each type, voltage and colour used.
 - .2 Two spare relays for each type and voltage used
 - .3 Three spare fuses for each type and voltage used.

3.0 EXECUTION

3.1 Installation

- .1 Co-ordinate concrete pad size to suit MCC shop drawings.
- .2 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .3 Make field power and control connection as indicated.
- .4 Separately secure the wiring of each starter in the horizontal and vertical wiring spaces.

3.1 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of system analysis.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.
 - .1 Draft and final stamped reports

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.
 - .1 Turn over ETAP files in native format upon acceptance of the completed studies and reports so that the Owner may, if so desired, maintain or alter the model by their own means.

2.0 EXECUTION**2.1 General Requirements**

- .1 The electrical distribution system shall be modelled using the latest version of ETAP.
- .2 Provide report documenting system data, single line diagrams, modeling configurations, short circuit study, protection coordination study and arc flash analysis results. Provide recommendations to improve equipment protection and personnel safety.
- .3 Study shall be performed and reported under the supervision and approval of a Professional Engineer, registered in the province of Saskatchewan.

2.2 System Data

- .1 Obtain data required to complete the studies including but not limited to:
 - .1 Utility data including transformer size, impedance, utility protective device models and settings. Obtain the utility 3-phase & single phase fault levels and X/R ratios applicable to the point of utility connection.
 - .2 Equipment and generator parameters including voltage and current ratings, protective device types and rating, short-circuit ratings, interrupting duty, bracing and clearances.

- .3 Cable length and size as installed.
- .2 Include system data within appendices of submitted reports.

2.3 Single Line Diagram

- .1 Develop a single line diagram showing each distribution system component. Lumped source or load modelling will not be accepted.
 - .1 Individual modelling of panelboard branch circuits is not required. Limits of the model shall be the incoming terminals of 120/208 V panelboards
 - .2 Utility meters and associated instrument transformers may be omitted.
- .2 Naming of equipment will be in accordance with the electrical single line diagram.

2.4 Modelling Configurations

- .1 Model each site separately
- .2 Utility Maximum Loading:
 - .1 Maximum Utility Configuration
 - .2 MBKR-601 closed
 - .3 TS-505 in Utility position
 - .4 All installed circuit breakers and disconnects closed, loads connected and running.
- .3 Utility Minimum Loading:
 - .1 Minimum Utility Configuration
 - .2 MBKR-601 closed
 - .3 TS-505 in Utility position
 - .4 All installed circuit breakers and disconnects closed, loads connected but not running.

2.5 Short Circuit Study

- .1 Use ETAP to calculate three phase bolted fault levels and line-to-ground fault levels at every node on the system for each configuration detailed.
- .2 Include motor contribution to fault levels taking into account motor starting method and use of VFD bypass where applicable.

- .3 Evaluate and report on adequacy of over current device interrupting ratings and bus ratings.

2.6 Protection Coordination Study

- .1 Provide settings for each protection device to provide device coordination while adequately protecting equipment.
- .2 Coordinate with the Utility, Contractor and equipment manufacturers to refine protective device ratings and settings as required.
- .3 Plot time current curves for a fault on each bus and load terminals. Indicate applicable short circuit levels on the ETAP TCC plots.
- .4 Plot conductor, motor, transformer and generator damage curves where applicable.
- .5 Evaluate and report on adequacy of protective device settings for coordination and protection of equipment. Provide relay configuration files in .pdf format to Engineer. Download configuration to the relays on-site.
- .6 Provide a separate report for each facility.

2.7 Arc-flash Analysis

- .1 Perform an Arc Flash Hazard Study using the latest version of ETAP using IEEE 1584 calculations.
- .2 Calculate the incident energy in cal/cm², hazard category and flash protection boundary for each node in each configuration, including motor and transformer terminals.
- .3 The intent is that incident energies are below 12 cal/cm². Coordinate with the Utility, Contractor and equipment manufacturers to refine protective device ratings and settings to achieve this within the presented equipment design parameters. Include recommendations for modification to equipment or system configuration that are required to reduce incident energy below 12 cal / cm².
- .4 Clearing times of protective devices to be capped at 2s.
- .5 Report the results for the worst-case scenario for each node. The report shall also include bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal protective equipment classes, and arc fault incident energy levels.
- .6 Include PPE equipment requirements for each hazard category.
- .7 Branch circuits at 208 V and under shall not be part of the analysis, and shall be assumed to be Hazard Category 0.

- .8 Affix permanent arc flash labels to all equipment. Labels shall be per CSA-Z462.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of control devices.

1.2 References

- .1 Programmable Control Systems Section 16827
- .2 Sequence of Operation Appendix A

1.3 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.4 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Control Panels**

- .1 CP-800 – PLC Control Panel
- .1 NEMA 1, painted mild steel free standing enclosure for a non-hazardous location.
- .2 Approved panel builders:
- .1 Delco Automation

2.2 PLC System

- .1 Approved PLC systems
- .1 Allen Bradley CompactLogix series.
- .2 Schneider Modicon M340 Series
- .3 Approved equal
- .2 PLC System Components

- .1 Provide materials specified below and arranged as indicated for CompactLogix series. Equivalent models shall be substituted as required for other platforms approved as equal.

Reference	Part Number	Description
1		Panel enclosure. Approved manufacturers: Hoffman and Hammond
2	1769-L36ERM	PLC Processor
3	1769-PB3	PLC Power Supply
4	1769-OW8I	PLC Discrete Output
5	1769-IQ16	PLC Discrete Input
6	1769-IF8	PLC Analog Input
7	1769-OF8C	PLC Analog Output

- .3 Configuration of PLC system shall be reviewed by manufacturer's technical service representatives.

2.3 Ethernet Switch

- .1 Modular managed Ethernet switch
- .2 Ten 10/100 Base T copper Ethernet ports.
- .3 24Vdc power supply.
- .4 Approved Product
- .1 Allen Bradley Stratix 8000 1783-MS10T
- .2 Approved equal

2.4 DC Power Supply

- .1 Power supply shall provide regulated DC power for all modules installed in the chassis, plus an additional 50% reserve capacity for future expansion.
- .2 Power supply shall be fed from 120 Vac.
- .3 Phoenix Contact Quint PS/1AC/24DC

2.5 DC Control Power UPS

- .1 24 V DC UPS complete with energy storage device, 3.4 Ah minimum, or as otherwise required to provide backup to connected loads for a minimum of ten minutes.
- .2 Approved product

- .1 Phoenix Contact Quint DC-UPS with Quint-Bat

2.6 Human-Machine Interface (HMI)

- .1 15" colour display with touchscreen capability,
- .2 Ethernet communication port.
- .3 Provide all interconnecting cable and accessories and downloading cable.
- .4 Centre of HMI shall be mounted at 1500 mm above finished floor.
- .5 Approved Product
 - .1 Allen Bradley Panelview Plus 7, 2711P-T15C22D9P
 - .2 Red Lion G3 series, 15"
 - .3 Approved equal

2.7 VPN Firewall

- .1 Operators will access the VPN from devices that are not included within this contract.
- .2 Approved Product: SonicWall TZ SOHO

2.8 Relays

- .1 Multi-pole relays shall be OMRON LY Series, or equal, complete with track-mount plug-in base, and with number of contacts as required on the control schematic. If necessary, relays may be paralleled to provide the required number of contacts. Relays with DC coils shall have built-in protection diode.
- .2 Time delay relays shall be OMRON D3DR Multifunction Timers, or equal, with time duration adjustable as indicated on the drawings control schematics, and with DPDT Contacts.
- .3 Relays with DC coils shall have built-in protection diode.

2.9 Selector Switches

- .1 Switches shall be heavy duty, 30 mm, oil tight, NEMA Type 4X, with contact arrangement as specified in the control drawing, complete with legend plates.

2.10 Pilot Lights

- .1 Pilot lights shall be heavy duty, 30 mm, oil tight NEMA Type 4X, push to test, LED type, complete with lamp, color cap, and legend plate as specified on the control drawings.

2.11 Controls Power Filter

- .1 Combination surge protector and EMI/RFI filter.
- .2 Type 2 surge protection to UL 1449.
- .3 60kA per phase (peak).
- .4 Noise attenuation: 74dB at 100kHz.
- .5 100-127Vac.
- .6 DIN rail mounted.
- .7 Form C alarm contacts.
- .8 Approved Product:
 - .1 Eaton AEGIS AG-PH-120-15
 - .2 Phoenix 2920683
 - .3 Approved equal

2.12 Remote Access Dial-up Modem

- .1 Rockwell Remote Access Dial-In Kit, 9300-RADKIT.
- .2 DIN rail mount.

2.13 Alarm Dialer

- .1 Barnett Protalk B1290 with battery backup
- .2 Operations to confirm alarms and call out numbers required during commissioning

2.14 Terminals

- .1 Feedthrough: Phoenix Contact UT4 or equal
- .2 Fused Terminal: Phoenix Contact UT4 HESILED or equal
- .3 Disconnect Terminal: Phoenix Contact UT4 MT

2.15 Spare Parts

- .1 Provide maintenance materials in accordance with Section 01784 – Spare Parts and Maintenance Materials.
- .2 Include:
 - .1 Five spare pilot lamps for each type, voltage and colour used.
 - .2 One spare 24 Vdc Power Supply.
 - .3 Five spare relays for each type and voltage used
 - .4 Five spare fuses for each type and voltage used.

2.16 Control Panel Accessories

- .1 Install tin-plated copper busbar (19 mm x 3 mm x 300 mm) for grounding. Install flexible ground strap to door.
- .2 Provide terminal blocks and plastic wiring duct to accommodate wiring connections between field points and the relay logic, and for interconnections within the control panel.
- .3 Provide a convenience receptacle in the control panel.

3.0 EXECUTION**3.1 Installation**

- .1 All control devices shall be installed in accordance to Section 16010 Electrical-General Provisions.
- .2 Supply and install the instrumentation listed, or the approved equals.
- .3 Follow manufacturer's recommendations for installation of the instruments.
- .4 Configure and scale the instruments according to the Engineer's instructions.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.

END OF SECTION

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the programming of equipment and instruments connected to the new PLC Control panel, CP-800.
- .2 Local HMI and SCADA terminal screen development for the same systems as well as configuration of Ethernet switches and communications systems supplied for the project.
- .3 Configuration of VPN for remote status reporting and control.
- .4 Programming to be in accordance with sequence of operation provided by the Engineer and supplier sequences of operation that have been reviewed by the Engineer.

1.2 References

- .1 Control Devices Section 16825
- .2 Sequence of Operation Appendix A

1.3 Submittals - Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.
 - .1 HMI Screen Layouts in .pdf format
 - .2 Alarm schedule in .pdf format
 - .3 PLC code in .pdf format
 - .4 Process sequence of operation

1.4 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.
 - .1 Supply complete electronic copies of all source code in its native format
 - .2 As-built process narrative for inclusion in operation and maintenance manual.

2.0 EXECUTION**2.1 Programming General Requirements**

- .1 Approved Programmers
 - .1 Delco Automation;
 - .1 Project Manager: Darren Beres, or approved equal
- .2 Programming Language:
 - .1 Code and comments are to be written in English.
 - .2 Programming will generally be accomplished using ladder logic. Function blocks may be used where required.
- .3 I/O Mapping:
 - .1 Each I/O point is to be directly mapped to an internal tag only once in the control program.
 - .2 I/O is to be logically arranged. Separate I/O modules with a NOP rung and pertinent comments.
- .4 Program Structure:
 - .1 The program will utilize a main program task which will call sub-process tasks, each responsible for control of one sub-process.
- .5 Commenting:
 - .1 Programming is to include comments and labels within the code for ease of troubleshooting:
 - .2 Comments are required for each section and task to explain the purpose of the section.
 - .3 Comments are required for each individual rung to explain the purpose of the rung.
 - .4 Each program file will include a consistent header comment stating:
 - .1 Owner.
 - .2 Site Name and Location.
 - .3 Programmer and Contact Information.
 - .4 Process / Sub-process.
 - .5 Program Version and date.

- .6 Provide unencumbered access to the complete system for the Owner, inclusive of programming and control software both written and electronic so that the Owner may, if so desired, maintain or alter the system by their own means. Any programs developed by the system integrator shall be the property of the Owner.
- .7 No passwords shall be required to access any of the information on the PLC or HMI.
- .8 Individual tags shall be made for all variables.
- .9 The intent is to have the HMI as a display and data entry device. E.g. All math, etc should be done in the controller, and the HMI will function as a display for the result.
- .10 Newest release of programming software for the PLC and operator interfaces supplied and licensed in the Owner's name utilized for the programming/commissioning and given to the Owner upon completion of the project.
- .11 Make changes to HMI screen layouts to suit Engineer and Owner preferences following shop drawing review or during commissioning.
- .12 Make changes to programmed logic, equipment tags, descriptions and alarms as required or as instructed by the Engineer in order to achieve a functional system accounting for the actual equipment installed.
- .13 Programmer to supply any software licenses required to achieve a functional system at handover.

2.2 HMI Screens

- .1 Configure I/O points for purpose of display, monitoring, alarming and control at facility HMIs and remote SCADA systems as indicated.
- .2 Symbols and lines:
 - .1 Components are to be logically arranged with spacing, sizes, orientation and direction of process or power flows designed for ease of operator use.
 - .2 HMI screens will be arranged such that space exists for all equipment identified on P&IDs, including identified future equipment without modification to the HMI representation of equipment installed in the initial contract.
 - .3 System will be represented using 2 dimensional, closed and filled component symbols and lines. Symbols should be simple in design, allowing immediate recognition of component function and should be easily discriminable from other icons and symbols.

- .4 Symbols and lines are to be sized for ease of identification with emphasis on relative size of physical piping such that the main process lines are easily distinguishable from sample lines, drains or other equipment not of critical importance where appropriate.
- .5 Symbols are to be shown in the upright orientation.
- .6 All symbols are to be accompanied by a text label
- .7 Develop equipment symbols, faceplates, pop-ups, functionality and color animation based on operator requirements.
- .8 Each piece of equipment that has associated control and monitoring I/O will include active text adjacent to the symbol or in a pop-up as appropriate:
 - .1 Equipment statuses as applicable including but not limited to:
 - i. Open / Closed / Unknown
 - ii. % Open position.
 - iii. % Speed.
 - iv. Running / Stopped / Unknown.
 - v. Fault / Healthy Status.
 - vi. Not in Auto / Auto Status.
 - .2 Status of interlocks.
 - .3 Operator mode controls.
- .9 Operator control commands will utilize a two-step click and confirm process. Location of confirm button will not overlap location of initial control selection.
- .10 Each screen will include with clickable links on pipe, cable or duct representation to navigate between pages where applicable. Descriptions of links are to match P&ID drawings or as otherwise approved.
- .3 Text:
 - .1 Labels for equipment are to be placed appropriately relative to the equipment symbol. Labels are to appear in the same position relative to the symbol for each component of the same type.

- .2 Equipment is to be labelled consistently such that a component is given the same label wherever it appears on screens, code or in alarm text.
 - .3 Text sizes are to be consistent. A maximum of three text sizes are to be used to distinguish between major headings, minor headings, alarms and component labels.
 - .4 Labels are to be oriented horizontally
 - .5 Acronyms should not be used except as included in alarm text or on issued for construction drawings.
 - .6 Alarm text is to follow the "Equipment Tag_Equipment Description_Alarm" format as indicated in alarm schedules.
 - .7 Text labels are to follow the Equipment Tag_Equipment Description format indicated in I/O schedules and sequence of operation, on two lines where practical.
 - .8 Equipment symbols and labels are to be spaced from one another for ease of component identification
- .4 Numbers:
- .1 Numeric displays of analog signals shall accommodate the variables full numeric range.
 - .2 Numeric displays of analog signals shall include values to one decimal place.
- .5 Units:
- .1 Units are to be used where applicable.
 - .2 Units to be SI units unless otherwise indicated in instrument configuration sheets. Units displayed by the HMI screens are to be consistent with units configured at the instrument display.
- .6 Graphical Overview:
- .1 Key indicators of system health are to be indicated on a dedicated overview screen using vertical fixed scale bargraphs.
 - .1 Bargraphs are to be 2 dimensional bar format to indicate actual analog values.
 - .2 Scales are to include a numerical value to accompany analog scale.

- .3 Scales should be linear and allow for display of the full instrument measurement range.
- .4 Scales will indicate by use of colour normal, high and low operating ranges, corresponding to alarm set-points where applicable.
- .5 Tick marks and grids to be provided at standard intervals of 1,2,10 or multiples of 10. Axis labels are to be clearly labelled with a description of the parameter represented.

.7 Colours:

- .1 Each symbol, label, faceplate and other feature is to be coloured in accordance with the table below except where specified colours leads to HMI screens to be not legible. Programmers may submit alternate colour schemes for approval by the Engineer. Active colour animation is to be used to indicate equipment status.

Colour	Typical Meaning
Red	Electrical Equipment closed, connected or Energized
Magenta	Alarm State, equipment only, not pipe, bus or duct
Dark Blue	Flow condition in pipe confirmed by valve or instrument status
White	Arrows for process flow direction Alarm list Backgrounds Button, text box where suitable contrast not otherwise achieved
Black	Faceplate and button Text Clickable page connectors Symbol outlines
Light grey	Background
Dark Grey	Faceplate Backgrounds Electrical Equipment Open, disconnected or de-energized Process and Mechanical Equipment not running or closed No flow condition of pipe confirmed by valve or FIT status
Green	Process and mechanical equipment running status

.8 Display Refresh Times:

- .1 Display update intervals to be as fast as practicable to ensure accurate representation and controllability of the plant.

.9 Screen Organization:

- .1 Process

.1 Process screens will include a graphical representation of the process systems and components, split and grouped logically and generally consistent with P&ID drawings. The process screen will include the following components as applicable:

- i. Process pumps, blowers, fans and associated pump wells or tanks
- ii. Filters, clarifiers,
- iii. Piping
- iv. Valves with wired status or control
- v. Instruments with wired outputs
- vi. Pressure relief valves with wired status
- vii. Nominal flow direction arrowheads within pipes

.2 The following components are to be omitted from the P&ID representation for clarity:

- i. Pipe dimensions and material data
- ii. Valves and check valves without status or control.
- iii. Drains, swab launches
- iv. Flanges, reducers, DMJs, HCCs, PBVs.

.2 Electrical:

.1 A minimum of one electrical screen which will include the following component symbols as applicable:

- i. Motor starters including VFD's, soft starters and FVNR starters with PLC wired control or status.
- ii. UPSs with wired PLC status.
- iii. SPD fault status,
- iv. MUA air flow proven status,
- v. ATS fault, Utility supply available, generator supply position.

.3 Alarm Summary:

.1 An alarm and event summary page is to be included with the following features:

- i. Alarm Text: As indicated by alarm schedule.

- ii. Time and date.
 - iii. Controls to acknowledge, reset, suppress, disable, alarms.
- .2 An alarm banner is required on each HMI page in identical location and configuration showing most recent alarms.
- .4 Set-points:
- .1 Control and alarm set-points are to be grouped on a dedicated HMI screen, with text box for value entry with engineering units as specified.
 - .2 It shall be possible to view and adjust all set-points from the HMI.

2.3 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.
- .2 The system shall run un-interrupted for a minimum of 30 days before the system will be considered commissioned. Any interruption to service or modification to the programming of any device under the scope of the contract, irrespective of the reasons for the programming change shall be considered cause to re-start the 30 day commissioning window.

2.4 I/O Schedules

- .1 Refer to the attached I/O schedules.

END OF SECTION

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16827 PROGRAMMABLE CONTROL SYSTEMS
I/O SCHEDULE
CP-800

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EQUIPMENT TAG	EQUIPMENT DESCRIPTION	FUTURE	EXISTING	I/O TAG	DESCRIPTION	DI	DO	AI	AO	RTD	DEVCNET	ETHERNET IP	MODBUS TCP
VFD-100A	RAW WASTEWATER PUMP VFD	<input type="checkbox"/>	<input type="checkbox"/>	XS-100A	RUNNING	1							
				YY-100A	READY	1							
FIT-100B	RAW WASTEWATER PUMP B FLOW	<input type="checkbox"/>	<input type="checkbox"/>	FIT-100B	FLOW				1				
				FQ-100B	FLOW TOTALIZED	1							
VFD-100B	RAW WASTEWATER PUMP VFD	<input type="checkbox"/>	<input type="checkbox"/>	HS-100B	AUTO		1						
				SC-100B	SPEED COMMAND						1		
				ST-100B	SPEED FEEDBACK					1			
				XA-100B	FAULT			1					
				XC-100B	START / STOP				1				
				XS-100B	RUNNING					1			
				YY-100B	READY					1			
FIT-100C	RAW WASTEWATER PUMP C FLOW	<input type="checkbox"/>	<input type="checkbox"/>	FIT-100C	FLOW				1				

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EQUIPMENT TAG	EQUIPMENT DESCRIPTION	FUTURE	EXISTING	I/O TAG	DESCRIPTION	DI	DO	AI	AO	RTD	DEVCNET	ETHERNET IP	MODBUS TCP
FT-100C	RAW WASTEWATER PUMP C FLOW	<input type="checkbox"/>	<input type="checkbox"/>	FQ-100C	FLOW TOTALIZED	1							
VFD-100C	RAW WASTEWATER PUMP VFD	<input type="checkbox"/>	<input type="checkbox"/>	HS-100C	AUTO	1							
				SC-100C	SPEED COMMAND				1				
				ST-100C	SPEED FEEDBACK				1				
				XA-100C	FAULT				1				
				XC-100C	START / STOP				1				
				XS-100C	RUNNING				1				
				YY-100C	READY				1				
				PT-110	PIT-110								
					PRESSURE							1	
LSHH-200	LAGOON EFFLUENT TANK LEVEL	<input type="checkbox"/>		LSHH-200	HIGH HIGH								
LSLL-200	LAGOON EFFLUENT TANK LEVEL	<input type="checkbox"/>		LSLL-200	LOW LOW							1	

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EQUIPMENT TAG	EQUIPMENT DESCRIPTION	FUTURE	EXISTING	I/O TAG	DESCRIPTION	DI	DO	AI	AO	RTD	DEVCNET	ETHERNET IP	MODBUS TCP
LT-200	LAGOON EFFLUENT TANK LEVEL	<input type="checkbox"/>	<input type="checkbox"/>	LT-200	LEVEL					1			
FIT-200A	LAGOON EFFLUENT PUMP A FLOW	<input type="checkbox"/>	<input type="checkbox"/>	FIT-200A	FLOW					1			
				FQ-200A	FLOW TOTALIZED					1			
VFD-200A	LAGOON EFFLUENT PUMP VFD	<input type="checkbox"/>	<input type="checkbox"/>	HS-200A	AUTO					1			
				SC-200A	SPEED COMMAND					1			
				ST-200A	SPEED FEEDBACK					1			
				XA-200A	FAULT					1			
				XC-200A	START / STOP					1			
				XS-200A	RUNNING					1			
				YY-200A	READY					1			
FIT-200B	LAGOON EFFLUENT PUMP B FLOW	<input type="checkbox"/>	<input type="checkbox"/>	FIT-200B	FLOW					1			
				FQ-200B	FLOW TOTALIZED					1			

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EQUIPMENT TAG	EQUIPMENT DESCRIPTION	FUTURE	EXISTING	I/O TAG	DESCRIPTION	DI	DO	AI	AO	RTD	DEVICENET	ETHERNET IP	MODBUS TCP
VFD-200B	LAGOON EFFLUENT PUMP VFD	<input type="checkbox"/>	<input type="checkbox"/>	HS-200B	AUTO	1							
				SC-200B	SPEED COMMAND				1				
				ST-200B	SPEED FEEDBACK				1				
				XA-200B	FAULT	1							
				XC-200B	START / STOP				1				
				XS-200B	RUNNING				1				
				YY-200B	READY				1				
				PIT-210	PRESSURE						1		
				LSHH-300	DRY WELL FLOOD SWITCH								
				XY-1-605	UTILITY SUPPLY POSITION	1							
TS-605	AUTOMATIC TRANSFER SWITCH	<input type="checkbox"/>	<input type="checkbox"/>	XAH-300	ALARM	1							
				XY-2-605	GENERATOR SUPPLY POSITION	1							

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EQUIPMENT TAG	EQUIPMENT DESCRIPTION	FUTURE	EXISTING	I/O TAG	DESCRIPTION	DI	DO	AI	AO	RTD	DEVCENET	ETHERNET IP	MODBUS TCP
SP-D-621	600V MCC SURGE PROTECTION DEVICE	<input type="checkbox"/>	<input type="checkbox"/>	XA-621	FAULT	1							
UPS-810	CONTROL POWER UPS	<input type="checkbox"/>	<input type="checkbox"/>	EAX-810	SUPPLY FAIL	1							
TT-811	MAIN FLOOR TEMPERATURE	<input type="checkbox"/>	<input type="checkbox"/>	TT-811	TEMPERATURE					1			
TT-812	DRY WELL TEMPERATURE	<input type="checkbox"/>	<input type="checkbox"/>	TT-812	TEMPERATURE					1			
SD-820-824	SMOKE DETECTOR	<input type="checkbox"/>	<input type="checkbox"/>	XAH-820-824	ALARM	1							

1.0 GENERAL**1.1 Scope**

- .1 This section covers work related to Section 16010 for the provision of instrumentation.
- .2 Instruments in contact with potable water shall be suitable for potable water service and meet the requirements of NSF/ANSI 61 and NSF/ANSI 372.

1.2 Shop Drawings

- .1 Submit shop drawings and installation instructions in accordance with Section 01300 and 16010.

1.3 Operation and Maintenance Data

- .1 Provide operation and maintenance data as specified in Division 1 and 16010.

2.0 PRODUCTS**2.1 Flow Transmitter**

- .1 Magnetic flow meter, carbon steel with epoxy coating, 150 ANSI flange ends and grounding rings.
- .2 Teflon PFA lined flow tube, flush design, 316 stainless steel electrodes,
- .3 NEMA 4X transmitter enclosure with linear 4-20 mA output and additional pulse output,
- .4 Provide remote display, showing flow rate and totalizer.
- .5 Configurable for instantaneous flow rate in L/s and totalized flow in m³.
- .6 Power shall be 24 Vdc.
- .7 Refer to process drawings for flow meter sizes.
- .8 Flowmeter shall be rated for Zone 2 hazardous area and Category 1 rated.
- .9 Approved Products:
 - .1 Rosemount series 8705
 - .2 Endress + Hauser Promag W 400
 - .3 ABB FEW Watermaster

- .4 Approved equal.

2.2 Level Switch High, High High, Low, Low Low

- .1 Float switch in IP68 polypropylene body.
- .2 Flexible cable with PVC sheath.
- .3 SPDT switch rated 10A AC/DC
- .4 162mm regulator length for 0.95 – 1.10 g/cm³ density.
- .5 Complete with stainless steel sway rings
- .6 Approved Product: Flygt ENM-10.

2.3 Temperature Transmitter

- .1 3-wire Pt 100 RTD temperature probe with 1/2" NPT aluminum connection head.
- .2 24Vdc loop-powered transmitter.
- .3 4-20mA transmitter in NEMA 4X housing.
- .4 Temperature transmitter in the drywell shall be Zone 2 hazardous area and Category 1 rated.
- .5 Approved Product:
 - .1 Rosemount 248
 - .2 Approved equal.

2.4 Pressure Transmitter

- .1 Pressure transmitter shall be gauge type with LCD indicator/configurator.
- .2 Range: 0 to 1000 kPa. 4-20mA output
- .3 Run stainless steel instrument piping to wall location if transmitter is mounted above 1600 mm.
- .4 Dry well is Zone 2, Category 1 location. Intrinsically safe equipment shall be provided.
- .5 Approved Products
 - .1 Rosemount 2088G
 - .2 Endress + Hauser PMP51

- .3 Approved equal

2.5 Pressure Transmitter - Hydrostatic

- .1 Submersible hydrostatic level transmitters for monitoring water level. All materials and measuring techniques to be compatible with raw sewage, including sludge and installation inside wet well.
- .2 Wet well is Zone 1, Category 2 location. Intrinsically safe equipment shall be provided.
- .3 Range: 0 to 100 kPa. 4-20mA output.
- .4 42mm Stainless steel housing, easy clean, heavy duty assembly.
- .5 Hanging loop, with stainless steel chain attachment for instrument removal
- .6 Approved Products
 - .1 Dwyer PBLTX
 - .2 Endress + Hauser FMX21
 - .3 Approved equal

3.0 EXECUTION

3.1 Installation

- .1 Supply and installation of instruments as specified within the specifications and drawings.
- .2 Supply all wiring, conduits, mounting hardware, terminals and other ancillary devices as required for installation of a complete working system.
- .3 Locate instruments in accordance with drawings. Refer to the structural, process, and mechanical drawings to assist in actual placement of instruments.
- .4 Install instruments level and plumb in such a manner as to provide access, protection from heat, shock, and vibration and freedom from interference with other equipment.
- .5 Instruments shall be mounted in such a position so they are readable from the floor.
- .6 Install instrument and control displays at 1500 mm unless indicated otherwise. Extend sensing lines or supply manufacturer's remote mounting kits as required for specified mounting heights.

- .7 Provide laminoid identification tags for each instrument as listed in the instrumentation schedule.
- .8 Manufacturer's and CSA labels to be visible and legible after equipment is installed.
- .9 Allow sufficient clearance for removal of equipment such as level displacers and floats, rotameter floats, control valve diaphragms and plugs.
- .10 Mount instruments on building columns and walls where accessible. Supply pipe stands or other supports where mounting on walls or columns is not practical.
- .11 Install instruments and control equipment per the manufacturer's instructions.
- .12 Install instruments with proper grounding, follow manufacturer's recommended procedures for grounding.

3.2 Process Piping Connections

- .1 Make connections in accordance with instrument mounting details and the drawings.
- .2 Process connections shall be from horizontal centreline of the pipe.
- .3 Supply and install all pneumatic and hydraulic tubing, piping, and tubing trays associated with instrumentation.
- .4 Piping, tubing, fittings and valves for process connections to instruments to be same type, material and pressure standard as specified for the process piping to which it is connected.
- .5 Install unions in the piping or tubing to allow easy removal of the instruments for replacement or service.
- .6 Install process leads sloped and vented.
- .7 Install flow tube with minimum five upstream and two downstream pipe diameters free of tees, elbows, or reducers. Coordinate with mechanical contractor.

3.3 Calibration

- .1 Arrange and pay for services of manufacturer factory service technician to supervise start-up of installation, check, adjust, balance and calibrate instruments.
- .2 Calibrate instruments per the specifications when ranges other than the factory settings are required.

- .3 Perform loop tests and calibration tests for each instrument. Complete manufacturer stat-up and calibration checklists and submit to Engineer.

3.4 Field Quality Control

- .1 Perform tests in accordance with Section 16010 – Electrical - General Requirements.

END OF SECTION