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- 1 WORK INCLUDED .1 Provide all labour, tools, and equipment necessary to complete the electrical and instrumentation removals, replacements and installations at the pump houses as indicated on the drawings including the installation of the pre-packaged pump station and appurtenances and as specified herein.
- .1 Supply and install PLC/RTU control panels as specified herein and on the drawings.
- .2 Remove existing electrical, control and instrumentation equipment as indicated on the drawings. Remove associated cables/wires and conduits back to the source from which they are fed controlled.
- .3 Provide and install general electrical equipment as indicated on the drawings and specified herein.
- .4 At the Brackley sewage pump station, coordinate with the power utility for replacement of the main disconnect switch. Pay all associated fees.
- .5 At the Cavendish Campground pump station coordinate with the power utility for replacement of the power conductors and conduit from Transformer T6 to the Pump Station.
- .6 Provide and install power and control/instrumentation wiring and conduits as shown on the drawings.
- .7 Provide and install Control panels, radio communications system and instrumentation equipment as indicated on the drawings and specified herein.
- .8 Provide and install grounding necessary to satisfy the CEC - Part 1 and the local provincial inspection authority.
- .9 Document, test and calibrate to the satisfaction of the Departmental Representative all electrical and instrumentation equipment as specified herein and on the drawings.
- .10 Safely store electrical equipment awaiting installation.
- .11 Protect installed electrical, controls and instrumentation equipment during construction.
- .12 Replace/repair equipment damaged during construction, or otherwise deemed defective or non-compliant with this specification at no expense to the Contract. These expenses will include all material, labour and other fees.
- .13 Coordinate and schedule with other trades to ensure that the construction proceeds in a timely and efficient manner.
- .14 Coordinate with the Departmental Representative, control supplier, pump supplier and instrumentation equipment supplier for proper set-up of pump controllers, instrumentation and equipment at the time of commissioning.
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2 RELATED WORK

- .1 Grounding - Secondary: Section 26 05 28
- .2 Splitters, Junction, Pull Boxes and Cabinets:
Section 26 05 31
- .3 Installation of Cables in Trenches and Ducts:
Section 26 05 44
- .4 Panelboard Breaker Type: SEction 26 24 17
- .5 Disconnect Switches - Fused and Non-Fused:
Section 26 28 23

3 REFERENCES

- .1 CSA C22.1-2015, Canadian Electrical Code, Part 1,
Safety Standard for Electrical Installations.
- .2 CSA C22.3 No.1-2010, Overhead Systems.
- .3 CSA C22.3 No. 7-2010, Underground Systems.
- .4 CAN3-C235-83(R2010), Preferred Voltage Levels for AC
Systems, 0 to 50 000 V.

4 CODES AND
STANDARDS

- .1 Do complete installation in accordance with CSA
C22.1, Canadian Electrical Code, Part I, Safety
Standard for Electrical Installations, except where
specified otherwise.
- .2 Do overhead and underground systems in accordance
with CSA C22.3 No. 7, Underground Systems, except
where specified otherwise.
- .3 Conform to CAN3 C235, Preferred Voltage Levels for
AC Systems, 0 to 50 000V.

5 PERMITS, FEES
AND INSPECTIONS

- .1 Submit to the Electrical Inspection Department,
Municipal Authority and Supply Authority the
necessary number of drawings and specifications, for
examination and approval prior to commencement of
work. Submit this information within twenty (20)
working days of the award of Tender and provide the
Departmental Representative with written notice at
the time this has been submitted.
- .2 Provide the Departmental Representative with a copy
of the Electrical Inspection Department and Supply
Authority Plans Review Report, immediately upon
receipt. No shop drawings will be reviewed prior to

5 PERMITS, FEES
AND INSPECTIONS
(Cont'd)

- .2 (Cont'd)
receipt of the Plans Review Report from the Contractor.
- .3 Obtain all necessary permits including an Electrical Wiring Permit for electrical work and Communications Cabling Permit for communications cabling Work from the authority having jurisdiction, prior to commencement of Work. Provide a copy of each permit to the Departmental Representative upon receipt. Display permits properly on the Work site.
- .4 Upon specific request, the Departmental Representative will provide, to the Contractor, up to a maximum of three (3) copies of the drawings and specifications required for submittal to the Electrical Inspection Department and Supply Authority. These drawings and specifications will be provided to the Contractor at no cost.
- .5 Arrange for all required inspections to be conducted by the authority having jurisdiction. Provide a copy of all inspection reports to the Departmental Representative immediately upon receipt. Notify the Departmental Representative immediately of changes required by the authority having jurisdiction, prior to making changes.
- .6 Furnish Certificates of Acceptance from authorities having jurisdiction upon completion of work. Include a copy in the Operation and Maintenance Manual.
- .7 Pay all associated fees.

6 SHOP DRAWINGS,
PRODUCT DATA AND
SAMPLES

- .1 Submit shop drawings, product data and samples in accordance with Section 01 33 00.
- .2 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .3 Where applicable, include wiring, single line and schematic diagrams.
- .4 Include wiring drawings or diagrams showing interconnection with work of other Sections.

7 OPERATION AND
MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual in accordance with Section 01 78 00.
- .2 Include in operations and maintenance data:
 - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.
 - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
 - .3 Wiring and schematic diagrams and performance curves.
 - .4 Names and addresses of local suppliers for items included in maintenance manuals.
 - .5 Copy of reviewed shop drawings.

8 CARE, OPERATION
AND START-UP

- .1 Instruct operating personnel in the operation, care and maintenance of equipment.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.
- .3 Except where note otherwise, provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

9 VOLTAGE RATINGS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, heating, ventilation, 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.

10 MATERIALS AND
EQUIPMENT

- .1 Provide materials and equipment in accordance with Section 01 33 00.
- .2 Equipment and material to be CSA certified or certified by an agency approved by the Electrical Inspection Department.
- .3 Where there is no alternative to supplying equipment which is not certified (CSA or other approved certification agency), obtain special approval, in writing, from Electrical Inspection Department.
- .4 Factory assemble control panels and component assemblies.
- .5 Use stainless steel fasteners throughout for all conduits, cables and equipment. Fasteners include nuts, bolts, screws and washers.
- .6 Wall mount electrical distribution equipment and control panels on 21 mm thick fire retardant plywood backboards. paint backboard with two (2) coats of fire retardant paint to match wall colour.

11 ELECTRIC MOTORS,
EQUIPMENT AND
CONTROLS

- .1 Coordinate supplier and installer responsibility for mechanical and process equipment specified in other specification divisions to achieve a complete and functioning system.
- .2 Confirm location of mechanical and process equipment and associated control devices specified in other divisions. Device locations may not be necessarily shown on the electrical drawings.

12 FINISHES

- .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean, prime and paint exposed hangers, racks, fastenings to prevent rusting.

13 EQUIPMENT
IDENTIFICATION

- .1 Identify electrical equipment with nameplates as specified herein.
- .2 Identification:
 - .1 Provide panels, disconnect switches, splitters, receptacles, transformers, control panels, magnetic starters, TOL's, etc. with "lamicoid" nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true and level, and plumb in all instances.
 - .2 Affix nameplates to surfaces with contact type cement.
 - .3 Affix nameplates to building "exterior" surfaces with nylon inserts and self tapping screws unless specifically indicated otherwise.
 - .4 Apply contact type cement to complete rear side of plate (battered), as opposed to several locations or areas on same.
 - .5 Lamicoid nameplates installed on distribution panelboards, transformers, and splitters to indicate the following:
 - .1 Designated name of equipment.
 - .2 Amperage of overcurrent protection device.
 - .3 Voltages, number of phases and wires.
 - .4 Designation of power source.

PANEL C - 100 AMPS
120/208V - 3 PH - 4 2
FED FROM PANEL B
 - .6 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, etc., to contain the following information:
 - .1 Designated name of equipment or equipment being fed, whichever is applicable.
 - .2 Designated name of power source.
 - .3 Branch circuit breaker number(s) where possible.
 - .4 Voltage(s) and phase.

FAN NO. 5 SUPPLY FAN NO. 3
PANEL H - CKT.17 M.C.C. NO. 1
120V - 1 PH 600V - 3 PH
 - .7 Lamicoid nameplates installed on fusible type disconnect switches to also indicate the maximum designated/designed fuse size.
 - .8 Install lamicoid nameplates on all junction and pull boxes sized 150 mm x 150 mm and larger indicating name of system, designated panel name and electrical characteristics where applicable.

13 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .2 Identification:(Cont'd)
- .9 Install lamicaid nameplates above all types of receptacles and abutted directly to tops of their respective device plates. Identification is to indicate respective panel source complete with associated circuit breaker number(s). Lamicaid plate to be 1.5 mm thick x 13 mm high complete with 6 mm black letters on white core, directly above all flush receptacles. Plate to be identical width as finish device plate and the top left and right corners are to be rounded off.
- .10 Identify lamicaid nameplates above 120V receptacles protected by GFCI circuit breakers, or GFCI type receptacles as per the following:
- .1 1.5mm thick x 19mm wide complete with 6 mm black letters on white core above all receptacles. Identical width as finish device plate (EX: GFCI Protected Panel H-26).
- .11 Allow for an "average" of 40 letters for each lamicaid nameplate.
- .12 Lamicaid to be 3 mm thick plastic engraving sheet, white face, black core, for all electrical systems.
- .13 Lettering on lamicaid nameplates must not "start", nor "end" nearer than 9 mm from either, or both ends of said plates.
- .14 Size of lettering, including overall lengths of various plates must be as indicated in the following chart.

NOMINAL NAMEPLATE SIZES

Size 1	10mm x 50mm	1 line	5mm high letters
Size 2	13mm x 75mm	1 line	6mm high letters
Size 3	16mm x 75mm	2 lines	5mm high letters
Size 4	19mm x 90mm	1 line	10mm high letters
Size 5	50mm x 90mm	2 lines	13mm high letters
Size 6	25mm x 100mm	1 line	13mm high letters
Size 7	25mm x 100mm	2 lines	6mm high letters
Size 8	50mm x 150mm	2 lines	13mm high letters
Size 9	50mm x 100mm	3 lines	10mm high letters

- .3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .4 Coordinate names of equipment and systems with other trades to make equipment identification consistent.
- .5 Identification to be English.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

13 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .7 Install lamicoid nameplates on, or adjacent to, all various systems' control panels and/or cabinets. Nameplates to reflect individual systems assigned name and where applicable, must also indicate designated name of power source and branch circuit breaker number(s) and voltage(s) and phase.
- .8 Provide clearly visible marking on electrical equipment to warn persons of potential electrical shock and arc flash hazards as specified in Section 2 of the Canadian Electrical Code.
- .9 Provide terminal boxes, panels and miscellaneous equipment fed from two (2) or more sources with a warning nameplate prominently displayed: "CAUTION - MORE THAN ONE (1) SOURCE VOLTAGE".
- .10 Terminal boxes, panels and miscellaneous wire ways containing intrinsically safe circuits shall be provided with a warning nameplate prominently displayed: "INTRINSICALLY SAFE CIRCUIT".

14 WIRING
IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.

15 WIRING
TERMINATIONS

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

16 MANUFACTURERS'
AND CSA LABELS

- .1 Visible and legible after equipment is installed.

17 WARNING SIGNS

- .1 Provide warning signs as specified and to meet requirements of Electrical Inspection Department. Include arc flash hazard equipment labels.
- .2 Porcelain enamel signs, minimum 180 x 250 mm.

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| <u>18 MOUNTING
HEIGHTS</u> | .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 Panelboards: as required by the code or as indicated.
.2 Wall receptacles: 1200 mm AFF
.3 Lighting switches: 1350 mm AFF |
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| <u>19 PROTECTION</u> | .1 | Protect exposed live equipment during construction for personnel safety. |
| | .2 | Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage in English. |
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| <u>20 LOAD BALANCE</u> | .1 | Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes. |
| | .2 | Submit, at completion of Work, report listing phase and neutral currents on panelboards and transformers operating under normal load. State hour and date on which each load was measured, and voltage at time of test. |
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| <u>21 TESTS</u> | .1 | Conduct and pay for tests of the following:
.1 Power distribution system including phasing, voltage, grounding and load balancing.
.2 Circuits originating from branch distribution panels.
.3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
.4 Lighting and its control |
| | .2 | Furnish manufacturer's, certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturers instructions. |
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| 21 TESTS
(Cont'd) | .3 | Advise Departmental Representative of dates when testing will take place. Provide five (5) days notice of such tests. |
| | .4 | Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. |
| | .5 | Submit test results for Departmental Representative's review and approval. |
| | .6 | Insulation Resistance Testing:
.1 Megger circuits, feeders and equipment up to 350 V with 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Check resistance to ground before energizing.
.4 Provide typewritten tabular report indicating test results. |
| | .7 | Provide a typewritten tabular report indicating the normal field measured load current for all motors indicating the motor circuit over current protection settings. Indicate the motor nameplate current. |
| | .8 | Provide typewritten reports for "as-commissioned" settings for VFD's. |
| 22 CO-ORDINATION
OF PROTECTIVE
DEVICES | | |
| | .1 | Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings. Obtain motor data from the equipment supplier. |
| 23 CLEANING | | |
| | .1 | Do final cleaning in accordance with Section 01 10 10. |
| | .2 | Clean the interior of all power distribution equipment, cabinets and control equipment. |
| | .3 | At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt. |
| 24 QUALITY
ASSURANCE | | |
| | .1 | Instructions:
.1 Interferences: electrical drawings are generally of a diagrammatic nature. Plan and coordinate the Work to eliminate interferences with other trades. Provide all necessary raceway offsets, |
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24 QUALITY
ASSURANCE
(Cont'd)

- .1 Instructions:(Cont'd)
 - .1 (Cont'd)
fittings, and boxes, adjust all equipment boxes, adjust all equipment locations and provide all supporting materials required for a planned, coordinated and neat installation. Where interferences occur, the Departmental Representative's authorized representative will decide which item must be relocated regardless of which was installed first.
 - .2 Electrical workmanship: provide workmanship of the highest quality. Sub-standard Work will not be accepted. Use only persons skilled in the trades involved.
 - .3 Electrical materials: provide all materials used in this work, unless particularly specified otherwise, that are new, free from flaws, or imperfections.
 - .4 Sleeves and inserts: furnish and locate all sleeves and inserts required for this work in accordance with drawings.
- .2 Applicable standards:
 - .1 Electrical Work to conform with the requirements and recommendations of the latest edition of the Canadian Electrical Code and all local codes and ordinances. In conflicts between codes, the more stringent requirements will govern.
 - .2 In no instance will the standard established by this specification be reduced by any of the codes or standards referred to in this specification.
 - .3 Standards: the specifications and standards of the following organizations are by reference made as part of these specifications and all electrical Work, unless otherwise indicated, must comply with their requirements and recommendations wherever applicable.
 - .4 Canadian Standard Association (CSA).
 - .5 Institute of Electrical and Electronics Engineers (I.E.E.E.).
 - .6 Instrument Society of America (I.S.A.).
 - .7 American Society for Testing Materials (A.S.T.M.).
 - .8 Insulated Power Cable Consultants Association (I.P.C.E.A.).
 - .9 National Manufacturer's Association of Canada (N.E.M.A.).
 - .10 National Fire Protection Association (N.F.P.A.).
 - .11 Underwriter's Laboratories of Canada (U.L.C.).
 - .12 Joint Industrial Council (J.I.C.)

25 PROCESS/
MECHANICAL
EQUIPMENT PROCESSES

- .1 Coordinate electrical work with the pumping, process and mechanical system vendors.
- .2 Verify connection details and requirements for interwiring process and mechanical equipment packages as specified in other divisions.
- .3 Refer to manufacturer's shop drawings for connection details and recommended installation details.
- .4 Supply and install cable, conduit, supports and miscellaneous hardware as per the requirements of this Specification.

26 RECORD
DRAWINGS

- .1 Record Drawings:
 - .1 After award of Contract, Departmental Representative will provide a set of full-sized drawings for purpose of maintaining record drawings. Accurately and neatly record deviations from Contract Documents caused by site conditions and changes ordered by Departmental Representative.
 - .2 Identify drawings as "Project Record Copy". Maintain in new condition and make available for inspection on site by Departmental Representative.
 - .3 On completion of Work and prior to final inspection, submit record documents to Departmental Representative.
 - .4 Refer to Section 01 78 00 for more details.

27 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Remove from site and dispose of all debris and waste materials at appropriate disposal/recycling facilities.
- .2 Separate and recycle waste materials in accordance with applicable Construction/Demolition Waste Management and Disposal Regulations.
- .3 Refer to Section 01 35 44 for additional requirements for disposal and recycling.

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Electrical General Requirements: Section 26 05 00
 - .2 Motor Connections: Section 26 29 13

PART 2 - PRODUCTS

- 2.1 WIRE AND BOX CONNECTORS
- .1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
 - .2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
 - .3 Tin-plated copper, colour-keyed, crimp type compression connectors (long barrel, two hole) with a straight, 45°, or 90° lug tongue configuration as required.
 - .1 Acceptable products: Thomas & Betts "Color-keyed" compression connectors or approved equivalent.
 - .4 Clamps or connectors for armoured cable, liquid tight, flexible conduit, as required.
 - .5 All wire connectors shall be rated for operating voltage indicated.

PART 3 - EXECUTION

- 3.1 WIRE AND BOX CONNECTORS INSTALLATION
- .1 Make all connections and terminations electrically and mechanically secure. Sizes of connectors shall be as per manufacturer's recommendations for various sizes and combinations of wire sizes.
 - .2 Make joints required in lighting and receptacle branch wiring #8 AWG and smaller utilizing "twist-on" type connectors as manufactured by "Ideal" (colour coded wirenut) or "Marrettes" #31, #33 or #35, or approved equivalents.

3.1 WIRE AND BOX
CONNECTORS
INSTALLATION
(Cont'd)

- .3 Make joints required in receptacle branch wiring larger than #8 AWG shall be made utilizing colour keyed crimp type compression connectors (two hole, long barrel, tin-plated copper) complete with manufacturer approved compression tools. Install layers of rubber insulating type tape followed by additional layers of vinyl electrical tape in accordance with the manufacturer's instructions.. Compression connectors shall be bolted together and torqued in accordance with manufacturer's recommendation.
- .4 "Twist-on" type connectors to be plier tightened.
- .5 Make connections to equipment not provided with lugs utilizing colour keyed, crimp type compression connectors (long barrel, two hole, tin-plated copper, straight lug tongue) complete with manufacturer approved compression tools. Alternate lug tongue configurations (45° and 90°) will be accepted where required by application.

PART 1 - GENERAL

- 1.1 SUBMITTALS .1 Submit shop drawings, and product data in accordance with Section 01 33 00.
- 1.2 RELATED SECTIONS .1 Conduits, Conduit Fastenings and Conduit Fittings: Section 26 05 34
- .2 Wire and Box Connectors (0 - 1000V): Section 26 05 20
- .3 Primary Process Instrumentation Devices and Cabling: Section 26 91 00
- 1.3 REFERENCES .1 CSA C22.1-15, Canadian Electrical Code.

PART 2 - PRODUCTS

- 2.1 BUILDING WIRES .1 Conductors: soft drawn stranded, copper. Minimum size #12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90-XLPE
- .3 Copper conductors: size as indicated, with 1000V insulation of chemically cross-linked thermosetting polyethylene material rated RUW90-XLPE.
- .4 Colour code Wiring in accordance with the Canadian electrical Code.
- 2.2 PROCESS CONTROL CABLING .1 Refer to Section 26 90 00.

PART 3 - EXECUTION

3.1 INSTALLATION OF BUILDING WIRES .1 Install wiring as follows:
.1 In conduit systems in accordance with Section 26 05 34.

3.2 INSTALLATION OF CABLES: GENERAL .1 Support cables independently of supports used for equipment of other trades; do not support from or secure cables to ductwork, piping.
.2 Install cables in a neat and professional manner, so as to conserve headroom.
.3 Install cables parallel and perpendicular to building lines.
.4 In process areas and outdoors, cables shall enter into the bottom of the equipment.
.5 Twist together stranded conductors at each termination.
.6 Drop cables vertically from ceiling above. Avoid running cables horizontally on walls except in between adjacent wall mounted equipment.
.7 Terminate conductors/cables.

PART 1 - GENERAL

- 1.1 RELATED WORK .1 Electrical general requirements: Section 26 05 00
- 1.2 REFERENCES .1 IEEE 837-2002, Qualifying Permanent Connections Used in Substation Grounding.
- 1.3 PRODUCT DATA .1 Submit product data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

- 2.1 EQUIPMENT .1 Clamps for grounding of conductor, size as required to grounding electrodes.
- .2 Direct buried grounding conductors: bare stranded copper, un-tinned, soft annealed, size as indicated.
- .3 Insulated grounding and bonding conductors: soft-drawn, stranded copper, type RW90 green coloured insulation, size as indicated. Conductors to be FT4 rated when installed in free air
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
- .1 Grounding and bonding bushings.
- .2 Protective type clamps.
- .3 Bolted type conductor connectors.
- .4 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.
- .7 Copper crimp type compression connectors, (long barrel, one or two hole as space permits).
- .8 Copper crimp type compression connectors (cable to cable, cable to ground rod, etc.).
- 2.2 MANUFACTURERS .1 Acceptable manufacturers: FCI - Burndy Corporation, Erico Inc., Thomas & Betts, Ilsco.

PART 3 - EXECUTION

3.1 INSTALLATION
GENERAL

- .1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including, conductors, connectors, accessories, as indicated, to conform to requirements of Departmental Representative, and local authority having jurisdiction over installation.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections and connections to electrodes using copper welding process by thermit process or inspectable copper crimp type compression connectors.
- .5 Use mechanical connectors for grounding connections to equipment provided with grounding lugs.
- .6 Soldered joints not permitted.
- .7 Make grounding connections in radial configurations only, with connections terminating at single grounding point. Avoid loop connections.
- .8 Provide insulated copper bonding conductor in all conduit runs. Size bonding conductor per the Canadian Electrical Code (minimum size #14 AWG).

3.2 SYSTEM AND
CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of secondary systems.

3.3 EQUIPMENT
GROUNDING AND
BONDING

- .1 Install grounding and/or bonding connections to typical equipment included in, but not necessarily limited to, the following list: frames of motors, motor starters, control panels, distribution panels, process equipment, communications equipment, instrumentation and pipe systems.

- 3.4 FIELD QUALITY CONTROL
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- .1 Perform tests in accordance with Section 26 05 00.
 - .2 Perform tests before energizing electrical system.
 - .3 Disconnect ground fault protection during tests.

PART 1 - GENERAL

- 1.1 RELATED WORK .1 Conduits, Conduit Fastenings and Conduit Fittings:
Section 26 05 34

PART 2 - PRODUCT

- 2.1 SUPPORT CHANNELS .1 U shape, size 41 mm x 41 mm, 2.7 mm thick, surface mounted, suspended or set in poured concrete walls and ceilings unless otherwise indicated.
- .2 Standard rolled structural steel shapes and plates or prefabricated structural systems.
- .3 Unless otherwise indicated, use hot dipped galvanized steel (after fabrication) or stainless steel. Zinc plated not acceptable.
- 2.2 CABLE TIES .1 Nylon flame retardent, low smoke cable tie, size as required.
- .2 Nylon flame retardant, low smoke cable tie mounting bracket. Mechanical fastening type only; adhesive mounts not acceptable.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls with stainless steel toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
.1 One-hole straps to secure surface conduits and cables 50 mm and smaller.

3.1 INSTALLATION
(Cont'd)

- .5 (Cont'd)
 - .2 Two-hole straps for conduits and cables larger than 50 mm.
 - .3 Conduit straps to match conduits in material and finish. Cable straps to be galvanized steel or stainless steel.
 - .4 Use heavy duty cable/conduit clamps (with adjustable saddles) to secure conduits/cables to support channels.
- .6 Suspended support systems for horizontal runs.
 - .1 Support individual cable and conduit runs with minimum 9 mm dia. continuously threaded rods and spring clips.
 - .2 Support 2 or more cables and conduits on channels supported by minimum 12 mm dia threaded rod hangers where direct fastening to building construction is impractical.
 - .3 Continuously threaded rods shall be zinc plated or stainless steel to match supporting hardware.
- .7 For surface mounting of two or more conduits and cable, use channels spaced in accordance with the Canadian Electrical Code (maximum 1.5m spacing).
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Provide adequate support for conduits and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure conduits or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Owner's representative.
- .12 Provide fastenings and supports as required for each type of equipment, cables and conduits, and in accordance with manufacturer's installation recommendations.
- .13 Various suspended types of junction, pull and/or outlet boxes as well as conduits, are to be supported with minimum size 9 mm threaded rod, nuts and flat washers. Threaded rods to be secured to boxes with one flat washer and nut installed on both sides of box.
 - .1 One rod required for all type boxes sized 150 mm x 150 mm and smaller.

3.1 INSTALLATION
(Cont'd)

- .13 (Cont'd)
 - .2 Two rods required for boxes sized 200 mm x 200 mm and larger, up to and including those sized 300 mm x 300 mm.
 - .3 Minimum of four rods required for all boxes sized larger than 300 mm x 300 mm.
 - .4 All excess rod is to be cut-off within 12 mm of channel bottom.
- .14 In addition to C.E.C. minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one additional support rod installed not greater than 300 mm and mid point of "all" 90° bends. Maximum spacings between conduit support channels shall be as dictated by smallest size conduit(s) being supported and/or secured to same.
- .15 Where galvanized steel supports are exposed to moisture, touch-up all field cut surfaces with galvanizing paint.

PART 1 - GENERAL

- 1.1 SUBMITTALS .1 Submit shop drawings, and product data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

- 2.1 JUNCTION AND PULL BOXES .1 Unless otherwise noted, all junction and pull boxes shall be minimum NEMA 4X.
- .2 Junction and pull boxes larger than 200mm x 200mm shall be complete with continuously hinged door. Junction and pull boxes 200mm x 200mm and smaller shall be complete with screw cover.
- .3 Junction boxes located outdoors shall be equipped with locking door/cover.
- .4 Hazardous Rated Boxes:
.1 Boxes shall be suitable for the hazardous classification as noted on the drawings.
.2 Boxes shall be cast ferrous metal boxes with threaded connection for use with threaded galvanized steel conduit.
.3 Boxes shall be copper free cast aluminum boxes with threaded connections for use with threaded aluminum conduit.
- .5 Provide terminal blocks (rated minimum 30A, 600V, quantity as required) in junction boxes used to connect integral cabling from devices (pumps, float switches, level sensors, etc.) located in the pump house.
- 2.2 SPLITTER BOX .1 14 gauge steel enclosure, welded corners and formed hinged cover suitable for locking in the closed position.
- .2 Phenolic insulated splitter blocks to match required number and size of incoming and outgoing conductors as indicated.
- .3 Provide minimum of three (3) spare terminals on each set of lugs.
- .4 Electrical ratings as indicated on Drawings.

- | | | |
|-------------------------------------|----|--|
| <u>2.2 SPLITTER BOX</u>
(Cont'd) | .5 | Unless otherwise indicated on the Drawings, enclosure rating shall be NEMA 4X. |
| | .6 | Finish: unpainted and brushed smooth |
| | .7 | Acceptable Materials: EXM 1400TSS Series or approved equivalent. |

PART 3 - EXECUTION

- | | | |
|---|----|--|
| <u>3.1 JUNCTION AND
PULL BOX
INSTALLATION</u> | .1 | Install junction and pull boxes in inconspicuous but accessible locations. |
| | .2 | Mount junction and pull boxes as noted on the Drawings and as described in the specifications. |
| | .3 | Provide all required mounting hardware. |
| <u>3.2 SPLITTER BOX</u> | .1 | Install splitters where indicated. Mount plumb, true and square to building lines. |
| <u>3.2 IDENTIFICATION</u> | .1 | Provide equipment identification in accordance with Section 26 05 00. |
| | .2 | Install size 2 identification labels indicating source, voltage and phase. |

PART 1 - GENERAL

1.1 REFERENCES .1 CSA 22.1-15, Canadian Electrical Code.

1.2 PRODUCT DATA .1 Submit product data in accordance with Section
01 33 00

PART 2 - PRODUCTS

- 2.1 OUTLET AND CONDUIT BOXES .1 General:
.1 Size boxes in accordance with CSA C22.1.
.2 100 mm square or larger outlet boxes as required for special devices.
.3 Gang boxes where wiring devices are grouped.
.4 Blank cover plates for boxes without wiring devices.
.5 Combination boxes with barriers where outlets for more than one system are grouped.
- .2 Surface mounted outlet boxes:
.1 Cast FS or FD copper free aluminum boxes with factory threaded hubs and mounting feet for surface wiring of switches and receptacles.
- .3 NEMA 4X PVC outlet boxes where conduit is PVC and as required.
- .4 Hazardous rated outlet boxes:
.1 Surface mounted, single gang, cast aluminum outlet box with factory threaded hubs, rated for installation in the hazardous area classification as noted on the drawings.
.2 Ensure that the outlet box and device are compatible and that the required hazardous rating is maintained.
- 2.2 FITTINGS - GENERAL .1 Bushing and connectors with nylon insulated throats.
.2 Knock-out fillers to prevent entry of foreign materials.
.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

2.2 FITTINGS -
GENERAL

(Cont'd)

PART 3 - EXECUTION

- .4 Double locknuts and insulated bushings on sheet metal boxes. Use watertight locknuts for all cable/conduit terminations in process control cabinets and NEMA 4X pull and junction boxes.

3.1 OUTLET BOX,
AND CONDUIT BOX
INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of construction material.
- .3 Provide correct size of openings in boxes for conduit and armoured cable connections. Reducing washers not allowed.

PART 1 - GENERAL

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|------------------------------------|----|--|
| <u>1.1 LOCATION OF
CONDUIT</u> | .1 | Drawings do not show all conduits. Those shown are in diagrammatic form only. |
| | | |
| <u>1.2 RELATED WORK</u> | .1 | Wires and Cables (0 - 1000V): Section 26 05 21 |
| | .2 | Fastenings and Supports: Section 26 05 29 |
| | .3 | Outlet Boxes, Conduit Boxes and Fittings: Section 26 05 32 |
| | .4 | Excavating, Trenching and Backfilling: Section 31 23 10 |
| | | |
| <u>1.3 REFERENCES</u> | .1 | CAN/CSA-C22.2 No. 18-04, Outlet Boxes, Conduit Boxes and Fittings and Associated Hardware. |
| | .2 | CSA-C22.2 No.45.1-2007(R2012), Electrical Rigid Metal Conduit - Steel. |
| | .3 | CSA-C22.2 No.45.2-2008(R2013), Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel. |
| | .4 | CSA-C22.2 No. 56-13, Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit. |
| | .5 | CSA-C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit. |

PART 2 - PRODUCTS

- | | | |
|---------------------|----|--|
| <u>2.1 CONDUITS</u> | .1 | Rigid galvanized steel threaded conduit, fittings and connectors: to CSA C22.2 No. 45.1. |
| | .2 | Rigid aluminum threaded conduit, fittings and connectors: to CSA C22.2 No. 45.2. |
| | .3 | Rigid PVC conduit, fittings and connectors: to CSA C22.2 No. 211.2. |
-

2.1 CONDUITS
(Cont'd)

- .4 Flexible aluminum conduit and liquid-tight flexible metal conduit: to CSA C22.2 No. 56.
- .5 Minimum power and control/instrumentation conduit size for all areas: 21mm.
- .6 Rigid PVC conduit shall be FT4 rated.

2.2 CONDUIT
FASTENINGS

- .1 One (1) hole conduit straps to secure surface conduits 50 mm and smaller. Two (2) hole conduit straps for conduits larger than 50 mm.
- .2 Heavy duty pipe clamps (with adjustable saddle) to secure conduits to support channels.
- .3 Refer to specification Section 26 05 29 for suspended and surface support systems for conduits.
- .4 Finish and material to match conduit.

2.3 CONDUIT
FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 27mm and larger conduits.

2.4 EXPANSION
FITTINGS FOR RIGID
CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for linear expansion as required.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to building as required.
- .4 Provide expansion fittings at exit point (above-ground) of all underground services, and where indicated on the drawings.
- .5 Where rigid PVC conduit is used indoors or above ground, provide expansion fittings spaced in accordance with manufacturers' instructions and the Canadian Electrical Code.

2.5 FISH CORD .1 Polypropylene.

PART 3 - EXECUTION

3.1 CONDUIT
INSTALLATION .1 General:

.1 Use rigid aluminum or hot dipped galvanized steel threaded conduit unless otherwise indicated.

.2 Use rigid PVC conduit underground: minimum size 27mm diameter. Rigid PVC conduits are also permitted to be used in the Pumphouse buildings where not subjected to mechanical damage. Do not run rigid PVC conduit through attic spaces.

.3 In non-hazardous areas, use liquid-tight flexible metal conduit for connection to motors and other vibrating and/or mechanical equipment including but not limited to the following: valves, instruments, transformers and motorized dampers.

.4 In hazardous areas, use flexible couplings (explosion-proof, watertight, Appleton Type EXGJH or EXLK or approved equivalent for vibrating equipment (motors, valves, etc.)).

.5 Install conduits overhead as high as possible to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

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

.7 Mechanically bend steel conduit over 19 mm dia.

.8 Field threads on rigid threaded conduit must be of sufficient length to draw conduits up tight.

.9 Install polypropylene fish cord in each spare conduit. Cap and seal at each end.

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

.11 Dry conduits out before installing wire.

.12 Provide minimum 300 mm spacing between instrumentation/control conduits and 600V power conduits. Where possible, instrumentation control conduits to cross at right angles to 600V power conduits.

.13 Seal around all conduit penetrations into the wet well with non-shrink grout. Seal conduits penetrating into the wet well using duxseal.

.14 Install conduit sealing fittings in hazardous areas in accordance with Canadian Electrical Code requirements. Fill with compound. All conduit leaving a hazardous area shall be sealed using an approved sealing fitting when conduit is continuous.

.15 Drawings do not show all required unions. Unions shall be installed to facilitate removal of

3.1 CONDUIT
INSTALLATION
(Cont'd)

- .1 General:(Cont'd)
 - .15 (Cont'd)
equipment. Where seals are installed, the unions shall be installed between the equipment and the seal.
 - .16 Conduits shall be installed to prevent low pockets where moisture can accumulate. A combination breather and drain fitting shall be installed at the lowest point of each above-grade conduit system, which is unbroken by sealing fittings or other obstructions.
- .2 Surface conduits:
 - .1 Run parallel or perpendicular to building lines.
 - .2 Group conduits wherever possible on suspended or surface channels.
 - .3 Do not pass conduits through structural members except as indicated.
 - .4 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum 25 mm at crossovers.
 - .5 Fasten to flutes of metal roof deck when practical.
 - .6 Do not run conduits where they might obstruct lifting devices such as monorails.
 - .7 Install support channels on walls for vertical conduit drops.
- .3 Concealed conduits:
 - .1 Do not install horizontal runs in masonry walls.
 - .2 Do not install conduits in concrete toppings.
 - .3 Run parallel or perpendicular to building lines.
- .4 Conduits underground: slope conduits to provide drainage.

PART 1 - GENERAL

1.1 RELATED WORK .1 Electrical General Requirements: Section 26 05 00

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 CABLE
INSTALLATION IN
DUCTS .1 Install cables as indicated in ducts.
.2 Do not pull spliced cables inside ducts.
.3 Install multiple cables in duct simultaneously.
.4 Use CSA approved lubricants of type compatible with
cable jacket to reduce pulling tension.
.5 To facilitate matching of colour coded
multiconductor control cables, reel off in same
direction during installation.
.6 Before pulling cable into ducts and until cables are
properly terminated; seal ends of cables with
moisture seal tape.
.7 After installation of cables, seal duct ends with
duct sealing compound.

3.2 FIELD QUALITY
CONTROL .1 Perform tests in accordance with Section 26 05 00.

PART 1 - GENERAL

- | | | |
|--|----|--|
| <u>1.1 RELATED WORK</u> | .1 | Electrical - General Requirements: Section 26 05 00 |
| | .2 | Moulded Case Circuit Breakers: Section 26 28 21 |
| | | |
| <u>1.2 SHOP DRAWINGS
AND PRODUCT DATA</u> | .1 | Submit shop drawings in accordance with Section 01 33 00. |
| | .2 | Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension. |
| | | |
| <u>1.3 OPERATIONS AND
MAINTENANCE DATA</u> | .1 | Provide operations and maintenance data for panelboards for incorporation in to manual as specified in Section 01 78 00. |
| | .2 | Include panel schedules. |

PART 2 - PRODUCTS

- | | | |
|------------------------|----|--|
| <u>2.1 PANELBOARDS</u> | .1 | Panelboard:
.1 Install circuit breakers in panelboards before shipment.
.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand. |
| | .2 | Panelboard: bus and breakers rated for the interrupting capacity (momentary rms symmetrical) as indicated on the drawings. |
| | .3 | Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase. |
| | .4 | Panelboard: mains, number of circuits, and number and size of branch circuit breakers as indicated on the drawings. |
| | .5 | Provide two (2) keys for each panelboard and key panelboards alike. |

2.1 PANELBOARDS
(Cont'd)

- .6 Tin-plated, copper busbars with neutral of same
ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.
- .10 Provide panelboard complete with NEMA 12 enclosure.
- .11 Surface mount panelboards unless noted otherwise.

2.2 BREAKERS

- .1 Breakers: as specified in Section 26 28 21.
- .2 Bolt-on breakers with thermal and magnetic tripping
in panelboards except as indicated otherwise.
- .3 Lock-on devices for 10 % of 15 to 30 A breakers
installed as indicated. Turn over unused lock-on
devices to Departmental Representative.

2.3 EQUIPMENT
IDENTIFICATION

- .1 Provide equipment identification in accordance with
Section 26 05 00.
- .2 Nameplate for each panelboard size 9 engraved.
- .3 Nameplate for each circuit in distribution
panelboards size 2 engraved.
- .4 Complete circuit directory with typewritten legend
showing location and load of each circuit.

2.4 ACCEPTABLE
MANUFACTURERS

- .1 Cutler-Hammer, Schneider Canada (Square D), Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Locate panelboard as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Connect panelboard to source transformer or circuit breaker as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.
- .5 Install type-written panel schedule in panelboards.

PART 1 - GENERAL

- 1.1 SUBMITTALS .1 Submit shop drawings, and product data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

- 2.1 SWITCHES .1 Heavy duty, specification Grade, 20 A, 120 V, single pole, three-way, four-way switches as indicated, with the following features:
- .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 Ivory nylon, heavy duty toggle.
 - .6 Integral ground terminal.
 - .7 Standard of Acceptance: Hubbell #HBL1221I.
 - .8 Acceptable Manufacturers: Hubbell, Pass & Seymour, CWD (Cooper Wiring Devices), Leviton.
- .2 Toggle operated fully rated for lamps, and up to 80% of rated capacity of motor loads.
- .3 Use the switches of one (1) manufacturer throughout project.
- 2.2 RECEPTACLES .1 Design R1:
- .1 Heavy duty, specification grade duplex receptacles, CSA type 5-15R, 125V, 15A, U-ground, with following features:
 - .1 Urea molded housing, ivory colour.
 - .2 Suitable for #10AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles as indicated.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Nylon face.
 - .7 Standard of Acceptance: Hubbell #HBL5262I.
 - .8 Acceptable Manufacturers: Hubbell, Pass & Seymour, CWD (Cooper Wiring Devices), Leviton.

- | | | |
|-------------------------------------|----|---|
| <u>2.2 RECEPTACLES
(Cont'd)</u> | .2 | Other receptacles with ampacity and voltage as indicated. |
| | .3 | Receptacles of one manufacturer throughout project. |
| | | |
| <u>2.3 COVER PLATES</u> | .1 | Provide cover plates for wiring devices. |
| | .2 | Cover plates from one manufacturer throughout project. |
| | .3 | Brushed Stainless steel, 1 mm thick, cover plates, for wiring devices mounted in flush-mounted outlet boxes. |
| | .4 | Electrogalvanized or cast aluminum cover plates with gaskets for wiring devices mounted in surface-mounted FS or FD type conduit boxes. |
| | .5 | Self-closing, weatherproof spring-loaded cast aluminum or PVC cover plates, complete with gaskets for duplex or single receptacles as indicated. Cover plates must be suitable for wet locations whether or not a plug is inserted into a receptacle. |

PART 3 - EXECUTION

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|--|----|---|
| <u>3.1 SWITCH,
RECEPTACLE AND
COVER PLATE
INSTALLATION</u> | .1 | Switches: <ul style="list-style-type: none">.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 these Specifications or as indicated..4 Install size 1 identification lamicaid for control switches for pumps, motors, and process equipment. |
| | .2 | Receptacles: <ul style="list-style-type: none">.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location..2 Mount receptacles at height specified in these Specifications or as indicated. |
| | .3 | Cover plates: <ul style="list-style-type: none">.1 Install suitable common cover plates where wiring devices are grouped. |

3.1 SWITCH,
RECEPTACLE AND
COVER PLATE
INSTALLATION
(Cont'd)

.3 Cover plates:(Cont'd)

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

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

PART 1 - GENERAL

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|---|----|--|
| <u>1.1 REFERENCES</u> | .1 | CSA C22.2 No. 248, SET, 2000, Low Voltage Fuses Complete Set. |
| <u>1.2 SHOP DRAWINGS AND PRODUCT DATA</u> | .1 | Submit shop drawings and product data in accordance with Section 01 33 00. |
| <u>1.3 MAINTENANCE MATERIALS</u> | .1 | Three (3) spare fuses of each type and size. |
| <u>1.4 DELIVERY AND STORAGE</u> | .1 | Ship fuses in original containers. |
| | .2 | Do not ship fuses installed. |
| | .3 | Store fuses in original containers in moisture free location. |

PART 2 - PRODUCTS

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|--------------------------|----|---|
| <u>2.1 FUSES GENERAL</u> | .1 | Fuses: product of one manufacturer. |
| | .2 | Low voltage fuses, types as specified, shall be CSA certified in accordance with CSA Standard C22.2 No. 248. |
| <u>2.2 FUSE TYPES</u> | .1 | All fuses shall be high rupturing capacity (HRC) type, minimum 200kA interrupting rating (momentary RMS symmetrical). |

2.2 FUSE TYPES
(Cont'd)

- .2 Class J:
 - .1 Fuses rated 1 to 600 amperes, 600 Vac, shall be CSA certified Class J in accordance with Standard C22.2 No. 248.8.
 - .2 Where a time delay characteristic is required, fuses shall carry 500% of their ampere rating for not less than 10 seconds and shall be clearly labeled "time delay".
- .3 Class CC:
 - .1 Fuses rated 1 to 30 amperes, 600 Vac, shall be CSA certified Class CC in accordance with Standard C22.2 No. 248.4.
 - .2 Where a time delay characteristic is required, fuses shall carry 200% of their ampere rating for not less than 12 seconds.
- .4 Standard of acceptance:
 - .1 Class J: Mersen type A4J (non-time delay) and AJT (time delay) and HSJ (time delay).
 - .2 Class CC: Mersen type ATMR (non-time delay) and ATDR (time delay) and ATQR (time delay).
- .5 Acceptable manufacturers:
 - .1 Mersen.
 - .2 Bussmann.
 - .3 Littlefuse.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Confirm correct fuses fitted to physically matched mounting devices.
- .3 Confirm correct fuses fitted to assigned electrical circuit.
- .4 Confirm fuse size is correctly identified on equipment.
- .5 For feeder circuit fuses, use fast acting Class J fuses unless otherwise noted.
- .6 For full voltage non-reversing motor starters, full voltage reversing motor starters, full voltage multi-speed motor starters and transformers, use time delay Class J fuses.
- .7 For VFD, use Class HSJ time delay fuses.

3.1 INSTALLATION .8
(Cont'd)

For 600Vac control circuits, use Class CC type fuses. Use time delay Class CC fuses upstream of control transformers and solenoids.

PART 1 - GENERAL

- 1.1 RELATED WORK .1 Panelboard Breaker Type: Section 26 24 17
- 1.1 SHOP DRAWINGS AND PRODUCT DATA .1 Submit shop drawings and product data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

- 2.1 BREAKERS GENERAL
- .1 Moulded case circuit breaker, quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common trip breakers: with single handle for multiple applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 5 to 10 x current rating.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Circuit breakers to have minimum 10,000A interrupting rating (momentary RMS symmetrical) as indicated.
- 2.2 THERMAL MAGNETIC BREAKERS
- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping.
- .2 Provide ground fault interrupter type for circuits so marked.
- 2.3 MANUFACTURERS .1 Acceptable manufacturers: Schneider Canada, (Square D), Cutler-Hammer, Siemens.

Parks Canada
Cavendish/Brackley Sewage
Pump Station Upgrades
Project No. R.075015.001

MOULDED CASE CIRCUIT
BREAKERS

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Page 2
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PART 3 - EXECUTION

3.1 INSTALLATION .1 Install circuit breakers as indicated.

PART 1 - GENERAL

1.1 RELATED WORK .1 Electrical General Requirements: Section 26 05 00

1.2 SHOP DRAWINGS AND PRODUCT DATA .1 Submit shop drawings and product data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Heavy duty, fusible and non-fusible horsepower rated, disconnect switch in size and voltage as indicated.
- .2 Heavy duty, non-fusible horsepower rated double throw disconnect switch, complete with solid neutral for connection of a portable emergency generator.
- .3 Provision for padlocking in the off switch position by three pad locks.
- .4 Mechanically interlocked door to prevent opening when handle in ON position.
- .5 Fuses: size and type as indicated.
- .6 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .7 Quick-make, quick-break action.
- .8 ON-OFF switch position indication on switch enclosure cover.
- .9 Provide equipment identification in accordance with Section 26 05 00.
- .10 Switches shall be CSA Enclosure Type 4X unless noted otherwise.
- .11 Switches shall be complete with window to view open/close status of disconnect switch blades.
- .12 Disconnect switches to be complete with auxiliary contact (10A @ 120V) where specified. Auxiliary contacts shall make after and break before main switch contacts.

2.1 DISCONNECT
SWITCHES
(Cont'd)

- .13 Disconnect switches to be service entrance rated where indicated.
- .14 Acceptable manufacturers: Square D, Cutler Hammer, Hubbell, Siemens.

PART 3 - EXECUTION

3.1 DISCONNECT
SWITCH INSTALLATION

- .1 Install disconnect switches, complete with fuses, type and rating as indicated on drawings.
- .2 Install true, plumb and square to building lines.
- .3 Ensure disconnect switch has proper clearance for operation of handle.

PART 1 - GENERAL

1.1 GENERAL .1 This section pertains only to the electrical connection of motors.

1.2 RELATED WORK .1 Wire and Box Connectors (0 - 1000V):
Section 26 05 20

PART 2 - PRODUCTS

2.1 MOTORS .1 Supply motors with associated mechanical, and process equipment.

PART 3 - EXECUTION

3.1 INSTALLATION .1 Install wiring, flexible connections and grounding.
.2 Terminate wiring as per Section 26 05 20.
.3 Use liquid tight flexible conduit for connections to motors.
.4 Check rotation before coupling to driven equipment.
.5 Confirm electrical installation does not interfere with rotation, operation or maintenance of equipment.

PART 1 - GENERAL

- | | |
|---|--|
| <u>1.1 RELATED WORK</u> | <ul style="list-style-type: none">.1 General Instructions: Section 01 10 10.2 Electrical General Requirements: Section 26 05 00 |
| <u>1.2 REFERENCES</u> | <ul style="list-style-type: none">.1 ANSI C82.11 Consolidated-2004, High Frequency Fluorescent Lamp Ballasts..2 IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000 V and Less) A/C Power Circuits..3 CAN/CSA C654-M91(R2002), Fluorescent Lamp Ballast Efficiency Measurements. |
| <u>1.3 SHOP DRAWINGS AND PRODUCT DATA</u> | <ul style="list-style-type: none">.1 Submit shop drawings and product data in accordance with Section 01 10 10..2 Submit shop drawings for the following:<ul style="list-style-type: none">.1 luminaire..2 lamp for each luminaire type..3 ballast for each luminaire type..3 Shop Drawings:<ul style="list-style-type: none">.1 Shop drawings shall clearly indicate the following:<ul style="list-style-type: none">.1 Luminaire ID number as identified in contract documents..2 Fixture specification as identified in Part 2..3 Lamp specification as identified in Part 2..4 Ballast specification as identified in Part 2..5 Photometric data for each luminaire type..4 Catalogue cuts lacking sufficient detail to indicate compliance with Contract documents will not be acceptable..5 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative. Photometric data to include:<ul style="list-style-type: none">.1 VCP Table, spacing criterion;.2 Total input watts;.3 Candlepower summary, candela distribution, zonal lumen summary; |

- 1.3 SHOP DRAWINGS .5 (Cont'd)
AND PRODUCT DATA
(Cont'd)
- .4 Luminaire efficiency, C.I.E. type, coefficient of utilization;
 - .5 Lamp type;
 - .6 Lumen ratings; and
 - .7 Summary in accordance with IES procedures.

PART 2 - PRODUCTS

2.1 LAMPS .1 Linear fluorescent lamps.

Lamp Design	Wattage	Base	Initial Lumens	Life h	Colour Temp	CRI	Additional Information
1	32 W	Md.bip	2,950	20,000	3,500 K,	85	T8 lamp type

- .2 Installed lamps to be the same manufacturer and compatible with the ballast.
- .3 Approved manufacturers.
 - .1 General Electric
 - .2 Philips
 - .3 Osram Sylvania

- ### 2.2 BALLASTS .1 Fluorescent Electronic Programmed Rapid Start ballast:
- .1 Performance requirements:
 - .1 Electronic programmed rapid start.
 - .2 Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamps(s) to maintain full light output when one or more lamps fail.
 - .3 Auto restart circuitry in order to restart lamps without resetting power.
 - .4 Operate from 60 Hz input source of 120V, 277V or 347V as applicable with sustained variations of +/- 10% voltage and frequency with no damage to the ballast.
 - .5 High frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.
 - .6 Power factor greater than 0.98 for primary lamp.
 - .7 Minimum ballast factor of 0.85 for primary lamp.
 - .8 Lamp current crest factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.2 BALLASTS
(Cont'd)

- .1 (Cont'd)
 - .1 Performance requirements:(Cont'd)
 - .9 Total harmonic distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
 - .10 Class A sound rating.
 - .11 Minimum starting temperature of -18°C (0°F).
 - .12 End of life (EOL) protection circuit.
 - .13 Polychlorinated Biphenyl (PCB)free.
 - .2 Regulatory requirements:
 - .1 Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified.
 - .2 Meet or exceed IEEE C62.41.1 Category A for Transient protection.
 - .3 Meet or exceed ANSI C82.11 where applicable.
 - .4 Meet or exceed the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
 - .5 Ballast shall meet or exceed the requirements of CAN/CSA C654 for ballast efficiency.
 - .6 Ballast shall be provided with integral leads color coded per ANSI C82.11.
 - .3 Warranty:
 - .1 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a minimum case temperature of 70°C.

2.3 LUMINAIRES

- .1 Fluorescent luminaire design F1.
 - .1 Vapour proof, non-metallic industrial fluorescent luminaire suitable for surface or chain mounting indoors (wet location listed).
 - .2 Input voltage: 120V, 60Hz.
 - .3 Nominal dimensions: 1219 mm long, 255 mm wide, and 143 mm high.
 - .4 Lamp: two (2) 32W T8 fluorescent lamps.
 - .5 Ballast: one (1) 2-lamp fluorescent electronic programmed rapid start ballast factory wired to lamp holders.
 - .6 Housing: fiberglass reinforced polyester housing with impact resistant, smooth acrylic lens and stainless steel latches.
 - .7 Finish: baked white enamel (metal parts).
 - .8 Options: chain hangers, length as required for mounting height specified on the Drawings.

- 2.3 LUMINAIRES
(Cont'd)
- .1 (Cont'd)
 - .9 Acceptable material:
 - .1 Metalux VT3 Series.
 - .2 CFI VTS Series.
 - .3 Lithonia DMW Series.
 - .2 LED luminaire design L1.
 - .1 Wall mounted LED luminaire suitable for outdoor mounting (wet location listed)..
 - .2 Input voltage: 120V, 60Hz.
 - .3 Nominal dimensions: 400mm long, 140mm high and 240mm deep.
 - .4 Lamp: LED module, 35W, 4300K, 75CRI.
 - .5 LED driver:
 - .1 Less than 20% THD.
 - .2 Greater than 0.95 power factor.
 - .3 -30°C minimum starting temperature.
 - .4 10kV, surge protector.
 - .6 Housing: die cast aluminum.
 - .7 Door frame: single piece die-cast aluminum, hinged closed and secured to the housing.
 - .8 Optics: full cut-off, glass lens, wide throw.
 - .9 Finish: polyester powder coat, bronze colour.
 - .10 Options:
 - .1 Integral photocell control.
 - .2 Passive infrared (PIR) motion sensor (field adjustable). After a preset time delay (nominal 5 minutes), the fixture will reduce wattage levels to 10% ± and decrease the fixture light output accordingly.
 - .11 Acceptable material:
 - .1 Philips Gardco 121 LED series with motion response, Lithonia D Series or approved equivalent.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Connect luminaires to lighting circuits as indicated. Each light fixture shall have a separate "fixture drop" installed and connected to a junction box located in the ceiling space.
 - .2 Install each luminaire properly and safely.
 - .3 Luminaires applied to a surface mounting outlet box, a finishing ring shall be utilized.
 - .4 Provide a minimum of four (4) spare fluorescent lamps.

3.2 LUMINAIRE
SUPPORTS

- .1 Support all luminaires independently of ductwork, piping or cable tray.
- .2 Chains shall be corrosion resistant design (hot dipped galvanized or stainless steel), rated for unit load and securely anchored to wooden frame ceiling or clamped/bolted to building supports.

3.3 LUMINAIRE
ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines, or as indicated.

3.4 LUMINAIRE
CLEANING

- .1 Contractor shall clean all luminaires one week prior to Substantial Performance application.
- .2 Replace blemished, damaged, or unsatisfactory luminaires as directed.

3.5 MAINTENANCE

- .1 Provide, for each type of luminaire, recommended maintenance information including:
 - .1 Tools required.
 - .2 Types of cleaners to be used.
 - .3 Replacement parts identification lists.
 - .4 Final, as-built shop drawings.
- .2 Provide material in accordance with Section 01 10 10.

PART 1 - GENERAL

- 1.1 WORK INCLUDED
- .1 This section and specifies the requirements for the supply, calibration, storing, installation, cabling, termination, programming, testing and commissioning of the instrumentation and controls equipment required for the upgrade of the Cavendish and Brackley sewage pump stations as indicated in the contract documents.
 - .2 This section and its associated drawings specify the requirmenets for the design, fabrication, supply, testing, preparation for shipment and delivery of the control system including, but not limited to, the PLC/RTU control panel, termination junction boxes, communications wiring, etc.
 - .3 Confirm the instrumentation and controls equipment/cabling termination details (for all instrumentation and controls cabling), to reflect the equipment and panels actually supplied (after shop drawing approval), and to match the intent as indicated or implied in the Contract Documents, to supply a complete and functioning sewage pump station
 - .4 Safely store all instrumentation and controls equipment awaiting installation.
 - .5 Protect installed instrumentation and controls equipment during construction.
- 1.2 RELATED WORK
- .1 Electrical General Requirements: Section 26 05 00
 - .2 Wires and Cables (0 - 1000): Section 26 05 21
 - .2 Suction Lift Pumping Station: Section 33 32 13
 - .3 Process Mechanical: Division 40
- 1.3 REFERENCES
- .1 The work under this section shall be carried out in accordance with all applicable Federal, Provincial, Municipal and other laws/ordinances, and with the latest edition of the following standards which shall be deemed to be and form part of this specification:
 - .1 American Society of Mechanical Engineers.
 - .2 Institute of Electrical and Electronic Engineers.
 - .3 American Society for Testing Materials.
-

1.3 REFERENCES
(Cont'd)

- .1 (Cont'd)
 - .4 Manufacturers Standardization Society.
 - .5 Canadian Standards Association.
 - .6 Instrument Society of America.
 - .7 Canadian Electrical Code.
 - .8 National Fire Protection Association
- .2 In the event of a conflict between the above mentioned standards, this specification, or the attached drawings, the Contractor is to notify the Departmental Representative, who will then advise on which standard is to be followed.
- .3 All Instrumentation and controls works (Instrumentation mounting, tubing, cabling, terminating, calibration, testing and commissioning) shall be carried out by certified inter-provincial ticketed Instrument Tradesmen and all works shall be verified/checked by its associated manufacturer's representative before putting in service.

1.4 SUBMITTALS

- .1 Submit equipment shop drawings in accordance with 01 33 00. Contractor to ensure that shop drawings have been reviewed and approved by the Departmental Representative before any equipment is ordered.
- .2 Instrumentation and controls equipment shop drawings shall include, but not be limited to, the following:
 - .1 Complete model number of each instrument being proposed, with model number breakdown codes.
 - .2 Applicable instrument/equipment tag numbers shall be identified on every shop drawing.
 - .3 Equipment operational specifications.
 - .4 Equipment dimensions, weight, mounting details, and materials of construction.
 - .5 Equipment power requirements, air supply requirements, process signal type, etc.
 - .6 Electrical termination information specific to the device being purchased in this contract.
 - .7 Complete parts list with recommended inventory of spare parts.
 - .8 Frequency and method of calibration (if applicable).
 - .9 Manufacturer's installation recommendations/requirements.
 - .10 Any sizing calculations (if applicable).
 - .11 For control panels and field junction boxes, provide:
 - .1 Dimensional outlines, sections and details of all equipment.
 - .2 Detailed bill of materials.
 - .3 Equipment layout details.

1.4 SUBMITTALS
(Cont'd)

- .2 (Cont'd)
 - .11 (Cont'd)
 - .4 Equipment labelling details.
 - .5 Terminal block arrangements.
 - .6 All equipment specifications and instruction manuals.
 - .12 Upon request by the Departmental Representative, the Contractor shall supply a similar application user list (at least two references), complete with contact names and phone numbers, for any proposed instrument the Departmental Representative has no experience with. Failure to produce a requested user list (within five (5) working days after request), or a bad review by a contacted user, will result in the automatic rejection of the proposed equipment.
- .3 Submit data for operations and maintenance manuals in accordance with Section 01 78 00. Include information based on the following requirements:
 - .1 Operation and maintenance instructions to be sufficiently detailed with respect to design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, calibration, maintenance and repair of the supplied equipment.
 - .2 Include names and addresses of local suppliers for all items included in maintenance manuals.
 - .3 Include all instrumentation calibration sheets.
 - .4 Include instrumentation and controls equipment termination drawing or termination schedules.
- .4 Maintain an "as-built" mark-up set of the drawings on site to be turned over to the Departmental Representative at the end of the work.
- .5 Provide "as-built" wiring and schematic diagrams and general arrangement drawings for control panels.

PART 2 - PRODUCT

2.1 GENERAL
INSTRUMENTATION

- .1 All instrumentation and controls equipment shall be of a proven design for each application and designed, manufactured, inspected, and tested to comply with the applicable regulations, codes, and standards.
- .2 All instrumentation and controls equipment shall be selected to suit the process and environmental requirements for each application as described or implied in this specification and the drawings.

2.1 GENERAL
INSTRUMENTATION
(Cont'd)

- .3 All instrumentation and controls equipment shall be constructed to operate safely and reliably under all operating conditions without undue wear, vibration, heat, noise, or other operating problems. Parts subject to wear, corrosion, or other deterioration, or requiring adjustment, inspection or repair, shall be accessible and capable of convenient field maintenance.
- .4 All proposed instrumentation and controls equipment shall be certified by an agency (preferably CSA) recognized by the applicable provincial Electrical Inspection Department. Where there is no alternative to supplying equipment that is not appropriately certified, special approval from the applicable provincial Electrical Inspection Department will be required. All costs associated with obtaining such approval shall be the responsibility of the Contractor.
- .5 All instrumentation and controls equipment located in process areas shall have a minimum enclosure rating of NEMA 4X (IP66), unless identified otherwise.
- .6 All electronic instrumentation and controls equipment installed in hazardous areas must be rated to match its corresponding hazardous area classification (refer to the Electrical hazardous locations drawings).
- .7 Equipment requiring intrinsically safe wiring to meet a hazardous area classification shall come complete with all recommended intrinsically safe barriers, etc., as required to meet the applicable hazardous classification.
- .8 The minimum instrumentation and controls equipment electrical connection size shall be 13 mm NPT.
- .9 Instrumentation and controls equipment requiring a power supply shall be 120 VAC, 60 Hz.
- .10 All "wired" instrumentation and controls equipment shall have provision for externally grounding the instrument housing/enclosure.
- .11 Provide instrumentation and controls equipment complete with a securely fastened manufacturer's nameplate indicating instrument model, serial number, calibrated range, etc., as required for ordering a replacement item.

2.1 GENERAL
INSTRUMENTATION
(Cont'd)

- .12 Mount instruments not directly coupled to a process connection on manufactured instrument stands (2 NPS pipe construction with sealed ends, galvanized) or on a nearby wall. All mounting hardware for mounting instrument stands and instruments shall be 316 SS. Instruments shall be mounted as per manufacturer's recommendations.
- .13 Supply instrument tags for all plant instruments indicated on the Drawings. Affix a non-ferrous tag indicating the instrument tag number to the instrument using contact cement or non-ferrous chain. The tag shall be approximately 50 mm x 25 mm and shall be stamped in a legible manner, with a minimum 10 mm character size, and in the same format as shown on the Drawings.
- .14 All instruments to be EMI and RFI protected.

2.2 GENERAL CONTROL
PANELS

- .1 All control panels, shall be supplied, completely tested and ready for terminating field cables. They are to include all hardware (PLC/RTU modules, relays, power supplies, etc.), terminal blocks (for power supplies and field I/O), wire ducts, internal panel wiring etc., as required.
- .2 Control panels are to be wall mounted and be NEMA 4X rated. All cables shall be sealed at entry point.
- .3 Inside all panels, terminal blocks, terminal block strips, and all internal wire conductors shall be labelled in accordance to the panel fabricator standards.
- .4 All panels shall be complete with a back mounting plate.
- .5 There is to be at least a 50 mm clearance between the terminal blocks and the plastic wiring duct. Wire ducts shall be slotted complete with covers. Wiring ducts shall be on 3 mm standoffs so that a ty-rap may be passed behind it. Wiring ducts with a terminal strip on one side only shall be a minimum size of 50 mm x 75 mm (supplier to determine if a larger size is required). Wiring ducts with a terminal strip on each side shall be a minimum size of 100 mm x 75 mm (supplier to determine if a larger size is required).
- .6 Analog and digital signals within the same panel or junction box shall be wired to separate terminal strips.

2.2 GENERAL CONTROL .7 Completed panels to have CSA approval.
PANELS

(Cont'd)

- .8 All panels are to be adequately sized by the builder to accommodate the required hardware, terminal blocks, wire ducts, etc., as well as the number of cables to be glanded.
- .9 The panel is to include a drawing pocket to be installed on the inside of the door to hold "Record" drawings.
- .10 Panel to have a pre-drilled and tapped copper ground bar and to be provided with a grounding lug for a #6 AWG external ground connection. All PLC/RTU I/O chassis, terminal block mounting rails, etc., to be grounded to the panel ground bar. All PLC/RTU I/O cabinets shall also have a separate "isolated" copper ground bar for grounding of analog type 4-20 mA control signals.
- .11 Terminal blocks shall be rated for at least 600V, 35A, minimum of 6 mm wide, capable of accepting a 10 AWG conductor size, DIN rail mounted, complete with white marking tags with black lettering. Acceptable manufacturers: Weidmuller WDU4, or approved alternate.
- .12 Control wiring circuit breaker type terminal blocks shall be rated for 250 V, up to 16 A, single pole, pushbutton operated, DIN rail mounted, complete with white marking tags with black lettering. Acceptable manufacturers: Weidmuller 4201 Series, or approved alternate.
- .13 Control panel 120 VAC distribution power circuit breakers to be single pole, DIN rail mounted, rated for up to 240 V, toggle switch operated, and capable of accepting a 6 AWG conductor size. Acceptable manufacturers: Weidmuller 9926 Series, Merlin Gerin C60N or approved alternate.
- .14 All panel internal wiring to be 14 AWG type RW90 or TEW as a minimum. All +120 VAC power and control wiring shall be black. All -120 VAC neutral wiring shall be white. All DC wiring shall be blue. All ground wiring shall be green. Stranded copper wiring shall be provided throughout. AC and DC wiring shall be segregated and shall be installed on separate terminal strips.
- .15 Auxilliary relays shall have 120 VAC operating coil, DPDT 15 amp @ 120 VAC rated. Acceptable

2.2 GENERAL CONTROL .15 (Cont'd)
PANELS
(Cont'd) manufacturers: Allen Bradley 700-HB, or approved
alternate.

2.3 LEVEL .1 Level switch:
INSTRUMENTS
.1 Provide internally weighted mechanical switch
for control.
.2 One (1) SPDT contact rated at 10 amps @ 120VAC
(continuous) minimum.
.3 Complete with integral cable, length to suit
installation.
.4 Acceptable product: Flygt ENM-10, Conery B6 or
approved equivalent.
.2 Level transmitters:
.1 Submersible level transmitter in stainless
steel (316 grade) housing, suitable for waste water,
complete with 4-20mA output. Install as per drawings
and manufacturer's recommendations.
.2 Sensor range to be suitable for the application
depth. Cable to be of sufficient length and include
vent tube and aneroid bellows. Bellows to be located
in junction boxes.
.3 Sensor to be complete with surge protection.
.4 Sensors to be suitable for a Class 1, Zone 1
environment, complete with an intrinsically safe
barrier.
.5 Acceptable manufacturers: KPSI, Ametek or
approved equivalent.
.3 Level instrument hanger:
.1 Provide stainless steel level switch hanger
with strain relief connectors suitable for four (4)
floats/level instruments.

2.4 FLOW METER .1 Magnetic flowmeter shall meet the following design
(CAVENDISH SITE) and performance requirements.
.1 Flowmeter to be EMI and RFI protected.
Flowmeter to be suitable for installation in a damp
environment.
.2 Flowmeter suitable for pipe size and pipe
materials as shown on the drawings.
.3 Flow tube liner material to be suitable for
waste water.
.4 Connection type: flanged.
.5 Flow tube to be manufactured for continuous
submergence.

2.4 FLOW METER
(CAVENDISH SITE)
(Cont'd)

- .1 (Cont'd)
 - .6 Flow converter/display to be remotely mounted in the pump control panel. Provide Necessary mounting hardware. To be coordinated with panel fabricator.
 - .7 Minimum 316 SS, self cleaning electrodes.
 - .8 Supply grounding hardware in accordance with manufacturer's recommendations.
 - .9 Process conditions:
 - .1 Maximum pressure: 50 psig.
 - .2 Material: Waste water
 - .10 120Vac power supply.
 - .11 Able to program flow transmitter locally using keypad via simple menu-driven software, with integral display showing flow rate with engineering units and totalized flow.
 - .12 Online diagnostics, with configurable alarm functions. Operator alarm notification via transmitter display, relay outputs and output signal (4-20mA upscale/downscale manipulation).
 - .13 4-20 mA output of flow rate, transmitter powered, isolated. Pulsed output signal (dry contact) for determining totalized flow.
 - .14 Minimum system flow accuracy of $\pm 0.5\%$ of reading.
 - .15 Have an adjustable damping ability.
 - .16 Have an adjustable low flow cutoff.
 - .17 Flow tube to be rated for a Class 1, Zone 2 installation.
 - .18 Acceptable products:
 - .1 Siemens, Toshiba, Krohne, ABB, or approved equivalent.
- .2 Provide potting kit and suitable length of signal cable for connection to the remote electronics. Terminations and potting shall be carried out by the manufacturer's representative on site. Contractor to field measure signal cable length prior to submitting show drawings.

2.5 Pump
Controller

- .1 Supply completely assembled control panel for the duplex operation of self-priming pumps.
- .2 Pumping Station:
 - .1 Brackley - Two (2) pumps at 7.45 kW (10 HP), three phase, 208 volt.
 - .2 Cavendish - Two (2) pumps at 11.2 kW (15 HP), three phase, 208 volt.
- .3 Pump controller shall be provided with the following features:
 - .1 Single insulated enclosure, stainless steel, NEMA 4X, to accommodate the controls, flow meter

2.5 Pump
Controller
(Cont'd)

- .3 (Cont'd)
- .1 (Cont'd)
display, level display, PLC/RTU, fuses, terminals, HOA switches, pilot lights, reset buttons, starters, breakers, UPS, intrinsically safe devices, heaters and thermostat and main breaker.
 - .2 Door mounted HMI.
 - .3 Main circuit breaker, three phase, 208V AC, size as required. Installation to meet Maritime Electric requirements. 22 kA minimum interrupting rating.
 - .4 Individually protected across the line NEMA design motor starters for each pump. Each starter to be complete with electronic overload relay with ground-fault/single phasing protection. Each motor starter is to be complete with a separate moulded case circuit breaker, complete with pad locking attachment to lock in the off position.
 - .5 Provide CTs to monitor pump current on each pump.
 - .6 Provide pump motor overload and over temperature protection.
 - .7 Provide voltage monitor protection.
 - .8 Provide provision for Two (2) float switches for emergency pump control as indicated and intrinsically safe relays on floats.
 - .9 Provide one intrinsically safe provision for level transmitter for primary pump control.
 - .10 Provide ground fault type convenience receptacle.
 - .11 Provide panel mounted HOA selector switches, start counters, runtime meters, pump pilot lights (power on, Pump 1 running, Pump 2 running, Pump 1 fault, Pump 2 fault and High level alarm) and reset buttons for each pump. All devices to be NEMA 4X and 30.5 mm in diameter. Pilot lights to be LED.
 - .12 Provide individually protected 120VAC circuits for pump control, and 15A receptacle circuit. Use circuit breakers.
 - .13 Provide 120V and 24V control transformers including primary and secondary fusing for control power. Size for anticipated loads plus 50% additional capacity.
 - .14 Lightning and surge protection.
 - .15 Analog inputs are 4 - 20 mA dc. Discrete I/O is 120VAC.
 - .16 Provide 10% spare I/O.
 - .17 Individual outputs will be protected by fuses in groups of 4.
 - .18 Provide logic for duplex pump operation.
 - .19 Software pump start staging preventing both pumps from starting at the same time.
 - .20 Pump controller shall be PLC/RTU based with colour touch screen and be capable of SCADA

2.5 Pump
Controller
(Cont'd)

- .3 (Cont'd)
- .20 (Cont'd)
- communications with Parks Canada system's base station in Dalvay.
- .21 Provide an Elpro licensed radio modem complete with antenna, cables and surge arrestors. Radio to be fully programmed for integration into the Dalvay SCADA network.
- .22 Provide a UPS to provide at least 15 minutes of backup power in the event of a power loss to the control pump. The UPS shall be a SOLA SDU series c/w powerless contacts or approved equivalent.
- .23 Provide heater with thermostat on individual breaker.
- .24 Provide provision for flowmeters converter/display. Coordinate with flowmeter provider. Provide a NEMA 4X viewing window for display if required.
- .25 Common alarm output wired to terminal blocks.
- .26 Provide alarm light assembly, loose for installation by electrical contractor on the building exterior.
- .1 Outdoor NEMA 4X rated LED lamp type with guard over glass globe. Red flashing light suitable for wall or pendant mounting.
- .4 Provide integration services to add these two (2) sewage pump stations to the SCADA system PC in Dalvay. The SCADA software is Trihedral's VTS. Integrator is to be a registered integrator. New screens are to be the same in appearance and functionality as the existing screens.
- .5 Acceptable manufacturer: The Panel Shop, ECSI or approved alternate.

2.6 RADIO SYSTEM

- .1 Provide, test and commission the radio communications system between the Dalvay Administration Building and the two pump station sites as indicated on the drawings. The radio system is to be UHF. Radio license frequency will be provided by Departmental Representative during construction. Refer to the drawings for the Control System Block Diagram.
- .2 Provide a radio communications test followed by a radio path survey analysis that is to be prepared by the radio supplier for all sites based on the selected radio system and components (antenna, antenna cabling, etc.). The analysis will verify the required antenna types, antenna cabling types and antenna mounting heights required for a fully

2.6 RADIO SYSTEM
(Cont'd)

- .2 (Cont'd)
functional and reliable system. Submit the analysis to the Departmental Representative for review and approval.
- .3 Each radio is to be a licensed radio modem completely compatible with the Parks Canada Dalvay system.
- .4 Provide the radio antennas as follows:
 - .1 Cavendish Building: Directional /Yagi Antenna(s), UHF, minimum 10dBd Gain, cover.
 - .2 Brackley Building: Omni-directional, UHF, minimum 5dBd Gain.
 - .3 Verify the required UHF frequency during construction.
- .5 Supply and install an Antenna Lightning Arrestor.
- .6 Antenna cabling to be a flexible, low loss communications coaxial cable complete with UV resistant polyethylene jacket. Antenna cabling to be suitable for installation outdoors and compatible with the selected radio and antenna. Acceptable materials: Times Microwave System LMR-400, LMR-600 or LMR-900 as required by the radio path survey and antenna cable lengths.
- .7 Supply and install required antenna masts and supporting structure in accordance with the antenna manufacturer's instructions.
- .8 Supply and install grounding required by the manufacturer and as required by the latest edition of the Canadian Electrical Code.

2.7 INSTRUMENTATION
CABLING/WIRING

- .1 All instrumentation and controls cabling shall be rated for the area classification that each individual cable is run through (refer to drawings).
- .2 Digital circuits: stranded copper, minimum size #14 AWG with 600 volt chemically cross-linked thermosetting polyethylene material rated RW90.
- .3 Analog circuits: tinned stranded copper, minimum size #16 AWG with individually twisted shielded pairs, chemically cross-linked thermosetting polyethylene insulation, overall shield, minimum 300V, overall PVC jacket.

2.7 INSTRUMENTATION .4
CABLING/WIRING
(Cont'd)

Pump controllers panel wire: internal wiring to be type RW90 or TEW. 120 VAC power and control wiring (phase and neutral) to be minimum #14 AWG. Digital signal wiring to be minimum #16 AWG. Digital signal wiring to be minimum #16 AWG. 120 VAC power supply wiring to be black. All 120 VAC neutral wiring shall be white. All DC wiring to be blue. All ground wiring to be green. Provided stranded copper wiring throughout. AC and DC wiring will be segregated and be installed on separate terminal strips.

- .5 Handle, install and support cables in accordance with manufacturer's guidelines.
- .6 Ground shields for 24 VDC twisted pair and triad Instrumentation signal cables on the end supplying the loop power, and tape on the opposite end. All shield grounds to be continuous through any intermediate field junction boxes (individually terminated and isolated).
- .7 120 VAC multiconductor digital signal cable grounds to be grounded on both ends. When run through intermediate junction boxes, 120 VAC cable grounds are brought to a common junction box ground bar, and connected to earth ground via the junction box ground.
- .8 All Field Control Panels and Junction Boxes to be grounded to local structural steel (clamp) using a #6 green copper grounding cable.
- .9 All cables and conduits shall enter field instruments, control panels and junction boxes from the bottom only. Use grounding bushings when terminating in non-conductive boxes or plates.
- .10 Supply and install 24VDC instrumentation signal wiring conduits and 120VAC instrumentation digital control wiring conduits as per Division 26.
- .11 Inside all Instruments, Control Panels, and Termination Junction Boxes, all cable conductors shall be identified using wire markers (Weidmuller PT transparent sleeves with TM-I labels, or approved alternate). Conductors to be marked with their corresponding instrument tag number and Instrument terminal block number (ex: HS3004/C, where HS3004 is the Instrument tag number, and "C" is the Instrument terminal block number the conductor is terminated on). This "conductor identifier" shall remain the same through any intermediate junction boxes, etc., all the way back to its corresponding RTU/control cabinet.

2.7 INSTRUMENTATION .12
CABLING/WIRING
(Cont'd)

- Clearly identify cables at both ends with its cable number using flexible PVC slip-on wire markers. Labelling must be done at all cable terminal points and must be at the point of junction box/instrument entry.
- .13 Conductors being terminated within a junction box/control panel shall be left long enough to be removed from its assigned terminal block and reassigned to anywhere within the junction box/control panel.
- .14 Spare conductors of a cable shall be coiled together inside its associated junction box/control panel and clearly identified with the cable number (ex: Spare-JB3000), unless indicated to be terminated on spare terminals. Adequate length shall be left to run the spare conductors anywhere within the junction box/control panel. Terminate spare conductors where identified.
- .15 Stranded conductors to be fitted with vinyl insulated wire end ferrules when terminating to terminal blocks, and vinyl insulated locking fork terminal connectors when terminating to screw terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Complete work in a neat and professional manner.
- .2 Install all control panels and termination junction boxes in accordance with the manufacturer's instructions.
- .3 All cabling, patch panels, racks and equipment to be grounded as per manufacturer's instructions (use minimum #6).
- .4 All instrumentation and control equipment being supplied by, or issued to, the Contractor shall be installed where and as indicated on the drawings, and in accordance with the manufacturer's instructions. Manufacturer's installation instructions shall be strictly adhered to.
- .5 The Drawings indicate the extent and general arrangement of the instrumentation and controls equipment. Exact installation locations, distances and levels shall be governed by actual field conditions and is subject to approval by the

3.1 INSTALLATION
(Cont'd)

- .5 (Cont'd)
Departmental Representative; field verification of dimensions shown on drawings is obligatory.
- .6 If any departures from the original intent of the Drawings and/or the Specifications are deemed necessary by the Contractor, details of such departures with Drawings if necessary, together with reasons for the departure shall be submitted to the Departmental Representative as soon as practical for approval. No such departure shall be made without prior written consent of the Departmental Representative.
- .7 Unless otherwise specified, the Contractor shall fabricate and erect all support brackets or mounting brackets required. Contractor supplied instruments shall be purchased with all necessary mounting brackets from the instrument vendor.
- .8 Locate instruments to minimize the possibility of damage from high temperature, vibration or humidity, and shall not interfere with, or be damaged by, maintenance of other equipment. Instrument installation shall also provide for easy accessibility for operation, inspection, and maintenance purposes.
- .9 Install new radios and associated antennas where indicated.
- .10 Store materials in a manner as to ensure the preservation of their quality and fitness for the work, and to facilitate inspection by the Departmental Representative at any time. Instruments and equipment are to be kept clean and protected against damages, dirt, and moisture.
- .11 Protect installed equipment against water or dirt until it is commissioned. Clear plastic sheeting of not less than 8-mil thickness shall be used for this purpose.
- .12 Keep all enclosures, rooms, trenches, etc., free from construction debris, materials, dirt and water at all times during construction.
- .13 Equipment damaged during construction, or otherwise deemed defective or non-compliant with this specification, shall be repaired/ replaced at no additional cost to the contract.
- .14 Mount and position all panels and equipment in such a way as to allow for easy access and maintenance.

3.2 TESTING AND
CALIBRATION
EQUIPMENT

- .1 The panel fabricator is to test (power-up) all panel components and auxiliary devices to confirm functionality, and verify all internal panel wiring, and conduct functionality testing in accordance with the control schematics prior to delivery to site.
- .2 All test and calibration equipment used by the Contractor shall be calibrated to an industry recognized standard and have affixed proof of calibration along with date of next calibration.

3.3 TESTING AND
CHECK-OUT

- .1 Make all tests necessary to ensure that the material and workmanship are of the required degree of excellence, and that the supplied equipment will perform as specified and guaranteed (verify wiring, wire continuity checks, tubing leak tests, etc.).
- .2 Calibrate instruments, either purchased by or supplied to the Contractor before installation. If not factory calibrated secure the services of qualified personnel (manufacturer's representative) and equipment to conduct field instrument calibration.
- .3 Set up, test and commission the radio system as required for a fully functional and reliable system. Coordinate this work the the Departmental Representative.
- .4 The results of all tests/calibrations shall be documented by the Contractor and made available to the Departmental Representative and shall be included in the project "operations and maintenance manual" submission.
- .5 Coordinate with the Departmental Representative to schedule control and instrumentation suppliers for proper set-up.
- .6 Perform a series of starts/stops of the pumps under power from the genset to confirm operation.
- .7 Program, test and calibrate all instruments.
- .8 Coordinate with other division suppliers for their required testing and commissioning services.

3.4 COMMISSIONING
AND START-UP

- .1 Arrange and pay for the services of a manufacturer's factory service representative to supervise the installation, start-up, check, adjust, balance and calibrate all supplied instruments, to the satisfaction of the Departmental Representative. Provide these services for such period, and for as many visits as necessary to put the installation in working order, and to ensure that the operating personnel are conversant with all aspects of equipment and operation.
- .2 Submit a written report signed by the manufacturer's representative shall be submitted to the Departmental Representative stating the following:
 - .1 That a satisfactory installation of the equipment has been performed outlining modifications that have been made as a result of testing/commissioning the equipment; and
 - .2 That the maintenance instructions for the equipment have been presented to the Departmental Representative.
- .3 After the instrumentation and controls equipment have been installed, calibrated, checked out and tested by the Contractor, the PLC/RTU system testing/commissioning can begin. This phase of the work shall be carried out under the direction of the control system integrator for this project. This will involve a point-by-point check for all PLC/RTU system monitored field I/O points, logic checks, complete controls integration, and equipment start-ups.
- .4 Provide technical personnel during this phase of the work for instrument recalibration, re-wiring, reprogramming, etc., as required until the integrated plant control system is deemed ready for plant operation.
- .5 Develop and provide a commissioning schedule for review and approval.