

Parks Canada



Broad Cove Campground Water System

Issued for Tender

Broad Cove Campground Water System

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 <p>CBCL LIMITED Consulting Engineers</p> <p>ISO 9001 Registered Company</p>			

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PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS .1

Work of this Contract takes place at the Broad Cove Campground near Ingonish in Cape Breton Highlands National Park in Nova Scotia. The Work involves but is not necessarily limited to:

- .1 Supply and installation of monitoring equipment at well (PH2), at disinfection building (PH1) and at reservoir 2.
- .2 Supply and installation of photovoltaic solar system complete with connection to electrical system, power and control wiring.
- .3 Supply and installation of underground cable between PH1 and PH2.
- .4 Supply and installation of radio, controls and PLC and PC to allow for control, monitoring, trending and alarm of water system.
- .5 Pipe modifications at PH 1 and reservoir.

1.2 LIST OF DRAWINGS.1

<u>Drawing #</u>	<u>Drawing Name</u>
-	Cover Sheet
C01	Civil - Site Plans and Details
P01	Process - Reservoir Valve House & Chlorination Building Piping Modifications
E01	Electrical - Plans and Legend
E02	Electrical - Single Line Diagram and Block Diagram
E03	Electrical - Control System Block Diagram
E04	Electrical - RTU/PLC I/O Lists and Schedules
E05	Electrical - Details Sheet 1 of 2
E06	Electrical - Details Sheet 2 of 2

1.3 CONTRACT METHOD .1

Construct Work under lump sum contract.

1.4 WORK SEQUENCE .1

Do construct Work in stages to accommodate continued use of premises during construction. Work requiring shutdown of system or excavation is not permitted on weekends.

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- 1.4 WORK SEQUENCE (Cont'd)
- .2 Keep one (1) travel lane open to traffic at all times.
 - .3 Commence work upon notice of award and complete all work including installation and testing prior to October 2, 2015. Radio setup and commissioning must be completed by October 15, 2015.
 - .4 Maintain Emergency Services access/control.
 - .5 Short shutdowns can be accommodated upon approval from the Departmental Representative. Duration of shutdown could be between 4 and 8 hours depending on reservoir level and occupancy level of campground.
- 1.5 CONTRACTOR USE OF PREMISES
- .1 Follow all site standard operating procedures.
 - .2 Obtain work permits before entering confined spaces. Provide a fire watch for all hot work.
 - .3 Comply with all security requirements in place.
 - .4 At completion of operations condition of existing work area to be: equal to or better than that which existed before new work started.
- 1.6 PROGRAM OF WORKS AND SCHEDULES
- .1 As soon as it is practicable, in any case not later than one (1) week after the Award, submit to the Departmental Representative for review and approval, a program and construction schedule showing the order of procedure, significant Contract dates, and method in which the Contractor proposes to carry out and complete the Works within time period required by Contract Documents.
 - .2 Provide information regarding the implementation of the Works and of the Construction Equipment, temporary works, labour and construction crews which the Contractor intends to supply, use or construct as the case may be.
 - .3 Construction Schedule to be standard "bar" type, showing commencement, duration and completion of activities of all trades and suppliers involved.
 - .4 Construction Schedule is subject to review by Parks Canada and will be revised and resubmitted as directed.
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1.9 STANDARD
SPECIFICATIONS

- .1 Reference has been made to certain Domestic, National and International Standard Specifications throughout the various sections of the Specification contained herein. These Standard Specifications shall be considered an integral part hereof and shall be read in conjunction with the Drawings and Specifications as if they were reproduced herein. The Contractor must therefore be completely familiar with their contents and requirements. The latest editions of these Standard Specifications at the time of tendering will always govern.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

PART 1 - GENERAL

- 1.1 EXISTING SERVICES .1 Provide for vehicle, pedestrian, and other regular traffic for the duration of the construction.
- 1.2 USE OF THE WORK SITE .1 The Work Site will be specified by Parks Canada and will only be used for the purposes of the Work. The Work Site will be made available by Parks Canada to the Contractor for its non-exclusive use for the duration of the Work, unless otherwise provided in the Contract Documents. The Contractor's work or equipment must not exceed the contract boundaries.
- .2 Maintain adequate drainage at the Work Site.
- .3 Keep the Work Site clean and free from accumulation of waste materials and rubbish regardless of source.
- .4 Repair damage to the Work Site at no additional cost to the Contract.
- 1.3 UTILITIES .1 Shutdown of existing services is only permitted upon the approval of the Departmental Representative. Water service interruptions of between 4 to 8 hours are acceptable upon submitting a detailed plan, for approval, outlining the activities to occur during the shutdown and an emergency plan in the event the service cannot be returned as scheduled.
- .2 Coordinate an on-site inspection with the utility company and Departmental Representative to locate any utility prior to starting work. Be responsible for work related to the protection or relocation of all utilities.
- .3 The locations of utilities, if any, shown or not shown are subject to verification by the Contractor.
- .4 Whenever working in the vicinity of utilities, locate such utilities and expose those that may be affected by the Work, using hand labour as required.
- .5 Immediately report any damage to utilities to the Departmental Representative and to the utility company or authority affected and promptly undertake such remedial measures as are necessary at no additional cost to the Contract.

1.4 SURVEY OF
EXISTING PROPERTY
CONDITIONS

- .1 Submission of tender is deemed to be confirmation that the Contractor has inspected the site and is conversant with all conditions affecting execution and completion of work.
- .2 Regularly monitor the condition of the Work Site and of property on and adjoining the Work Site throughout the construction period. Immediately notify the Departmental Representative if any deterioration in condition is detected. Such monitoring must cover all pertinent features and property including, but not limited to: buildings, structures, roads, walls, fences, slopes, sewers, culverts and landscaped areas.

1.5 PROTECTION
OF PERSONS AND
PROPERTY

- .1 Comply with all applicable safety regulations of the Workers' Compensation Board of Nova Scotia including, but not limited to: WCB's Industrial Health and Safety Regulations, Industrial First Aid Regulations, and Workplace Hazardous Materials Information System Regulations.
- .2 Take all necessary precautions and measures to prevent injury or damage to persons and property on or near the Work Site.
- .3 Promptly take such measures as are required to repair, replace or compensate for any loss or damage caused by the Contractor to any property or, if Departmental Representative so directs, shall promptly reimburse the Departmental Representative the costs resulting from such loss or damage.

1.6 USE OF
PUBLIC AREAS

- .1 Do not allow vehicles and equipment to become a nuisance in public areas. Clean all vehicles and equipment leaving the Work Site and entering public roadways of mud and dirt clinging to the body and wheels of the vehicle. Load all vehicles arriving at or leaving the Work Site and transporting materials in a manner which will prevent dropping of materials or debris on the roadways, and where contents may otherwise be blown off during transit such loads shall be covered by tarpaulins or other suitable covers. Remove and clean spills of materials in public areas immediately at no additional cost to the Contract. Do activities in accordance with Section 01 35 43 - Environmental Procedures.

- 1.7 MEETINGS
- .1 The Work includes attending meetings between the Contractor and the Departmental Representative. The meetings will be called and chaired by the Contractor. The Contractor must be represented at such meetings.
 - .2 The Departmental Representative will schedule an initial meeting to be held on site after award notification.
 - .3 Cost of attending the above meetings will be considered incidental to the contract price proposal.

- 1.8 WASTE DISPOSAL
- .1 Remove all surplus, unsuitable and waste materials from the job site to appropriate sites outside of the Cape Breton Highlands National Park.
 - .2 Dispose of any excess fill from the project outside of Parks Canada boundaries and in an approved disposal site at no additional cost to the Contract.
 - .3 Deposit of any construction debris into any waterway is strictly forbidden.
 - .4 Cost for Waste Disposal described above shall be considered incidental to the contract price; no additional payment will be made.

PART 2 - PRODUCTS Not applicable.

PART 3 - EXECUTION Not applicable.

PART 1 - GENERAL

1.1 RELATED
SECTIONS

.1 Quality Control: Section 01 45 00

1.2 ADMINISTRATIVE

- .1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are coordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
- .10 Keep one (1) reviewed copy of each submission on site.

1.3 SHOP DRAWINGS
AND PRODUCT DATA

- .1 The term "Construction Drawing and Specifications" means drawings, diagrams, illustrations, schedules, detailed specification or descriptions of the Work as a part or a whole, statement or enumeration of particular of the Work as to size, quality, performance and terms and prepared by the Contractor.
- .2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .3 Submit shop drawings bearing stamp and signature of qualified professional engineer registered or licensed in the Province of Nova Scotia, Canada.
- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .5 Allow five (5) days for Departmental Representative's to review each submission.
- .6 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .7 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .8 Accompany submissions with transmittal letter, in duplicate, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Specification section submittal covers.
 - .6 Other pertinent data.

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- 1.3 SHOP DRAWINGS .9 After Departmental Representative's review,
AND PRODUCT DATA distribute copies.
(Cont'd)
- .10 Submit two (2) prints and one (1) electronic copy of
shop drawings for each requirement requested in
specification Sections and as Departmental
Representative may reasonably request.
- .11 Submit one (1) electronic and three (3) copies of
product data sheets or brochures for requirements
requested in specification Sections and as requested
by Departmental Representative where shop drawings
will not be prepared due to standardized manufacture
of product.
- .12 Submit one (1) electronic copy of test reports for
requirements requested in specification Sections and
as requested by Departmental Representative.
.1 Report signed by authorized official of testing
laboratory that material, product or system identical
to material, product or system to be provided has
been tested in accordance with specified
requirements.
.2 Testing must have been within one (1) year of
date of contract award for project.
- .13 Submit one (1) electronic copy of certificates for
requirements requested in specification Sections and
as requested by Departmental Representative.
.1 Statements printed on manufacturer's letterhead
and signed by responsible officials of manufacturer
of product, system or material attesting that
product, system or material meets specification
requirements.
.2 Certificates must be dated after award of
project contract complete with project name.
- .14 Submit one (1) electronic and three (3) copies of
manufacturer's instructions for requirements
requested in specification Sections and as requested
by Departmental Representative.
.1 Pre-printed material describing installation of
product, system or material, including special
notices and Material Safety Data Sheets concerning
impedances, hazards and safety precautions.
- .15 Submit one (1) electronic and three (3) copies of
Manufacturer's Field Reports for requirements
requested in specification Sections and as requested
by Departmental Representative.
.1 Documentation of the testing and verification
actions taken by manufacturer's representative to
confirm compliance with manufacturer's standards or
instructions.
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1.3 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd)

- .16 Submit one (1) electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .17 Delete information not applicable to project.
- .18 Supplement standard information to provide details applicable to project.
- .19 If upon review by Departmental Representative no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .20 The review of shop drawings by Departmental Representative is for the sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.4 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's Office, Cape Breton Highlands National Park, Ingonish Beach, NS, B0C 1L0.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.

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- 1.4 SAMPLES
(Cont'd)
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
 - .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
 - .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.
- 1.5 PROGRESS
PHOTOGRAPHS
- .1 On commencement of Work and at monthly intervals thereafter, supply the Departmental Representative with two (2) copies of (3) different view photographs to indicate progress of the Work. Take photographs from locations selected by Departmental Representative.
 - .2 On the back side of each photograph legibly indicate project name, date and location of exposure.
- 1.6 CERTIFICATES
AND TRANSCRIPTS
- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
 - .2 Submit transcription of insurance immediately after award of Contract.
- 1.7 MAINTENANCE
MANUAL AND
OPERATING
INSTRUCTIONS
- .1 Submit one (1) electronic and two (2) hard copies of completed volumes in final form of Maintenance Manual with application for Substantial Performance certificate. Maintenance Manual shall consist of shop drawings and Project Data Book.
 - .2 Include in Maintenance Manual one (1) copy of each final approved shop drawing issued for Project on which have been recorded changes made during fabrication and installation cause by unforeseen conditions.
 - .3 Submit extended guarantees together in one (1) report binder.
 - .4 The Manuals must:
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- 1.7 MAINTENANCE .4 The Manuals must:(Cont'd)
MANUAL AND
OPERATING
INSTRUCTIONS
(Cont'd)
- .1 Organize data in the form of an instructional manual in hard-covered, black, vinyl-covered binders of commercial quality, 8½" x 11" maximum ring size.
 - .2 Cover Identify each binder with typed or printed title "Project Record Documents"; list title of Project, identify subject matter of contents.
 - .3 Have a title sheet, or sheets, preceding data on which shall be a recorded Project name, Project number, date, list of contents, and Contractors and Subcontractors names.
 - .4 Be organized into applicable Sections of Work with each Section separated by hard paper dividers with plastic covered tabs marked by Section.
 - .5 Contain only typed or printed information and notes, and neatly drafted drawings.
 - .6 Contain maintenance and operating instructions on all building and mechanical and electrical equipment.
 - .7 Contain maintenance instructions as specified in various Sections.
 - .8 Contain brochures and parts lists on all equipment.
 - .9 Contain for each Product or System: List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .10 Contain lists of supply sources for maintenance of all equipment in Project of which more detailed information is not included above.
 - .11 Contain finished hardware schedule.
 - .12 Contain mechanical and electrical charts, diagrams and reports specified in Contract Documents.
- .5 Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings in size of text pages.
- .6 Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
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- 1.8 LIST OF .1 Provide the Departmental Representative the names of
SUBCONTRACTORS
- .1 Within 20 days of award of subcontract or prior to the subcontractor doing any work, whichever occurs first.
 - .2 When the subcontractors work is valued at 10% or more of the construction cost for the project to which he is subcontracted.
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1.8 LIST OF
SUBCONTRACTORS
(Cont'd)

- .1 (Cont'd)
 - .3 Submit a List of Subcontractors to the Departmental Representative stating:
 - .1 Indicate the names of all Subcontractors opposite the trades listed on a form.
- .2 Own forces may only be named in the form, when the Contractor is equipped to carry out by those named on the form. Substitutions of others must be approved by Departmental Representative.

1.9 CONSTRUCTION
SCHEDULE

- .1 Submit proposed construction schedule at beginning of Project, as specified in Section 01 11 00.
- .2 As construction progresses, submit up-dated construction schedules each month to Departmental Representative, to Contractor's consultant and to each Subcontractor who is included on Schedule.

1.10 AS-BUILT
INFORMATION

- .1 Record Drawings:
 - .1 After award of Contract, Departmental Representative will provide a set of 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. Also record unidentified buried services encountered during the Work.
 - .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.
- .2 Maintain as-built record drawings on site as the work progresses for all aspects of the work.
- .3 Departmental Representative will mark on "Project Record Copy" modifications made for work under the Scope of Work.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
 - .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .3 Province of Nova Scotia
 - .1 Occupational Health and Safety Act, S.N.S. 1996.
- 1.2 SUBMITTALS
- .1 Make submittals in accordance with agreed upon practice.
 - .2 Submit site-specific Health and Safety Plan: Within seven (7) days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
 - .3 Submit two (2) copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative.
 - .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
 - .5 Submit copies of incident and accident reports.
 - .6 Submit WHMIS MSDS - Material Safety Data Sheets.
 - .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within five (5) days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within three (3) days after receipt of comments from Departmental Representative.
 - .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's
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- 1.2 SUBMITTALS .8 (Cont'd)
(Cont'd) overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.
- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.
- 1.3 FILING OF NOTICE .1 File Notice of Project with authorities prior to beginning of Work.
- 1.4 SAFETY ASSESSMENT .1 Perform site specific safety hazard assessment related to project.
- 1.5 MEETINGS .1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.
- 1.6 REGULATORY REQUIREMENTS .1 Do Work in accordance with all existing regulatory requirements in place at the Site.
- 1.7 GENERAL REQUIREMENTS .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re- submission with correction of deficiencies or concerns.
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- 1.8 RESPONSIBILITY .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site- specific Health and Safety Plan.
- 1.9 COMPLIANCE REQUIREMENTS .1 Comply with Workers Compensation Act.
- .2 Comply with Occupational Health and Safety Act, Occupational Safety General Regulations, NS Reg.
- .3 Comply with Provincial Building Code Act.
- .4 Comply with National Building Code 2010, Part 8.
- .5 Comply with National Fire Code of Canada.
- .6 Comply with Dangerous Goods Transportation Act.
- 1.10 UNFORSEEN HAZARDS .1 When unforeseen or peculiar safety- related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Nova Scotia having jurisdiction and advise Departmental Representative verbally and in writing.
- 1.11 HEALTH AND SAFETY CO-ORDINATOR .1 Employ and assign to Work, competent and authorized representative as Health and Safety Coordinator. Health and Safety Coordinator must:
- .1 Have site-related working experience.
- .2 Have working knowledge of occupational safety and health regulations.
- .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
- .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
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- 1.11 HEALTH AND SAFETY CO-ORDINATOR (Cont'd) .1 (Cont'd)
.5 Be on site during execution of Work and report directly to and be under direction of site supervisor.
- 1.12 POSTING OF DOCUMENTS .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Nova Scotia having jurisdiction, and in consultation with Departmental Representative.
- 1.13 CORRECTION OF NON-COMPLIANCE .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
.2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
.3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.
- 1.14 BLASTING .1 Blasting or other use of explosives is not permitted.
- 1.15 WORK STOPPAGE .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
- PART 2 - PRODUCTS Not applicable.
- PART 3 - EXECUTION Not applicable.

PART 1 - GENERAL

1.1 RELATED
SECTIONS

.1 Health and Safety: Section 01 35 29.

1.2 REFERENCES

.1 Definitions:

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.3 ACTION AND
INFORMATIONAL
SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Prior to commencing construction activities or delivery of materials to site, provide Environmental Protection Plan for review and approval by Departmental Representative.

.3 Environmental Protection Plan to include comprehensive overview of known or potential environmental issues to be addressed during construction.

.4 Address topics at level of detail commensurate with environmental issue and required construction task(s).

.5 Include in Environmental Protection Plan:

.1 Name(s) of person(s) responsible for ensuring adherence to Environmental Protection Plan.

.2 Erosion and sediment control plan identifying type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan,

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- 1.3 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd) .5 (Cont'd)
- .2 (Cont'd)
Federal, Provincial, and Municipal laws and regulations.
- .3 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non- use. Include in plan measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.
- .4 Spill Control Plan including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
- .5 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
- .6 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.
- .7 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .8 Waste Water Management Plan identifying methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.
- .9 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.
- .10 Include pesticide treatment plan and update as required.
- 1.4 FIRES .1 Fires and burning of rubbish is not permitted on site.
- 1.5 DRAINAGE .1 Provide Erosion and Sediment Control Plan identifying type and location of erosion and sediment controls provided. Ensure plan includes monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment
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- 1.5 DRAINAGE
(Cont'd)
- .1 (Cont'd)
control plan, Federal, Provincial, and Municipal laws and regulations.
 - .2 Provide temporary drainage and pumping required to keep excavations and site free from water.
 - .3 Ensure pumped water into waterways, sewer or drainage systems is free of suspended materials.
 - .4 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.
- 1.6 SITE CLEARING
AND PLANT
PROTECTION
- .1 Protect trees and plants on site and adjacent properties as indicated.
 - .2 Wrap in burlap, trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2m minimum.
 - .3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.
 - .4 Minimize stripping of topsoil and vegetation.
 - .5 Restrict tree removal to areas indicated or designated by Departmental Representative.
- 1.7 WORK ADJACENT
TO WATERWAYS
- .1 Operate construction equipment on land only.
 - .2 Do not use waterway beds for borrow material.
 - .3 Waterways to be free of excavated fill, waste material and debris.
 - .4 Design and construct temporary crossings to minimize erosion to waterways.
 - .5 Do not skid logs or construction materials across waterways.
 - .6 Avoid indicated spawning beds when constructing temporary crossings of waterways.
-

1.8 POLLUTION
CONTROL

- .1 Maintain temporary erosion and pollution control features installed under this Contract.
- .2 Control emissions from equipment and plant to local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.9 HISTORICAL/
ARCHAEOLOGICAL
CONTROL

- .1 Provide historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction.
- .2 Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative.

1.10 NOTIFICATION

- .1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
 - .2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
 - .1 Do not take action until after receipt of written approval by Departmental Representative.
 - .3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.
 - .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.
-

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 CLEANING

- .1 Clean site to conditions equal to or better than prior to construction.
- .2 All rubbish and waste materials to be disposed of offsite at Contractors expense.
- .3 Keep public waterways, storm and sanitary sewers free of waste and volatile materials disposal.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Inspection and testing, administrative and enforcement requirements.
- .2 Equipment and system adjust and balance.
- 1.2 PRECEDENCE .1 For Federal Government projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.
- 1.3 INSPECTION .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, the Departmental Representative shall pay cost of examination and replacement.
- 1.4 ACCESS TO WORK .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.
-

1.5 TESTING

- .1 The Contractor is responsible to pay for the services of a testing laboratory for:
 - .1 Inspection and testing required by laws, ordinances, rules and regulations.
 - .2 Tests specified to be performed by Contractor.
 - .3 Inspection and testing performed exclusively for convenience of Contractor.
- .2 Provide such assistance, labour and materials as are normally required for examining, measuring and testing the quality, weight or quantity and pay all costs of any material used for testing as may be selected and as specified.
- .3 Perform or arrange for the performance of all tests on all equipment in complete accordance with the relevant clauses of these Specifications and in the presence of the Departmental Representative.
- .4 The cost of providing assistance for testing and of performing or arranging tests shall be deemed to be covered by and included in the Contract Price unless noted otherwise, elsewhere in these Specifications.
- .5 The Contractor has no claim against the Departmental Representative in respect of any financial loss which may be suffered from the rejection of any materials or equipment due to their failure to meet specified test requirements, and also bear the cost of remedying any defects such that the material or equipment will meet the specified tests, or failing this, of removing the material or equipment from the Site. The decision to repair or replace materials and equipment which have failed to meet test requirements will be made by the Departmental Representative.

1.6 PROCEDURES

- .1 Notify appropriate agency and the Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.

1.7 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.

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- 1.7 REJECTED WORK .3 If in opinion of Departmental Representative it is
(Cont'd)
- 1.8 REPORTS .1 Submit four (4) copies of inspection and test
reports to Departmental Representative.
- .2 Provide copies to Subcontractor of work being
inspected or tested and the manufacturer or
fabricator of material being inspected or tested.
- .3 Provide interim geotechnical compaction test data as
requested by the Departmental Representative.
- 1.9 MATERIALS AND .1 Equipment, materials and workmanship must be the
WORKMANSHIP best of the respective kinds described in the
Contract and in accordance with the Departmental
Representative's instructions and will be subjected
to such standard tests as the Departmental
Representative may direct at the place of manufacture
or fabrication or on the Site.
- .2 Before ordering materials for incorporation into the
Works, inform the Departmental Representative of the
source of the materials, except as regards to minor
matters, no order for such materials will be given
except with the authorization of the Departmental
Representative. Notwithstanding the fact that such
authorization may have been given, the Departmental
Representative may forbid the use of any such
materials, if upon delivery, they are found to be
defective or unsuitable for incorporation in the
Works. Keep the Departmental Representative fully
advised of the orders and delivery dates of
materials.
- .3 All material and equipment required to be
incorporated into the Work must be new and unused.
Any material found during the progress of the Work to
have cracks, flaws, or other defects will be rejected
by the Departmental Representative and replaced at no
additional cost to the Contract.
- .4 Replace materials and equipment found defective in
manufacturer or damaged in handling after delivery by
-

1.9 MATERIALS AND .4
WORKMANSHIP
(Cont'd)

(Cont'd)
the manufacturer. This includes the furnishing of all materials and labour required for the replacement of installed material and equipment discovered defective prior to the final acceptance of the Work.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES
- .1 As-built drawings, samples and specifications.
 - .2 Product data, materials and finishes, and related information.
 - .3 Spare parts, special tools and maintenance materials.
 - .4 Warranties.
 - .5 Attached forms.
 - .6 Operations and Maintenance Manuals start-up reports.
- 1.2 RELATED SECTIONS
- .1 Quality Control: Section 01 45 00
- 1.3 SUBMISSION
- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
 - .2 Copy will be returned after final inspection, with Departmental Representative's comments.
 - .3 Revise content of documents as required prior to final submittal.
 - .4 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
 - .5 If requested, furnish evidence as to type, source and quality of products provided.
 - .6 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
 - .7 Pay costs of transportation.
 - .8 Include equipment data collection and decommissioning forms in manual.
-

1.4 FORMAT

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.5 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 Date of submission; names,
 - .2 Addresses, and telephone numbers of Departmental Representative with name of responsible parties;
 - .3 Schedule of products and systems, indexed to content of volume.
 - .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
 - .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
-

1.6 RECORDING
ACTUAL SITE
CONDITIONS

- .1 Record information on set of black line opaque drawings, provided by Departmental Representative.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, field test records, required by individual specifications sections.

1.7 FINAL SURVEY

- .1 Submit final site survey certificate certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.
- .2 Provide detailed as-built survey in AutoCAD format showing three (3) metre grid elevations the site.

1.8 MATERIALS AND FINISHES

- .1 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .2 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Additional Requirements: as specified in individual specifications sections.

1.9 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.10 WARRANTIES

- .1 Provide warranty letter that states all materials and workmanship is warranted for one (1) year from date of Substantial Completion.
 - .2 Separate each warranty with index tab sheets.
 - .3 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .4 Obtain warranties, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of the applicable item of work.
 - .5 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
-

1.10 WARRANTIES .6 Verify that documents are in proper form, contain
(Cont'd) full information, and are notarized.

.7 Co-execute submittals when required.

.8 Retain warranties until time specified for
submittal.

PART 2 - PRODUCTS Not applicable.

PART 3 - EXECUTION Not applicable.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Procedures for demonstration and instruction of equipment and systems to the facility personnel.
- 1.2 RELATED SECTIONS .1 Closeout Submittals: Section 01 78 00
.2 Commissioning: Section 01 91 13
- 1.3 DESCRIPTION .1 Demonstrate operation and maintenance of equipment and systems to facility personnel.
.2 Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.
- 1.4 QUALITY CONTROL .1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct facility personnel, and provide written report that demonstration and instructions have been completed.
- 1.5 SUBMITTALS .1 Submit schedule of time and date for demonstration of each item of equipment.
.2 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
.3 Give time and date of each demonstration, with list of persons present.
- 1.6 CONDITIONS FOR DEMONSTRATIONS .1 Equipment has been inspected and put into operation in accordance with this Section.
.2 Testing, adjusting, and balancing has been performed.
.3 Provide copies of completed operation and maintenance for use in demonstrations and instructions.
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- 1.7 PREPARATION .1 Verify conditions for demonstration and instructions
comply with requirements.
- .2 Verify designated personnel are present.
- 1.8 DEMONSTRATION
AND INSTRUCTIONS .1 Demonstrate operation, control, adjustment,
trouble-shooting, servicing, and maintenance of each
item of equipment.
- .2 Instruct personnel in all phases of operation and
maintenance using operation and maintenance manual as
the basis of instruction.
- .3 Review contents of manual in detail to explain all
aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and
maintenance manual when the need for additional data
becomes apparent during instructions.
- PART 2 - PRODUCTS Not applicable.
- PART 3 - EXECUTION Not applicable.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Includes general requirements for commissioning wastewater treatment system.
- 1.2 RELATED SECTIONS .1 Quality Control: Section 01 45 00
- 1.3 QUALITY ASSURANCE .1 Testing organization services under provisions specified in Section 01 45 00.
- .2 Commissioning technician to be trained and certified by equipment manufacturer. Provide proof of training and certification of commissioning personnel.
- .3 Comply with applicable procedures and standards of the certification sponsoring association.
- .4 Perform services under direction of supervisor qualified under certification requirements of sponsoring association.
- 1.4 SUBMITTALS .1 Prior to start of Work, submit name of organization or Contractor personnel proposed to perform services. Designate who has managerial responsibilities for coordination of commissioning activities.
- .2 Submit documentation to confirm organization and personnel compliance with quality assurance provision.
- .3 Fifteen days prior to Substantial Performance, submit three (3) copies of final reports on applicable forms.
- .4 Submit testing reports postponed due to seasonal, climatic, occupancy, or other reasons beyond Contractor's control, promptly after execution of those services.
-

1.5 PROCEDURES -
GENERAL

- .1 Comply with procedural standards of certifying association under whose standard services will be performed.
- .2 Notify Departmental Representative three (3) days prior to beginning of operations.
- .3 Accurately record data for each step.
- .4 Report to Departmental Representative any deficiencies or defects noted during performance of services.

1.6 FINAL REPORTS

- .1 Organization having managerial responsibility shall make reports.
- .2 Ensure each form bears signature of recorder, and that of supervisor of reporting organization.
- .3 Identify each instrument used, and latest date of calibration of each.

1.7 CONTRACTOR
RESPONSIBILITIES

- .1 Prepare each system for testing.
- .2 Cooperate with testing organization and provide access to equipment and systems.
- .3 Provide personnel and operate systems at designated times, and under conditions required for proper testing and adjusting.
- .4 Notify testing organization seven (7) days prior to time project will be ready for testing.

1.8 PREPARATION

- .1 Provide instruments required for testing and adjusting operations.
- .2 Make instruments available to Departmental Representative to facilitate spot checks during testing.
- .3 Retain possession of instruments and remove at completion of services.
- .4 Verify systems installation is complete and in continuous operation.
- .5 Verify equipment is in full operation.

- 1.9 EXECUTION .1 Test pumps, instruments and controls, and adjust devices for systems.
- .2 Acceptance testing by manufacturer or approved service technician.

PART 2 - PRODUCTS Not applicable.

PART 3 - EXECUTION Not applicable.

- 1 GENERAL .1 This Section covers items common to Division 26 and 48. This section supplements requirements of Division 01.
- 2 REFERENCES .1 CSA-C22.1-15, Canadian Electrical Code, Part 1.
.2 CAN/CSA C22.2 No. 0.1-M1985(R2013), General Requirements for Double-Insulated Equipment.
.3 CAN/CSA-C22.3 No. 1-2010, Overhead Systems.
.4 CSA-C22.3 No. 7-2006, Underground Systems.
.5 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50 000 V.
.6 EEMAC Y1-2-1979, Standard for Performance Specification for Finishing Systems for Outdoor Electrical Equipment.
.7 EEMAC 2Y-1-1958, Standard for CEMA Light Gray Colour for Indoor Switchgear.
- 3 SCOPE OF WORK .1 The Work under this Contract consists of furnishing all materials, tools, equipment and labour, and performing the electrical services as indicated and as specified herein and on the Electrical Drawings.
.2 Remove existing electrical, control and instrumentation equipment as indicated on the drawings. Remove associated conduits and conductors back to the source or shared junction box from where they are fed/controlled.
.3 Supply and install new electrical underground ductbanks as indicated on the drawings.
.4 Coordinate installation of the new telephone/internet with the Owner and the telephone/internet utility.
.5 Supply and install new power distribution equipment as indicated on the drawings including, but not necessarily limited to the following list:
panelboards, transformers, circuit breakers, motor starters, disconnect switches, fuses, receptacles and UPS units.
-

3 SCOPE OF WORK
(Cont'd)

- .6 At the Reservoir Valve House, supply and install one (1) new solar power system as indicated on the drawings and specified herein.
- .7 Supply and install new lighting fixtures and light switch at the Chlorination building (PH1).
- .8 Supply and install new electric unit heater at the Chlorination building (PH1).
- .9 At the Reservoir Valve House, supply and install one (1) new 120 Vac receptacle and matching plug and matching plug for connection of a portable emergency generator.
- .10 Supply and install new RTU/PLC control panels where indicated on the drawings and specified herein.
- .11 Supply and install new instruments and telecommunications equipment as indicated on the drawings and specified herein.
- .12 Supply and install power distribution and general services wiring and cables.
- .13 Supply and install control, instrumentation and communication wiring and cables.
- .14 Supply and install required cable glands, conduit, conduit fittings and required mounting hardware.
- .15 Supply and install new grounding as indicated and as necessary to satisfy the CEC - Part 1 and the local provincial inspection authority.
- .16 Replace existing well pump PH2 with new Owner-supplied well pump. Disconnect existing well pump conductors back to the well pump control panel. Supply and install new power conductors and conduit as indicated.
- .17 Document, test and calibrate to satisfaction of the Departmental Representative, electrical, instrumentation and control equipment as specified herein and on the drawings.
- .18 Safely store all electrical, instrumentation and controls equipment awaiting installation.
- .19 Protect all installed electrical, instrumentation and controls equipment during construction.
- .20 Repair and/or replace equipment damaged during construction, or otherwise deemed defective or

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- 3 SCOPE OF WORK (Cont'd) .20 (Cont'd)
non-compliant with this specification, at no expense to the Departmental Representative. These expenses are to include all material, labour and other fees.
- .21 Coordinate and schedule with other trades to ensure that the construction proceeds in a timely and efficient manner. Minimize disturbance to existing systems and provide access for facility staff to conduct routine maintenance and inspection.
- .22 Refer to individual Sections for additional Scope of Work items.
- 4 CODES AND STANDARDS .1 Do complete installation in accordance with the Canadian Electrical Code, CSA C22.1, and local regulations except where specified otherwise.
- .2 Do overhead systems in accordance with CAN/CSA-C22.3 No. 1 and underground systems in accordance with CSA C22.3 No. 7, except where specified otherwise.
- .3 Comply with all CSA electrical bulletins in force at the time of tender submission. While not identified or specified by reference number in this division, the bulletins shall be considered to form part of the related CSA part II standard.
- .4 Abbreviations for electrical terms: to CSA Z85.
- 5 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 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.
- 6 VOLTAGE RATINGS .1 Operating voltages: to CAN3-C235.
- .2 Motors, control and distribution devices and equipment to operate satisfactorily at 60 Hz within
-

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- 6 VOLTAGE RATINGS .2 (Cont'd)
(Cont'd)
- normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- 7 PERMITS, FEES AND INSPECTION .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 receipt of the Plans Review Report from the Contractor.
- .3 Obtain the 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. Properly display the permits 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, unless specified otherwise.
- .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. All changes must be approved by the Departmental Representative.
- .6 Furnish Certificates of Acceptance from authorities having jurisdiction upon completion of Work. Include a copy in the Operations and Maintenance Manual.
-

7 PERMITS, FEES
AND INSPECTION
(Cont'd)

.7 Pay all associated fees.

8 MATERIALS AND
EQUIPMENT

.1 Provide materials and equipment in accordance with
Section 01 45 00.

.2 Equipment and material to be CSA certified or
certified by an agency recognized by the Electrical
Inspection Department. Where there is no alternative
to supplying equipment which is not certified, obtain
special approval from Electrical Inspection
Department and the Departmental Representative.

.3 Factory assemble control panels and component
assemblies.

9 ELECTRIC MOTORS,
EQUIPMENT AND
CONTROLS

.1 Coordinate supplier and installer responsibility for
mechanical and process equipment specified in other
specification Divisions to confirm complete and
functioning systems.

.2 Confirm location of mechanical and process equipment
and associated control devices specified in other
divisions. All device locations may not be
necessarily shown on the electrical drawings.

10 FINISHES

.1 Shop finish metal enclosure surfaces by application
of rust resistant primer inside and outside, and at
least two (2) coats of finish enamel.
.1 Paint indoor switchgear and distribution
enclosures light grey to EEMAC 2Y-1.
.2 Paint outdoor electrical equipment green finish
to EEMAC Y1-2.

.2 Clean and touch up surfaces of new shop-painted
equipment scratched or marred during shipment or
installation, to match original paint to the
satisfaction of the Departmental Representative. If
not acceptable to the Departmental Representative,
replace equipment at no additional cost to the
Contract.

.3 Clean, prime and paint exposed non-galvanized steel
hangers, racks and fastenings to prevent rusting.

11 FASTENERS AND
EQUIPMENT MOUNTING

- .1 Fastening devices for all equipment and components, including bolts, nuts, washers, and screws shall be stainless steel or galvanized steel throughout.
- .2 Where there is no wall for mounting control panels, major junction boxes, instrumentation, transmitter/analyzer, etc., supply and install an 8 mm thick aluminum plate or stainless steel (316SS) plate for mounting this equipment. Secure mounting plate to back-to-back U-shaped strut as specified. Remove all sharp edges on backplate.
- .3 Wall mount electrical distribution equipment on 21mm thick fire retardant plywood backboards that are fastened directly to the wall. Paint plywood backboards with two (2) coats of fire retardant paint to match wall colour.

12 EQUIPMENT
IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as specified herein.
- .2 Identification:
 - .1 Supply and install "lamicoid" nameplates on all new and existing panels, disconnect switches, receptacles, transformers, control panels, magnetic starters, TOL's, etc. as further described herein. Affix plates true, level and plumb in all instances.
 - .2 Affix nameplates to surfaces with contact type cement.
 - .3 Attach 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 must indicate the following:
 - .1 Designated name of equipment.
 - .2 Amorage of overcurrent protection device.
 - .3 Voltages, number of phases and wires.
 - .4 Designation of power source.

PANEL C - 100 AMPS
120/208V - 3PH - 4W
FED FROM PANEL B

- .6 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect

12 EQUIPMENT
IDENTIFICATION
(Cont'd)

.2 Identification:(Cont'd)

.6 (Cont'd)
switches, etc., must 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.

Example:

FAN NO. 5
PANEL H - CKT. 17
120V - 1 PH

Example: EXHAUST

SUPPLY FAN NO. 3
M.C.C. NO. 1
600V - 3 PH

.7 Lamicoid nameplates installed on fusible type disconnect switches are 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.

.9 Install lamicoid 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). Lamicoid 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 Lamicoid nameplates above 120V receptacles protected by GFCI circuit breakers, or GFCI type receptacles are to be identified 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 (EXAMPLE: GFCI Protected Panel H-26).

.11 Allow for an "average" of 40 letters for each lamicoid nameplate.

.12 Lamicoid to be 3 mm thick plastic engraving sheet, white face, black core, for all electrical systems.

.13 Lettering on lamicoid nameplates shall 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 to be as indicated in the following chart:

13 WIRING
IDENTIFICATION

- .1 Identify wiring with self-laminating, permanently mechanical imprinted labels on both ends of phase conductors of feeders and branch circuit wiring. Install labels in a "flagged" manner around individual conductors.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.
- .5 Indicate panel and circuit number on all phase conductors (i.e., Panel A, ckt 3) at the device and at any intermediate junction/pull boxes.
- .6 Identify all neutral conductors to indicate the phase conductor with which they are associated and at any intermediate junction/pull boxes.

14 CONDUIT AND
CABLE
IDENTIFICATION

- .1 Colour code conduits, boxes and cables to match existing systems.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 19 mm wide auxiliary colour. Colour to match existing systems.
- .4 For power cables to electrical equipment, indicate designated name of equipment and designated name of power source (i.e., Fuel Pump #1 - fed from MCC #1).
- .5 Where more than one cable terminates at a device, add cable number (i.e., -1, -2) to end of cable identification.
- .6 Use Electrovert PVC K-marking sleeves (black on yellow), complete with PVC carrier strip and self-locking nylon cable ties (black) or approved equal.

15 WIRING
TERMINATIONS

- .1 Use lugs, terminals and screws for termination of wiring that are suitable for either copper or aluminum conductors.

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- 16 MANUFACTURERS AND CSA LABELS .1 Visible and legible after equipment is installed.
- 17 WARNING SIGNS .1 As specified and to meet requirements of Electrical Inspection Department.
.2 Decal or Porcelain enamel signs, minimum size 180 mm x 250 mm.
- 18 LOCATION OF EQUIPMENT .1 Locate outlets in accordance with the Project Drawings and these Specifications.
.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
.3 Change location of equipment at no extra cost or credit, providing distance does not exceed 3 m and information is given before installation.
.4 Locate light switches on latch side of doors.
- 19 MOUNTING HEIGHTS .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
.3 Install electrical equipment at following heights unless indicated otherwise.
.1 Wall receptacles:
.1 General: 1200 mm AFF.
.2 Outdoors: 1200 mm above finished grade.
.2 Panelboards: as required by Code or as indicated.
.3 Wall mounted telephone and data outlets:
.1 General: 1200 mm AFF.
.2 Outdoors: 1200 mm above finished grade.
- 20 LOAD BALANCE .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.
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- 20 LOAD BALANCE
(Cont'd)
- .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.
 - .3 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- 21 CONDUIT AND CABLE INSTALLATION
- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.
 - .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
 - .3 Arrange and pay for holes through exterior walls; provide flashings and make weatherproof.
 - .4 Install conduits to be embedded or plastered over, neatly and close to the building structure so furring can be kept to a minimum.
- 22 FIELD QUALITY CONTROL
- .1 Conduct and pay for following tests:
 - .1 Power distribution system including phase rotation, 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.
 - .2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
 - .3 Insulation resistance testing:
 - .1 Megger circuits, feeders and distribution equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and distribution equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
 - .4 Provide a type written tabular report indicating test results.
 - .4 Advise of dates when testing will take place. Provide five (5) days notice of such tests.
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- 22 FIELD QUALITY CONTROL (Cont'd) .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for review and approval.
- 23 COORDINATION OF PROTECTIVE DEVICES .1 Install circuit protective devices such as circuit breakers, overcurrent relays and fuses to required values and settings.
- 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, fittings, and boxes, adjust all fixture and equipment boxes, adjust all fixture and equipment locations and provide all supporting materials required for a planned, coordinated and neat installation. Where interferences occur, the 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 Do electrical Work conformance with the requirements and recommendations of the Canadian Electrical Code and all local codes and ordinances. In conflicts between codes, the more stringent requirements shall 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, shall comply with their requirements and recommendations wherever applicable.
 - .4 Canadian Standard Association (CSA).
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- 24 QUALITY ASSURANCE (Cont'd) .2 Applicable standards:(Cont'd)
- .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 Engineers Association (I.P.C.E.A.).
 - .9 National Electrical Manufacturers Association (NEMA).
 - .10 National Fire Protection Association (N.F.P.A.).
 - .11 Underwriter's Laboratories of Canada (U.L.C.).
- 25 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.
- 26 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.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA C22.2, No. 65-2013, Standard for Wire Connectors.

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 Clamps or connectors for armoured cable, liquid tight, flexible conduit, as required.
- .3 Use wire connectors rated for operating voltage indicated.

PART 3 - EXECUTION

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

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 90 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(of 98% conductivity). 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 Use wiring colour coded in accordance with the Canadian electrical Code.
- 2.2 PROCESS CONTROL AND INSTRUMENTATION CABLING .1 Refer to Section 26 90 00 and electrical drawings.
- 2.3 COMMUNICATIONS CABLES .1 Refer to Section 26 90 00 and electrical drawings.
-

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.
 - .2 Twist together stranded conductors at each termination.
 - .3 Ty-rap branch circuit phase conductors and neutral (where applicable) at the closest point of entry within all panelboards, pullboxes and junction boxes.
- 3.2 INSTALLATION OF CABLES: GENERAL
- .1 Support cables independent of supports used for equipment of other trades. Do not support from or secure cables to ductwork and 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 wet/damp areas and outdoors, enter cables into the bottom of the equipment.
 - .5 Terminate conductors/cables.

PART 1 - GENERAL

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

1.2 REFERENCES .1 CSA C22.2 No. 41-2013, Grounding and Bonding Equipment.

PART 2 - PRODUCTS

- 2.1 EQUIPMENT .1 Clamps for grounding conductors, size as required and suitable for application.
- .2 Direct buried grounding conductors: bare stranded copper of minimum 98% conductivity, un-tinned, soft annealed, size as indicated.
- .3 Insulated grounding and bonding conductors: soft-drawn, stranded copper of minimum 98% conductivity, type RW90 (green coloured insulation). Conductors to be FT4 rated when installed in free air.
- .4 Rod electrodes, copper clad steel, 21mm diameter, 3m long.
- .5 Ground bus: copper, minimum size as indicated on the Project Drawings, complete with insulated supports, fastenings and connectors.
- .6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
- .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Pressure wire connectors.
 - .6 Thermit welded type connectors.
 - .7 Copper crimp type compression connectors, (long barrel, two hole).
 - .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, Hydrel.

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 exothermic welding 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. Minimum size #14AWG or as indicated in Table No. 16 of the CEC, whichever is larger.

- 3.2 ELECTRODES .1 Bond separate, multiple electrodes together.
- .2 Use bare copper grounding conductors, size as indicated on the Project Drawings for connections to electrodes.
- .3 Install power system ground rods at the reservoir where indicated on the Project Drawings connect to electrical grounding system with grounding conductor, size as indicated on the Project Drawings.
- .4 Install communication system grounding electrodes where indicated on the Project Drawings and connect as indicated on the Project Drawings.

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- 3.3 SYSTEM AND CIRCUIT GROUNDING .1 Install system and circuit grounding connections to neutral of secondary systems.
- 3.4 EQUIPMENT GROUNDING/BONDING .1 Install grounding and bonding connections to typical equipment included in, but not necessarily limited to following list: service equipment, transformers, frames of motors, motor starters, control panels, distribution panels, process equipment, instrumentation, process piping, outdoor lights, air ducts and metallic process/mechanical pipes.
- 3.5 GROUND BUS .1 Install new copper grounding bus on the wall of each building where specified on the Project Drawings.
.2 Ground items of electrical equipment, to ground bus.
- 3.6 COMMUNICATION SYSTEMS .1 Install grounding connectors for telephone and data systems as follows:
.1 Telephone: make grounding connections in accordance with the telephone company's requirements.
.2 Data: as indicated or as recommended by manufacturer.
- 3.7 FIELD QUALITY CONTROL .1 Perform tests in accordance with Section 26 05 00.
.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over the installation.
.3 Perform tests before energizing electrical system.

PART 1 - GENERAL

Not applicable.

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 Use stainless (304SS or 316SS) or hot dipped galvanized steel unless noted otherwise.

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.
 - .2 Two-hole straps for conduits and cables larger than 50 mm.
 - .3 Conduit straps to match conduits in material and finish.
-

- 3.1 INSTALLATION .5 (Cont'd)
(Cont'd)
- .4 Use heavy duty cable/conduit clamps (with adjustable saddles) to secure conduits/cables to support channels.
- .6 Suspended support systems for horizontal cable and conduit runs:
- .1 Support individual cable and conduit runs with minimum 9 mm dia. continuously threaded rods and spring clips where direct fastening to building construction is impractical.
- .2 Support two (2) or more 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.
- .4 Install strut in attic space above roof truss to secure threaded rod. Strut is to span a minimum of two (2) trusses. Secure strut to truss with wood screws.
- .7 For surface mounting of two or more conduits and cable, use support channels spaced in accordance with the Canadian Electrical Code.
- .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 Departmental 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 In addition to C.E.C. minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one (1) additional support rod installed not greater than 300 mm and mid point of "all" 90° bends. Maximum spacings between conduit support channels will be as dictated

- 3.1 INSTALLATION
(Cont'd)
- .13 (Cont'd)
by smallest size conduit(s) being supported and/or
secured to same.
- .14 Where galvanized steel supports are exposed to
moisture, touch-up all field cut surfaces with
galvanizing paint.
- .15 Provide isolator pads between dissimilar metals as
required.
- .16 Coordinate the location of electrical support
systems with other trades before installing.

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 General: Provide outlet, tap, junction, pull and floor boxes with screw-fastened covers. Provide junction and pull boxes 300mm and longer in any dimension complete with continuously hinged cover.
- .2 Junction and pull boxes to be NEMA type 4 or 4X complete with clamped, hinged or bolted covers.
- .3 Boxes to be stainless steel, cast ferrous alloy/ copper free cast aluminum boxes (to match conduit material), or PVC.
- 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.
- .5 Unless otherwise indicated on the Drawings, enclosure rating shall be NEMA 12.
- .6 Finish: baked grey enamel.
- .7 Acceptable Materials: Eurobex 1400T Series or approved equivalent.
-

PART 3 - EXECUTION

3.1 JUNCTION AND
PULL BOXES

- .1 Only main junction and pull boxes are indicated on the drawings. Provide boxes to suit field conditions and where required by the Canadian Electrical Code.
- .2 Install junction and pull boxes in inconspicuous but accessible locations.
- .3 Provide all required mounting hardware.
- .4 Bond all junction and pull boxes with bonding conductor.
- .5 Junction boxes longer than 150mm x 150mm used in branch circuit wiring are to be complete with a bonding terminal strip.

3.2 SPLITTER BOX

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

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.

PART 1 - GENERAL

Not applicable

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 Sheet steel outlet boxes:
 - .1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 75 x 50 x 38 mm or as indicated. 100 mm square outlet boxes when more than one conduit enters one side.
 - .2 100 mm square or octagonal outlet boxes for lighting fixture outlets.
 - .3 Electro-galvanized steel utility boxes for outlets connected to surface mounted EMT, minimum size 100mm x 54mm x 47mm.
- .3 Masonry boxes: electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.
- .4 Concrete boxes: electro-galvanized steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
- .5 Surface mounted outlet boxes:
 - .1 Cast FS or FD copper free aluminum or ferrous alloy boxes (to match conduit material) with factory threaded hubs and mounting feet for surface wiring of switches, receptacles, thermostats, etc.
 - .2 NEMA 4X PVC outlet boxes in areas where PVC conduit is to be used.

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 - .4 Double locknuts and insulated bushings on sheet
GENERAL metal boxes.
(Cont'd) .5 Use watertight bushings and cable connectors for all
cable/conduit terminations in process control
cabinets and NEMA 3R/4/4X pull/ junction boxes.

PART 3 - EXECUTION

- 3.1 OUTLET BOX, .1 Support boxes independently of connecting conduits.
AND CONDUIT BOX
INSTALLATION .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.
.4 Vacuum clean interior of outlet boxes before
installation of wiring devices.

PART 1 - GENERAL

- 1.1 LOCATION OF CONDUIT .1 Drawings do not show all conduits. Those shown are in diagrammatic form only.
- 1.2 RELATED WORK .1 Fastenings and Supports: Section 26 05 29
.2 Outlet Boxes, Conduit Boxes and Fittings: Section 26 05 32
- 1.3 REFERENCES .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. 83-M1985(R2013), Electrical Metallic Tubing.
.6 CSA-C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.

PART 2 - PRODUCTS

- 2.1 CONDUITS .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.
.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.
-

2.1 CONDUITS
(Cont'd)

.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 Chlorination building (PH1), Reservoir Valve House, Wellhead chamber and Electrical building (PH2) where not subjected to mechanical damage. Do not run rigid PVC conduit through attic spaces.
 - .3 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 Install conduits overhead as high as possible to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
 - .5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
 - .6 Mechanically bend steel conduit over 19 mm dia.
 - .7 Field threads on rigid threaded conduit must be of sufficient length to draw conduits up tight.
 - .8 Install polypropylene fish cord in each spare conduit. Cap and seal at each end.
 - .9 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
 - .10 Dry conduits out before installing wire.
 - .11 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.
- .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.

- 3.1 CONDUIT
INSTALLATION
(Cont'd)
- .2 Surface conduits:(Cont'd)
 - .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
- 1.2 SHOP DRAWINGS AND PRODUCT DATA .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- 1.3 OPERATIONS AND MAINTENANCE DATA .1 Provide maintenance data for transformers for incorporation into manual as specified in Section 01 78 00.

PART 2 - PRODUCTS

- 2.1 TRANSFORMERS .1 Use transformers of one (1) manufacturer throughout project.
- .2 Design 1:
.1 Type: dry
.2 1-phase, kVA as indicated, 600V input, 120/240V, output voltage, 60 Hz.
.3 Voltage taps: standard.
.4 Insulation: Class 185, 115°C temperature rise.
.5 Basic Impulse Level (BIL): standard.
.6 Hipot: standard.
.7 Average sound level: standard.
.8 Impedance at 170°C: standard.
.9 Enclosure: epoxy impregnated suitable for damp environment, complete with NEMA 3R enclosure.
.10 Mounting: wall.
.11 Finish: in accordance with Section 26 05 00.
.12 All windings copper.
- 2.2 EQUIPMENT IDENTIFICATION .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Label size: 9.
-

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Securely mount dry type transformer as indicated.
 - .2 Transformers containing electrical termination points located on the rear side are not acceptable.
 - .3 Confirm adequate clearance around transformer for ventilation and fire separations in accordance with the Canadian Electrical Code and the electrical inspection department having jurisdiction.
 - .4 Install transformers in level upright position.
 - .5 Remove shipping supports only after transformer is installed and just before putting into service.
 - .6 Loosen isolation pad bolts until no compression is visible.
 - .7 Megger both primary and secondary windings with 1000 V and 500 V megger as recommended by manufacturer and report immediately any reading below 100 megohms. Submit test results for Departmental Representative's review and approval.
 - .8 Confirm transformer is on the correct tap.
 - .9 Make primary and secondary connections in accordance with wiring diagram.
 - .10 Connect transformer neutral and case solidly to ground.
 - .11 Energize transformers after installation end testing is complete.

PART 1 - GENERAL

- 1.1 SHOP DRAWINGS AND PRODUCT DATA .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.
- 1.2 OPERATIONS AND MAINTENANCE DATA .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

- 2.1 PANELBOARDS .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.
- .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.

- 2.1 PANELBOARDS
(Cont'd)
- .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.

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.
- .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, 125 V, 15 A, U ground, with following features:
 - .1 Urea molded housing, ivory colour.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Nylon face.
- .2 Design R2:
- .1 Heavy duty, specification grade duplex ground fault circuit interrupter (GFCI) receptacles, CSA type 5-15R, 125V, 15A, u-ground, with the following features:
 - .1 Urea molded housing, ivory colour.
 - .2 Suitable for No. 10 AWG for back and side wiring.

-
- 2.2 RECEPTACLES .2 Design R2:(Cont'd)
(Cont'd) .1 (Cont'd)
- .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Nylon face.
 - .7 Indicator light (green - ok, red - trip/fault).
 - .8 Trip test function.
 - .9 Maximum trip threshold of 5mA.
- .2 Standard of Acceptance: Hubbell #GFR5252IA
.3 Acceptable Manufacturers: Hubbell, Pass & Seymour, CWD (Cooper Wiring Devices), Leviton.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Use the receptacles of one (1) manufacturer throughout project.
-
- 2.3 COVER PLATES .1 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

3.1 SWITCH,
RECEPTACLE, AND
COVER PLATE
INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height specified in these Specifications or as indicated.
 - .4 Install size 1 identification lamicaid for control switches for pumps, motors, and process equipment.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one (1) receptacle is required in one location.
 - .2 Mount receptacles at height specified in these Specifications or as indicated.
- .3 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CAN/CSA C22.2 No. 248. 8-11, Low Voltage Fuses:
Class J.
- .2 CAN/CSA C22.2 No. 248.4-00(R2015), Low Voltage
Fuses: Class CC.
- 1.2 SHOP DRAWINGS
AND PRODUCT DATA .1 Submit shop drawings and product data in accordance
with Section 01 33 00.
- 1.3 MAINTENANCE
MATERIALS .1 Three (3) spare fuses of each type and size.
- 1.4 DELIVERY AND
STORAGE .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

- 2.1 FUSES GENERAL .1 Fuses: use the product of one (1) manufacturer.
- .2 Low voltage fuses, types as specified, shall be CSA
certified in accordance with CSA Standard C22.2 No.
248.4 and 248.8.
- 2.2 FUSE TYPES .1 All fuses must be high rupturing capacity (HRC)
type, minimum 200kA interrupting rating (momentary
RMS symmetrical).
- .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 must carry 500% of their ampere rating for not
less than 10 seconds and shall be clearly labeled
"time delay".

2.2 FUSE TYPES
(Cont'd)

- .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.

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 power distribution transformers, use time delay Class J fuses.
- .7 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 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 Bolt-on moulded case circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient. Plug-in moulded case circuit breakers are acceptable in panelboards and load centres that are presently installed with this type of circuit breaker.
 - .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. Instantaneous 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 interrupting rating (momentary RMS symmetrical) as indicated, minimum 10KA at rated voltage.
 - .6 Half size circuit breakers are not acceptable.
- 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.
-

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install circuit breakers as indicated.
 - .2 New circuit breakers indicated for installation in existing panelboards and load centres shall be approved for installation in the existing panelboard/load centre and the breaker must match the existing breakers in type and interrupting rating.

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 Provision for padlocking in the off switch position by three pad locks.
 - .3 Mechanically interlocked door to prevent opening when handle in ON position.
 - .4 Fuses: size and type as indicated.
 - .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
 - .6 Quick-make, quick-break action.
 - .7 ON-OFF switch position indication on switch enclosure cover.
 - .8 Provide equipment identification in accordance with Section 26 05 00.
 - .9 Switches to be NEMA enclosure type 12 (painted steel) unless noted otherwise.
 - .10 Provide switches complete with window to view open/close status of disconnect switch blades.
 - .11 Switches to be service entrance rated with neutral kit where indicated.
 - .12 Acceptable manufacturers: Square D, Cutler Hammer, Siemens.
-

PART 3 - EXECUTION

3.1 DISCONNECT
SWITCH INSTALLATION

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

PART 1 - GENERAL

- 1.1 REFERENCES .1 ANSI C62.41.1-2008, Guide on the Surge Environment on Low-Voltage (1000V or Less) AC Power Circuits.
- .2 UL 1778-2014, Uninterruptible Power Systems.
- 1.2 SHOP DRAWINGS AND PRODUCT DATA .1 Submit shop drawings and product data for review and approval in accordance with Section 01 33 00.
- 1.3 OPERATION AND MAINTENANCE DATA .1 Provide maintenance data for UPS for incorporation into manual as specified in Section 01 78 00.
- 1.4 WARRANTY .1 Manufacturer to provide a product warranty for a period of not less than two (2) years from the date of Substantial Performance. Warranty must include full parts and labour.
- 1.5 SCOPE OF SUPPLY .1 One (1) UPS unit for Wellhead and Electrical building (PH2) RTU/PLC control panel (JB-990).
- .2 One (1) UPS unit for the Chlorination building (PH1) RTU/PLC control panel (JB-992).
- 1.6 SYSTEM DESCRIPTION .1 Uninterruptible Power Supply (UPS) System to be a solid state system providing single-phase uninterruptible AC power for sensitive electronic equipment loads. It must comply with the requirements of the Underwriters Laboratories standard 1778, FCC Part 15, Subpart B, Class A (RFI/EMI), also to ANSI C62.41.1 and must be listed under the Underwriters Laboratories of Canada.
-

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Provide UPS designed to operate as a true on-line double conversion system in normal, emergency, recharge and bypass modes.
- .2 UPS unit to be comprised of the following components housed in a NEMA type 1 enclosure:
 - .1 Input converter.
 - .2 Battery charger.
 - .3 Inverter.
 - .4 Battery (nominal 5 year life, hot swappable, consisting of the appropriate number of sealed battery cells).
 - .5 Cooling fan.
- .3 UPS system to include a front panel LCD screen or LED type status indicating the following:
 - .1 UPS on.
 - .2 Overload.
 - .3 Load percentage.
 - .4 Battery charge level.
 - .5 UPS inverter is operating and supplying power.
 - .6 UPS is in bypass.
 - .7 UPS is operating from battery power.
 - .8 UPS fault condition.
- .4 Provide UPS complete with an On/Off pushbutton and an audible alarm reset pushbutton.
- .5 UPS to have built-in protection against under voltage, overcurrent and over voltage conditions, including low-energy lightning surges on primary AC sources.
- .6 UPS to have an input power plug (to match UPS rating) and output distribution consisting of minimum three (3) NEMA 5-15R receptacles.
- .7 UPS to have automatic transfer bypass protection to transfer output load from the inverter to the bypass source in the event of overload, over temperature, DC bus over voltage and inverter failure conditions.
- .8 Design requirements:
 - .1 Input voltage: 120 Vac nominal, 60 Hz, single phase, 2 wire plus ground.
 - .2 Output voltage: 120 Vac \pm 3%, 60 Hz, single phase, 2 wire plus ground.
 - .3 Output load capacity: the PLC/RTU control panel fabricator must size the UPS to match the control panel power requirements.

2.1 MATERIALS
(Cont'd)

- .8 Design requirements:(Cont'd)
 - .4 Battery runtime: minimum fifteen (15) minute run time at the output load capacity rating.
 - .5 If required, provide external battery or upsize the UPS 'VA' rating to achieve minimum battery run times.
- .9 Performance requirements:
 - .1 AC input to UPS:
 - .1 Voltage: 120 Vac nominal, 70-138 V range.
 - .2 Input frequency: 60 Hz, range 40-70 Hz.
 - .3 Input power factor: greater than 0.95 lagging at rated load.
 - .4 Input line transient immunity: conforming to ANSI C62.41.1 tests.
 - .2 AC output, UPS inverter:
 - .1 Voltage: 120 Vac.
 - .2 Voltage regulation: $\pm 3\%$ steady state.
 - .3 Frequency: 60 Hz, $\pm 5\%$ synchronized to utility, ± 0.1 Hz free running or on battery operation.
 - .4 Frequency slew rate: 1.0 Hz per second (maximum).
 - .5 Load power factor range: 0.65 lagging to unity.
 - .6 Overload capability:
 - .1 130% rated load for 10 seconds.
 - .2 150% rated load for 1.5 seconds.
 - .3 200% sub-cycle.
 - .7 Voltage transient response:
 - .1 $\pm 7\%$ for 0-100% loading (normal).
 - .2 $\pm 9\%$ for 0-100% loading (battery mode).
 - .8 Transient recovery time: to nominal voltage within 90 milliseconds.
 - .9 Efficiency: minimum 83%.
 - .10 UPS to have a relay interface card complete with dry contacts (minimum 24 Vdc rated) for remote monitoring of the following conditions: Input Power Failure and Low Battery.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Locate UPS unit in the RTU/PLC control panel. Alternately, locate the UPS in a separate painted steel (NEMA 12 in the Electrical building (PH2) and NEMA 4 stainless steel in the Chlorination building (PH1)).
- .2 Assemble and interconnect components to provide complete UPS as specified.
- .3 Connect AC mains to UPS.
- .4 Connect UPS output to load.
- .5 Start up UPS and make preliminary tests to ensure satisfactory performance. Confirm run-time of UPS on battery power and record results.
- .6 Connect UPS relay interface to RTU/PLC I/O as specified.

PART 1 - GENERAL

- 1.1 RELATED WORK .1 Electrical General Requirements: Section 26 05 00
- 1.2 REFERENCES .1 ANSI C82.11-2011, High Frequency Fluorescent Lamp Ballasts.
- .2 IEEE C62.41.1-2008, Guide on the Surge Environment in Low-Voltage (1000 V and Less) A/C Power Circuits.
- .3 CAN/CSA C654-14, Fluorescent Lamp Ballast Efficiency Measurements.
- 1.3 SHOP DRAWINGS AND PRODUCT DATA .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Submit shop drawings for the following:
- .1 Luminaire.
- .2 Lamp for each luminaire type.
- .3 Ballast for each luminaire type.
- .3 Shop Drawings:
- .1 Shop drawings to clearly indicate the following:
- .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 Engineer. Photometric data to include:
- .1 VCP Table, spacing criterion;
- .2 Total input watts;
- .3 Candlepower summary, candela distribution, zonal lumen summary;
- .4 Luminaire efficiency, C.I.E. type, coefficient of utilization;
-

1.3 SHOP DRAWINGS AND PRODUCT DATA (Cont'd) .5 (Cont'd)
.5 Lamp type;
.6 Lumen ratings;and
.7 Summary in accordance with IES procedures.

1.4 OPERATION AND MAINTENANCE .1 Provide operation and maintenance data in accordance with Section 01 78 00.

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 must be of the same manufacturer and compatible with the ballast.

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 Provide ballast with integral leads color coded per ANSI C82.11.
 - .3 Warranty:
 - .1 Ballast must carry a five (5) 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 instant start ballast factory wired to lamp holders.
 - .6 Housing: fiberglass reinforced polyester housing with impact resistant, smooth acrylic lens (frosted) 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 .2 LED luminaire design L1:
(Cont'd)
- .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.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Connect luminaires to lighting circuits as indicated. Each light fixture will 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 two (2) spare fluorescent lamps.
- 3.2 LUMINAIRE SUPPORTS .1 Support all luminaires independently of ductwork, piping or cable tray.
- .2 Chains to 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 Clean all luminaires one (1) 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 78 00.

PART 1 - GENERAL

- 1.1 WORK INCLUDED .1 This Section specifies the requirements for the supply, installation, cabling, termination, calibration, testing and commissioning of the instrumentation and controls equipment.
- 1.2 REFERENCES .1 The work under this section must conform to the applicable requirements of the 2010 edition of the National Building Code of Canada, the National Plumbing Code of Canada, and the National Fire Code of Canada. Also in accordance with applicable provincial, municipal and other laws, and with the latest edition of the following standards which shall be deemed to be and form part of this specification:
- .1 National Fire Protection Association
 - .2 Underwriters Laboratories of Canada
 - .3 American Society of Mechanical Engineers
 - .4 American National Standards Institute
 - .5 American Water Works Association
 - .6 American Society of Testing and Materials
 - .7 Institute of Electrical and Electronic Engineers.
 - .8 Manufacturers Standardization Society.
 - .9 Instrument Society of America.
 - .10 Canadian Electrical Code
 - .11 Canadian Standards Association
 - .12 Canadian General Standards Board
- .2 NSF 61 Drinking Water System Components.
- .3 ASME/ANSI B16.5-2013, Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
- .4 EIA/TIA 568-B.1, Commercial Building Telecommunications Cable Standard: General Requirements.
- .5 EIA/TIA 568-B.2, Commercial Building Telecommunications Cable Standard: Balanced Twisted-Pair Cabling Components.
- .6 EIA/TIA 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .7 CSA C22.1-15 Canadian Electrical Code Part 1.
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- 1.3 IDENTIFICATION OF EQUIPMENT .1 Equipment assemblies comprised of electro-mechanical components shall be CSA approved where possible and shall bear the appropriate label. If the equipment in question is not CSA approved as an assembly, the manufacturer must arrange and pay for Spot approval and labeling of the equipment prior to installation.
- 1.4 SHOP DRAWINGS AND SUBMITTALS .1 Submit shop drawings for all process equipment to the Departmental Representative for review prior to equipment purchase in accordance with Section 01 33 00.
- .2 Instrumentation and controls equipment shop drawings include, but are not limited to the following:
- .1 Complete model number of each instrument being proposed, with model number breakdown codes.
 - .2 Identify applicable instrument/equipment tag numbers on every shop drawing.
 - .3 Equipment operational specifications.
 - .4 Equipment dimensions, weight, mounting details, and materials of construction
 - .5 Equipment power requirements, instrument air 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 Upon request by the Departmental Representative, the Supplier shall supply a similar application user list, 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, or a bad review by a contacted user, will result in the automatic rejection of the proposed instrument.
- .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.
-

1.4 SHOP DRAWINGS .4 Maintain an "as-built" mark-up set of the
AND SUBMITTALS .4 instrumentation and controls drawings on site to be
(Cont'd) .4 turned over to the Departmental Representative at the
end of the work in accordance with Section 01 78 00.

1.5 WORK NOT .1 PLC and HMI programming and system integration
INCLUDED .1 associated with this project will be completed by
others.

PART 2 - PRODUCTS

2.1 GENERAL .1 All instrumentation and controls equipment must be
INSTRUMENTATION .1 of a proven design for each application and designed,
manufactured, inspected, and tested to comply with
the applicable regulations, codes, and standards.

.2 Select all instrumentation and controls equipment to
suit the process and environmental requirements for
each application as described or implied in this
specification and the drawings.

.3 Construct all instrumentation and controls equipment
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 Have all instrumentation and controls equipment
certified by an agency recognized by the applicable
Electrical Inspection Department (preferably CSA).
Where there is no alternative to supplying equipment
that is not certified, special approval from the
applicable Electrical Inspection Department will be
required. Cover all costs associated with obtaining
such approvals.

.5 All instrumentation and controls equipment must have
a minimum enclosure rating of NEMA 4X.

.6 The minimum instrumentation and controls equipment
electrical connection size shall be 13 mm NPT.

.7 Instrumentation and controls equipment requiring a
power supply shall be 120 VAC, 60 Hz.

2.1 GENERAL
INSTRUMENTATION
(Cont'd)

- .8 All wired instrumentation and controls equipment must have provision for externally grounding the instrument housing/enclosure.
- .9 Provide all 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.
- .10 All process impulse line tubing from a process connection to an instrument must be a minimum 13 mm x 1.2 mm (1/2" x 0.049"), 316 SSL seamless and annealed (ASTM A269).
- .11 Identify all instruments with a lamicoid nameplate or stainless steel tag indicating the instrument description, measuring range and power source.

2.2 FLOW
INSTRUMENTS

- .1 Magnetic flow meter as specified below:
 - .1 Flow tube to be NSF 61 certified and of the "formed" type, complete with SS grid backing.
 - .2 Minimum 316 SS, self cleaning electrodes.
 - .3 Supply grounding hardware in accordance to manufacturer's recommendations.
 - .4 Mount flow transmitter integral to the flow tube.
 - .5 Flow transmitter must have a minimum enclosure rating of NEMA 4X.
 - .6 Flow transmitter to be programmable locally using keypad via simple menu-driven software, and to be complete with integral display showing flow rate with engineering units, and totalized flow.
 - .7 Online diagnostics of flow sensor and electronics, including process checks, linearity and calibration checks. Operator alarm notification via transmitter display, relay outputs, and output signal (4-20 mA upscale/downscale manipulation).
 - .8 4-20 mA output of flow rate, self powered, isolated. Frequency pulse output (dry contact rated 24Vdc) for flow totalization.
 - .9 Minimum system flow accuracy to $\pm 0.5\%$ of reading.
 - .10 Device must be certified to OIML R49 Class 2 and rated to IP68.
 - .11 Have adjustable damping ability.
 - .12 An adjustable low flow cutoff.
 - .13 Transmitter language to be English.

2.3 HYDROSTATIC
PRESSURE SENSORS

- .1 Hydrostatic pressure sensors for reservoir water level sensing.
- .2 Sensor to be suitable for deep water well application (PH2 only) and submersion in a treated water reservoir (reservoir only), CSA approved, and conforming with the following specifications:
 - .1 Probe housing: stainless steel (316 grade) or titanium.
 - .2 2-wire, loop-powered, with 4 to 20 mA output signal.
 - .3 Measuring range: 0 to 20 bar.
 - .4 Scaling 0 - 3 m (reservoir).
 - .5 Minimum accuracy of 0.25% of full scale.
 - .6 Stability: 0.1% full scale per year.
 - .7 Process temperature range: 0 to 70°C.
 - .8 Seal: Viton.
 - .9 Process diaphragm: aluminum oxide ceramic.
 - .10 Supply voltage: 24Vdc.
 - .11 Complete with attached cable (length to suit application and as determined by the Contractor) complete with vent tube and Kevlar tension members. Sensor to be supported by cable. Include all necessary mounting/installation hardware with each device.
 - .12 Integral surge suppression.

2.4 ANALYTICAL
INSTRUMENTS

- .1 Analytical instrument controllers/ transmitters must meet the following design and performance requirements:
 - .1 Microprocessor-based analyzer, with menu-driven self-contained LCD/keypad entry for equipment setup, calibration and troubleshooting.
 - .2 Able to accept multiple analytical sensors, with simple "plug and play" set-up for the different sensor types. Sensor types to include, but not be limited to: PH, conductivity, turbidity and residual chlorine.
 - .3 120 VAC, 60 Hz power supply.
 - .4 Graphic LCD display and keypad with easy menu-driven software for instrument set-up, calibration and troubleshooting.
 - .5 Complete with configurable 4-20 mA analog outputs for all available analog inputs per sensor plus two dry form 'C' alarm contacts per attached sensor.
 - .6 All user settings to be retained indefinitely in non-volatile memory (EPROM).
 - .7 Provide a minimum two (2) year warranty.
 - .8 Transmitter screen to show all reading from each devices at the same time.
-

2.4 ANALYTICAL
INSTRUMENTS
(Cont'd)

- .1 (Cont'd)
 - .9 Complete analytical system, probes and transmitter, to be supplied by one (1) vendor.

 - .2 Turbidity meter to meet the following design and performance requirements:
 - .1 Continuous reading on- line nephelometric measurement principle type meeting EPA Standard Method 180.1.
 - .2 Built-in or external bubble removal system that is immune to changes in sample flow, pressure and air content.
 - .3 One-point calibration with no interruption in sample flow.
 - .4 Measurement range of 0 - 10.
 - .5 Accuracy of $\pm 2\%$ of reading from 0 to 40 NTU.
 - .6 Repeatability of $\pm 1\%$ of reading.
 - .7 NEMA 4X enclosure, wall- mounted, complete with integral sensor cable for connection to the analytical controller/transmitter meeting section 2.4.1.
 - .8 Provide a minimum two (2) year warranty.
 - .9 Provide one (1) liquid or gel type dry reference standard set necessary for initial setup calibration and regular calibration/ maintenance.

 - .3 Conductivity sensor to meet the following design and performance requirements:
 - .1 Compatible with the analytical controller/transmitter selected (plug and play connection) under clause 2.4.1.
 - .2 Suitable for direct insertion into process stream. Self plumbed (panel mounted) with external feedwater connection per drawing.
 - .3 Include mounting/installation hardware accessories necessary to facilitate direct installation or removal from process stream without disconnecting probe and cable.
 - .4 Probe must be designed for use in potable water, temperature compensated, 150 psi minimum pressure rating.
 - .5 Transmitter to be remotely mounted according to 2.4.1. Provide minimum 5m cable length with probe.
 - .6 Minimum measuring range: 10 - 2,000 US/cm².
 - .7 Accuracy: $\pm 1.0\%$ of cell constant.
 - .8 NEMA 4X rated (probe + cable).
 - .9 Provide one (1) set of calibration and reference standards necessary for initial setup and regular maintenance.

 - .4 pH sensors to meet the following performance requirements:
-

2.4 ANALYTICAL
INSTRUMENTS
(Cont'd)

- .4 (Cont'd)
- .1 Compatible with the analytical controller/transmitter selected (plug and play connection).
 - .2 Differential electrode measurement technique with three electrodes for increased accuracy and elimination of sensor ground loops.
 - .3 Totally encapsulated sensor electronics with built-in preamplifier.
 - .4 Measuring range of 0 to 14 pH.
 - .5 Sensitivity of +/- 0.01 pH.
 - .6 Built-in temperature element and output for automatic temperature compensation.
 - .7 Self plumbed (panel-mounted) with external feedwater connection per drawing.
 - .8 Use sensor body constructed complete with salt bridge of matching material, glass process electrodes, titanium ground electrodes and Viton O-ring seals.
 - .9 Complete with integral sensor cable for connection to the analytical controller/ transmitter.
 - .10 Probe signal cable must be capable of separation from probe without calibration loss.
- .5 Chlorine residual analyser for measurement of free chlorine residual in water at PH1 and reservoir. Analyser may be amperometric, buffered, un-buffered, bare probe or membrane with pH compensation.
- .1 Water Quality Parameters:
 - .1 Free chlorine residual 0-5.0 mg/L.
 - .2 Compatible with the analytical controller/transmitter selected (plug and play connection).
 - .3 Continuous measurement chlorine type sensor, with pH and temperature compensation to calculate total and free chlorine.
 - .4 Measuring range of 0 to 10 ppm as hypochlorous acid (HOCl) is acceptable.
 - .5 Accuracy of ± 2% of measure value.
 - .6 Response time < 60 seconds.
 - .7 Wall mounted, complete with integral sensor cables for connection to the analytical controller/transmitter.
 - .8 Automatic temperature compensation as required.
 - .9 Suitable for application in water with pH up to 8.0 and conductivity as low as 50 µs/cm².

2.5 MISCELLANEOUS

- .1 Field-mounted selector switches to be 30.5mm heavy duty, watertight/oiltight, front-mounted, two or three position (refer to control schematic drawings), either maintained or spring return contact (refer to

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- 2.5 MISCELLANEOUS .1 (Cont'd)
(Cont'd)
- .2 control schematic drawings), minimum NEMA 4, and complete with one normally open and one normally closed contact per position.
- .2 Local control station enclosures (pushbutton, selector switch, or speed pot) to be the heavy industrial type, minimum NEMA 4, and sized to house the required number of pushbuttons, switches, etc., as indicated on the drawings.
- 2.6 INSTRUMENTATION .1 24Vdc Instrumentation signal and digital control
CABLING/WIRING cables (twisted pair or triads) to be stranded, insulated (XLPE) tinned copper conductors, #16AWG, minimum 300V, individually and overall shielded, with overall moisture resistant and fire retardant PVC jacket.
- .2 120Vac Instrumentation digital control cables to be multiconductor industrial control cable, #14 or #16 gauge insulated (XLPE) copper conductors, 600V, with overall moisture resistant and fire retardant PVC jacket. Alternately, single conductors (stranded copper, #14AWG, RW90, 600V) for control may be used.
- .3 Supply and install unarmoured instrumentation and control cables in conduit. Refer to Section 26 05 34 for conduit specifications.
- .4 Handle, install and support all cables in accordance with manufacturer's guidelines.
- .5 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 must be continuous through any intermediate field junction boxes (individually terminated and isolated).
- .6 120 VAC multiconductor industrial control 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.
- .7 Ground Field Control Panels and Junction Boxes to the nearest building ground connection using a #6 green copper grounding cable in conduit.
-

2.6 INSTRUMENTATION .8
CABLING/WIRING
(Cont'd)

- In wet/damp areas, cables and conduits must enter field instruments, control panels and junction boxes from the bottom only. Use grounding bushings when terminating in non-conductive boxes or plates.
- .9 Supply and install 24VDC instrumentation signal wiring conduits and 120VAC instrumentation digital control wiring conduits as per Section 26 05 34.
- .10 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). Mark conductors with their corresponding instrument tag number (or description) and Instrument terminal block number (ex: HS3004/C, where HS3004 is the Instrument tag number (or description), and "C" is the Instrument terminal block number the conductor is terminated on). This "conductor identifier" must remain the same through any intermediate junction boxes, etc., all the way back to its corresponding control panel.
- .11 Leave conductors being terminated within a junction box/control panel long enough to be removed from its assigned terminal block and reassigned to anywhere within the junction box/control panel.
- .12 Coil spare conductors of a cable together inside its associated junction box/control panel and clearly identify with the cable number (ex: Spare-JB3000), unless indicated to be terminated on spare terminals. Leave adequate length to run the spare conductors anywhere within the junction box/control panel. Terminate spare conductors where identified.
- .13 Fit stranded conductors with vinyl insulated wire end ferrules when terminating to terminal blocks, and vinyl insulated locking fork terminal connectors when terminating to screw terminals.
- .14 For instruments with existing wire leads that are unarmoured (for example: ultrasonic transducers, flow meter, etc.), install an intermediate field junction box (minimum NEMA 4X) as close to the instrument as practical, complete with required terminal blocks. Any exposed "non-armoured" wire leads shall be protected using liquid-tight flexible metallic conduit. Where sensor leads are long enough to reach the transmitter, provide conduit for routing "non-armoured" sensor wiring between sensor and transmitter.

2.7 ETHERNET
COMMUNICATIONS

- .1 The ethernet communications equipment is to be supplied by one (1) manufacturer. The Standard of Acceptance for data communications equipment is Cat 5E Belden/CDT or approved equivalent.
- .2 Work to comply with the latest editions of the following codes and standards where applicable.
 - .1 EIA/TIA 568-B.1, Commercial Building Telecommunications Cable Standard: General Requirements.
 - .2 EIA/TIA 568-B.2, Commercial Building Telecommunications Cable Standard: Balanced Twisted-Pair Cabling Components.
 - .3 EIA/TIA 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
 - .4 CSA C22.1-15 Canadian Electrical Code Part 1.
- .3 Horizontal data (Ethernet) cabling to be as follows:
 - .1 Horizontal cables to consist of eight (8) #24AWG insulated, solid conductors, formed into four individually twisted pairs (UTP) and enclosed in a PVC thermoplastic jacket (FT4 rated). Provide cable complete with internal ripcord.
 - .2 Refer to drawings for routing and length of horizontal data cable.
 - .3 Limit the horizontal cable length to 90m (295ft.) including line and patch chord lengths.
 - .4 UTP data cabling must be CAT 5E and meet or exceed the transmission and electrical characteristics of the EIA/TIA 568-B.2 requirements for horizontal cabling for Extended Frequency LANs.
 - .5 All horizontal data cabling must be home runs (1 cable per drop) from the specified data hub/ethernet switch to the work outlet.
 - .6 Horizontal data cabling to be blue in colour.
- .4 Ethernet patch and line cords to be Cat 5e, #24AWG insulated conductors enclosed in an overall jacket, manufacturer factory built and tested with RJ-45 connectors. Maximum patch cord length to be 6m. Maximum line cord length to be 3m.
- .5 Ethernet data connectors to be an eight (8) position modular UTP connector (RJ-45), Cat 5E rated and suitable for the environment. Provide wall mounted data connectors complete with ivory coloured faceplate. Panel mounted data connectors to be complete with removable cover (dust-tight and watertight).

2.8 OUTSIDE PLANT
CABLES

- .1 Provide fibre optic backbone cables complete with the following:
- .1 Suitable for underground installations.
 - .2 Loose tube cable construction with central strength member.
 - .3 62.5/125µm multimode mode fibres, number of fibre strands as indicated on the Project Drawings.
 - .4 Nominal 3.0mm buffer tube size.
 - .5 Dry water blocking technology.
 - .6 Medium density polyethylene overall jacket, flame retardant, UV resistant.
 - .7 Use all-dielectric cable construction.
 - .8 Corrugated steel armour.
 - .9 Integral rip cord.

2.9 PLANT SCADA
SYSTEM

- .1 Supply, install and terminate the new PLC/RTU control panels where indicated on the drawings (refer to specification Section 26 91 00).
- .2 Control system programming/integration services (for PLC and HMI) will be provided by the control system integrator. Coordinate testing, commissioning and start-up activities with the Departmental Representative and the control system integrator.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Execute all work in a neat professional manner.
- .2 Install all instrumentation and control equipment as indicated on the drawings, and in accordance with the manufacturer's instructions. Strictly adhere to the Manufacturer's installation instructions.
- .3 The Drawings indicate the extent and general arrangement of the instrumentation and controls equipment. Exact installation locations, distances and levels will be governed by actual field conditions and is subject to approval by the Departmental Representative. Field verify all dimensions.
- .4 If any departures from the original intent of the Drawings and/or the Specifications are deemed necessary by the Contractor, submit details of such departures with Drawings if necessary, together with reasons for the departure to the Departmental Representative as soon as practical for approval. No
-

3.1 INSTALLATION
(Cont'd)

- .4 (Cont'd)
such departure will be made without prior written consent of the Departmental Representative.
- .5 Unless otherwise specified, fabricate and erect all support or mounting brackets required. Purchase instruments complete with all necessary mounting brackets from the instrument vendor.
- .6 Locate instruments and controls to minimize the possibility of damage from high temperature, vibration or humidity, and must not interfere with, or be damaged by, maintenance of other equipment. Instrument installation must also provide for easy accessibility for operation, inspection, and maintenance purposes.
- .7 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. Keep instruments and equipment clean and protect against damages, dirt, and moisture.
- .8 Protect installed equipment against water, dirt and other debris until it is commissioned. Use clear plastic sheeting of not less than 8-mil thickness for this purpose.
- .9 Install ethernet data cabling in a professional manner and as follows:
- .1 All cabling must be continuous without joints, or splices.
 - .2 Run all data cables in conduit. The maximum number of bends between cable pulling points is two (2) ninety degree bends over a maximum of 30m.
 - .3 Horizontal fill ratios for conduit, raceways and ducts shall conform with standards and manufacturer recommendations plus 25% spare capacity for future installation. Minimum conduit size shall be 21mm diameter.
 - .4 Follow applicable standards for separation distances between cables and sources of electromagnetic interference.
 - .5 Handle, install and support all cables in accordance with the manufacturer's guidelines. During the installation of the cable, take care not to overstress the cable. After the cable is installed, make sure that all parts of the cable are supported properly and is stress free at both ends and throughout their length.
 - .6 Give appropriate attention to the handling of all cables to ensure that bending radius conforms to

3.1 INSTALLATION .9
(Cont'd)

(Cont'd)

.6 (Cont'd)

the manufacturer's requirements. The cable's static or dynamic bending radius must not be exceeded.

.7 Take care not to disturb any other services (mechanical or electrical) during installation.

.8 Terminate all four pairs of the Ethernet UTP cable on a single port. The splitting of cable pairs between different jacks is not permitted.

.9 Label data communications system components (data outlets, horizontal cabling, patch panels, etc.).

.10 Arrange and pay for a certified system vendor (CSV) to install and test the data communications work for this project.

.11 Conduct end-to-end testing for UTP copper for 100% of pairs as follows:

.1 Balanced twisted-pair cable testing:

.1 Testing procedures used are to be applicable to the horizontal cabling configuration to meet field test compliance.

.2 The field testing acceptance parameters for balanced twisted-pair cabling are as follows:

.1 Wire map (continuity).

.2 Length.

.3 Insertion loss.

.4 NEXT Loss.

.5 ELFEXT.

.6 Propagation delay and delay skew.

.7 Return loss.

.8 Power sum near-end crosstalk (PSNEXT) loss.

.9 Power sum equal level far-end crosstalk (PSELFEXT).

.3 Acceptance testing results are to be documented and provided.

.10 Connect the new PLC/RTU I/O in the new PLC/RTU control panels.

3.2 INSTALLATION OF .1
OUTSIDE PLANT
CABLES

.1 Install outside plant cables as indicated on the drawings.

.2 Terminate outside plant cables in the control panels/ethernet switches as indicated on the drawings.

- 3.2 INSTALLATION OF .3 Arrange and pay for field testing the fibre optic
OUTSIDE PLANT cable after installation. Conduct attenuation and
CABLES OTDR testing. Document and provide test results.
(Cont'd)
- 3.3 TESTING .1 Calibrate all test and calibration equipment to an
AND CALIBRATION industry recognized standard and have affixed proof
EQUIPMENT of calibration along with date of next calibration.
.2 Complete all testing before October 2, 2015.
- 3.4 TESTING AND .1 Make all tests necessary to confirm the material and
CHECK-OUT workmanship are of the required degree of excellence,
and that the supplied equipment will perform as
specified (verify wiring, wire continuity checks,
tubing leak tests, etc.).
.2 Calibrate all instruments, either purchased by or
supplied to the Contractor before usage. Secure the
services of qualified personnel (manufacturer's
representative) and equipment to conduct field
instrument calibration.
.3 Document the results of all tests/calibrations, make
available to the Departmental Representative and
include in the project "Operations and Maintenance
Manual" submission.
.4 Coordinate with all other Divisions suppliers for
their required testing and commissioning procedures.
.5 Document all instrument and controls settings and
include in the project "Operations and Maintenance
Manual Submission" as specified in Section 01 78 00.
- 3.5 COMMISSIONING .1 Arrange and pay for services of manufacturer's
AND START-UP factory service representative to supervise the
installation, start-up, check, adjust, balance and
calibrate components and systems to the satisfaction
of the Departmental Representative.
.2 Provide 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.
-

3.5 COMMISSIONING
AND START-UP
(Cont'd)

- .3 Submit a written report signed by the manufacturer's representative 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.
- .4 After the instrumentation, controls equipment and vendor packages have been installed, calibrated, checked out and tested by the Contractor, the PLC/RTU programming and HMI SCADA system testing/ commissioning can begin. Coordinate this phase of the work with the control system integrator. This will involve a point-by-point check for the PLC/RTU and HMI system monitored field I/O points, logic checks, communication checks, complete plant controls integration, and equipment start-ups.
- .5 Develop and provide a commissioning schedule for review and approval.
- .6 Provide technical personnel during this phase of the work for instrument recalibration, re-wiring, reprogramming, etc., as required until the integrated PLC/RTU control system is deemed ready for operation.

PART 1 - GENERAL

- 1.1 WORK INCLUDED .1 This section and its associated drawings specify the requirements for the design, fabrication, supply, testing, preparation for shipment, and delivery of the process control system equipment, including but not limited to: RTU/PLC control panels, radio communications equipment, and termination junction boxes required for this project.
- .2 At present, PH2 well is controlled via an existing well pump control panel. There is radio communications between the Reservoir valve house and the Wellhead and Electrical building (PH2) for remote monitoring of reservoir level to start/stop the PH2 well pump. Supply and install one (1) new RTU/PLC control panel at each site. At PH2, automatic control of the well pump is to be added through RTU/PLC controls. At the Chlorination building(PH1), automatic control of the chlorine dosing pump is to be added and new instruments are to be monitored by the new RTU/PLC. Additionally, install an industrial PC-based operator interface at PH1 for control, monitoring, data logging and alarming. At the Reservoir Valve House, new instruments (free chlorine and reservoir level) and the solar power system are to be monitored by the new RTU/PLC control system.
- .3 The electrical drawings supplement this specification section in defining the control panels scope of work required:
- .1 Before installation, confirm each panel/junction box is large enough to accommodate the required number of glanded cables/conduits.
- .2 The drawings list all of the hardwired I/O required for the new RTU/PLC control panels.
- .3 Use the Electrical Control Schematics to design each RTU/PLC control panel, indicating the number of relays, pushbuttons, switches, etc., required for each panel.
- .4 Use the RTU/PLC control panel layout indicated on the drawings as a guide in the design of the control panel layout.
- 1.2 REFERENCES .1 Carry out the work of this section in accordance with all applicable Federal, Provincial, Municipal and other laws, ordinances and with the latest edition of the following standards which are deemed to be and form part of this specification:
- .1 American Society of Mechanical Engineers.

1.2 REFERENCES
(Cont'd)

- .1 (Cont'd)
 - .2 Institute of Electrical and Electronic Engineers.
 - .3 American Society for Testing Materials.
 - .4 Manufacturers Standardization Society.
 - .5 Canadian Standards Association.
 - .6 Instrument Society of America.
 - .7 Canadian Electrical Code.
- .2 In the event of a conflict between the above mentioned standards, this specification, or the attached drawings, notify the Departmental Representative, who will then advise on which standard is to be followed.

1.3 SUBMITTALS

- .1 Supply shop drawings for all control panels and termination junction boxes being supplied in the Work. Have shop drawings reviewed and approved by the Departmental Representative before equipment can be ordered. Submit shop drawings in accordance with 01 33 00.
- .2 Panel shop drawings to include the following information:
 - .1 Dimensional outlines, sections and details of all equipment.
 - .2 Detailed Bill of Materials.
 - .3 Equipment layout details.
 - .4 Equipment labeling details.
 - .5 Terminal block arrangements.
 - .6 All equipment specifications and instruction manuals (RTU/PLC, I/O cards, relays, etc.). Supplier to provide a cross reference indicating which specifications refer to which panel.
 - .7 Instructions for the mounting of the control panels/junction boxes.
- .3 For field junction boxes, provide a layout and wiring diagram, complete with a detailed Bill of Materials.
- .4 Submit data for operations and maintenance manuals in accordance with Section 01 78 00. Include in manuals 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, maintenance, repair, modification extension and expansion of any portion or feature of the installation.

1.3 SUBMITTALS
(Cont'd)

- .5 Provide "Record" wiring and schematic diagrams and general arrangement drawings for control panels and junction boxes including a bill of materials.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Supply each RTU/PLC control panel and termination junction box completely tested and ready for terminating field cables. Include all hardware (RTU's/PLC's, relays, power supplies, pushbuttons, etc.), terminal blocks (for power supplies and field I/O), wire ducts, internal panel wiring etc., as required.
- .2 The RTU/PLC control panel located at the Chlorinator Building (PH1) to be wall mounted, NEMA 4 rated and of painted steel construction. The RTU/PLC control panels located at the Electrical Building (PH2) and at the Reservoir Valve House to be wall mounted, NEMA 12 rated and of painted steel construction.
- .3 Termination junction boxes are to be NEMA 4 rated and of painted steel or PVC construction unless otherwise noted. At the Electrical Building (PH2), termination junction boxes are to be NEMA 12 rated and of painted steel construction.
- .4 Field cables are to be bottom entry only outdoors and in wet areas.
- .5 Inside all panels and junction boxes, label terminal blocks, terminal block strips, and all internal wire conductors in accordance to the panel fabricator standards.
- .6 Panel junction box hardware (hinges, latches, etc.) to be zinc plated steel or stainless steel. Provide all panels and junction boxes to be complete with a back mounting plate.
- .7 Install components so that there is at least a 25 mm clearance between the terminal blocks and the plastic wiring duct. Provide slotted wire ducts complete with covers. Wiring ducts must be a minimum size of 25 mm wide x 50 mm high (supplier to determine if a larger size is required).
- .8 Design panel so that field wiring will be terminated on the right hand side (or bottom side) of terminal strips, and internal panel wiring, or multi-conductor homerun cables (for intermediate junction boxes), will be terminated on the left hand side (or top side) of terminal strips.

2.1 GENERAL
(Cont'd)

- .9 Wire analog and digital signals within the same panel or junction box to separate terminal strips.
- .10 Completed panels and junction boxes to have CSA approval.
- .11 Adequately size panels and junction boxes to accommodate the required hardware, terminal blocks, wire ducts, etc., as well as the number of cables/conduits.
- .12 Individually label all panels and junction boxes with a lamicaid tag on the outside of the door and shall include the cabinet tag number and its associated description. Nameplates are to have a white background with black undercut lettering (316 SS screw mounted). Minimum lettering size to be 25 mm.
- .13 Pushbutton and switch legend plates to be anodized aluminum with black lettering. Emergency stop pushbutton legend plates to be aluminum with a red background and white lettering.
- .14 All panels and junction boxes to include a drawing pocket to be installed on the inside of the door to hold "As Built" termination drawings.
- .15 All panels and junction boxes to have an adequately sized pre-drilled and tapped copper ground bar complete with a grounding lug for a #6 AWG external ground connection. Ground all RTU's/PLC's, terminal block mounting rails, etc., to the panel ground bar. RTU/PLC control panels to also have a separate "isolated" copper ground bar for grounding of analog type 4-20 mA control signal cabling.
- .16 Provide terminal blocks rated for at least 600V, 35A, minimum 6mm wide, capable of accepting a 10AWG conductor size, DIN rail mounted, complete with white marking tags with black lettering.
- .17 Arrange terminal blocks so that no more than two (2) wires are terminated on any one terminal block (including field wiring). The use of "wire jumpers" between terminal blocks will not be permitted. Only terminal block vendor approved "cross-connection systems" can be used for cross wiring between panel terminal blocks.
- .18 Panel internal wiring to be 16 AWG type TEW as a minimum. All 120 VAC power and control wiring to be black (#14AWG minimum). All 120 VAC neutral wiring to be white (#14AWG minimum). All DC digital signal

2.1 GENERAL
(Cont'd)

- .18 (Cont'd)
wiring to be blue (#16AWG minimum). All analog signal wiring to be twisted, pair (Bk/Wh) or triad (Bk/Wh/Rd), shielded (#16AWG minimum). All ground wiring to be green (#14AWG minimum). Provide stranded copper wiring throughout. Segregate AC and DC wiring and install on separate terminal strips.
- .19 Panel pushbuttons to be 30.5 mm heavy duty, watertight/oiltight, NEMA 4, flush, momentary contact (unless indicated otherwise on drawings), complete with one (1) normally open and one (1) normally closed contact (start, stop, etc.).
- .20 Panel selector switches to be 30.5mm heavy duty, watertight/oiltight, NEMA 4, front-mounted, two or three position (refer to control schematic drawings), either maintained or spring returned contacts (refer to control schematic drawings), and complete with at least one (1) normally open and one (1) normally closed contact per position, or as required. Acceptable manufacturers: Allen Bradley 800T type, or approved equivalent.
- .21 Panel mounted indicating lights to be 30.5 mm heavy duty, watertight/oiltight, NEMA 4, 120 VAC, LED and coloured as per the drawings.
- .22 Control relays to have either 24 VDC or 120 VAC operating coil as required, plug-in socket, minimum 15 amp @ 120 VAC rated contacts (2 form 'C') and LED indicator.
- .23 Provide a 24 VDC power supply for any 24 VDC I/O, panel equipment requirements and for the transmitters that are loop powered. Size to accommodate at least 150% of its present load requirements (minimum 100 Watt). Fuse the 24 VDC supply to each piece of equipment or protect by a circuit breaker.
- .24 For breaker circuits, provide 120VAC, single pole distribution circuit breakers, toggle type, DIN rail mounted, continuous current rating as required, minimum 10kA interrupting capacity.
- .25 For fused circuits, provide Class CC HRC fuses, complete with a 600V, 30A fuse holder (single pole, blown fuse indicator, dead-front construction).

2.2 RTU/PLC
CONTROL PANELS

- .1 Supply and install one (1) RTU/PLC panel at each of the following sites:
 - .1 Wellhead & Electrical Building (PH2) (JB-990).
 - .2 Reservoir Valve House (JB-991).
 - .3 Chlorination Building (PH1) (JB-992).
- .2 RTU/PLC Platform at the Wellhead & Electrical Building (PH2) and at the Chlorination Building (PH1): supply and install a microprocessor-based RTU or PLC style platform. The RTU or PLC is to have a minimum of sixteen (16) low voltage (24VDC) digital inputs, eight (8) digital outputs, eight (8) analog inputs (4-20mA) and two (2) analog outputs (4-20mA).
- .3 RTU/PLC Platform at the Reservoir Valve House: supply and install a microprocessor-based RTU or PLC style platform. The RTU or PLC is to have a minimum of eight (8) low voltage (24VDC) digital inputs, two (2) digital outputs and four (4) analog inputs (4-20mA).
- .4 Refer to the drawings for required I/O at each site.
- .5 The RTU/PLC I/O cards must be cross-wired to the field I/O terminals within the control panel by the panel fabricator. Install all RTU/PLC hardware as per manufacturer's instructions (clearances, grounding, etc.).
- .6 Local operator interface: control panel at the Chlorination Building (PH1) to contain a door mounted industrial PC to facilitate local control (start/stop, set point adjustments, etc.), monitoring (equipment and process status) and troubleshooting (alarms, diagnostics, etc.) of the water system and reservoir. The panel fabricator will provide required power connections and communication patch cables to the PC. The PC is to have the following specifications:
 - .1 Industrial grade, panel mounted PC with integral cooling fans.
 - .2 Anodized aluminum front, steel chasis. Minimum IP65 compliant front panel.
 - .3 Processor/Motherboard - Minimum Intel Core i3, 2.3Ghz.
 - .4 Memory - Minimum 4GB DDR3 DRAM.
 - .5 Monitor - 19 inch, TFT, colour, 1280x1024 display resolution.
 - .6 Hard Drive - Minimum 250 GB, SATA, anti-shock.
 - .7 Power supply - Integral, 120V, 1 phase, 60hz input.
 - .8 Serial Ports - Minimum one (1) RS-232 and one (1) RS-485.

2.2 RTU/PLC
CONTROL PANELS
(Cont'd)

- .6 Local operator interface:(Cont'd)
 - .9 Ethernet ports - Minimum two (2) Ethernet ports (10/100/1000 Mbps Base-T, RJ45).
 - .10 USB Ports - Minimum four (4) USB 2.0 ports.
 - .11 Compact flash card slot.
 - .12 PCI expansion slot.
 - .13 Audio - One (1) line out and Mic-in jack.
 - .14 VGA port.
 - .15 Operating System - Microsoft Windows 7.
 - .16 Wireless mouse.
 - .17 Wireless keyboard.
- .7 Provide 12 VDC or 24 VDC power supplies for any 24 VDC I/O, panel equipment requirements and for the transmitters that are loop powered. It shall be sized to accommodate at least 150% of its present load requirements (minimum 100 Watt). Fuse the 24 VDC supply to each piece of equipment or protect by a circuit breaker.
- .8 Provide a dedicated DC power supply for each radio, DC voltage to match radio input power requirements.
- .9 Pre-wire all I/O wiring to master terminal strips. Provide interposing relays where indicated on drawings, or as required.
- .10 Provide RTU/PLC panel with one (1) 120V power feed.
- .11 Provide the specified RTU/PLC panel complete with the radio as specified in 2.3 herein.
- .12 Include a 20A, 120VAC power conditioner/surge suppressor and wire as indicated. Acceptable materials: Leviton Wired-in Surge protective module, or approved equivalent.
- .13 Include a 120V UPS where indicated. Refer to specification Section 26 33 53.
- .14 Ethernet switch, managed with VLAN and IGMP snooping Din-rail mounted, minimum four (4) ethernet ports (RJ45), 10/100 Mbits/sec, 24VDC input power, industrial type. Provide ethernet switch complete with fibre optic port (multimode, SC or ST connector) where indicated.
- .15 Ethernet to serial converter, 10/100 base ethernet port, selectable RS232/485 serial port, 24VDC input, LED status indicators (power/ready, network link, network link activity), NEMA 1 enclosure, programmable.

2.2 RTU/PLC
CONTROL PANELS
(Cont'd)

- .16 Ethernet to fibre media converter, stand alone, unmanaged, 12-24 VDC power, LED status indicators (power on, network link on/off, network link activity), NEMA 1 enclosure duplex communications, 10/100 base ethernet port, multimode dual fibre port (SC or ST connector), fibre length to suit application.
- .17 Telephone to fibre converter, stand alone, 12-24 VDC power, LED status indicators (power on, network link on/off, network link activity), NEMA 1 enclosure, RJ11 port, multimode dual fibre port (SC or ST connector), fibre length to suit application.

2.3 PROGRAMMABLE
LOGIC CONTROLLER
(PLC)

- .1 PLC to be a modular and expandable system with the following features:
 - .1 Packaged controller with embedded I/O.
 - .2 Power supply input to be 24 VDC or 120 VAC.
 - .3 CPU to include:
 - .1 32 bit signed math functions (floating point).
 - .2 Battery backed memory.
 - .3 Real time clock.
 - .4 User memory, capacity to suit application.
 - .5 Programming via ladder logic.
 - .6 Internal counters and timers.
 - .7 PID loops.
 - .8 On-line editing.
 - .9 One (1) ethernet and one (1) serial (RS-232 or RS-485) communication port.
 - .4 16 point, 24 VDC, discrete input modules.
 - .5 Eight (8) point, 120 VAC, 2.5A/per point (continuous) relay contact output module.
 - .6 Four (4) point analog (4-20mA) input module.
 - .7 Four (4) point analog (4-20mA current) output module.
- .2 Operation sequence shall be field programmable via laptop PC, all required connecting cables and software to be included.
- .3 Operating environment:
 - .1 Temperature range: -20 to 60 deg. C.
 - .2 Humidity range: 5% to 95% non condensing.
- .4 Ladder logic programming software and linking drivers to be supplied, all software to be Microsoft Windows based.
- .5 Include means to make operating mode changes (program/remote/run).

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- 2.3 PROGRAMMABLE LOGIC CONTROLLER (PLC)
(Cont'd)
- 2.4 SMART REMOTE TERMINAL UNIT (RTU)
- .6 Include LED status lights for processor, I/O and communication parts.
-
- .1 The RTU will be a modular and expandable system with the following features:
 - .1 Packaged Smart RTU controller with embedded I/O.
 - .2 Power supply input to be 24 VDC or 120 VAC.
 - .3 CPU to include:
 - .1 32 bit signed math functions (floating point).
 - .2 Battery backed memory.
 - .3 Real time clock.
 - .4 User memory, capacity to suit application.
 - .5 Programming via ladder logic.
 - .6 Internal Counters and timers.
 - .7 PID loop.
 - .8 On-line editing.
 - .9 One (1) ethernet port (10/100 modbus TCP/IP), one (1) configurable RS232 communication port, one (1) RS232 communication port.
 - .4 16 point, 24 VDC discrete input modules.
 - .5 Eight (8) point, 120 VAC, 2.5A/per point (continuous) relay contact output module.
 - .6 Four (4) point analog (4-20mA current) input module.
 - .7 Four (4) point analog (4-20mA current) output module.
 - .2 Operation sequence shall be filed programmable via laptop PC, all required connecting cables and software to be included.
 - .3 Operating environment:
 - .1 Temperature range: -20 to 60 deg. C.
 - .2 Humidity range: 5% to 95% non condensing.
 - .4 Ladder logic programming software and linking drivers to be supplied, all software to be Microsoft Windows based.
 - .5 Include means to make operating mode changes (program/remote/run).
 - .6 Include LED status lights for processor, I/O and communication ports.
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- 2.5 RADIO SYSTEM .1 Provide the radio communications system between the Reservoir Valve House and the Wellhead & Electrical Building (PH2) as indicated on the drawings. The existing radio system is UHF. The existing radio license frequency will be provided during construction. Refer to the drawings for the control system block diagram.
- .2 Radios to be licensed UHF Ethernet based, 370-520MHz (frequency to be confirmed during construction), minimum 19,200bps over-air data rate and complete with store/forward and/or repeater functionality one (1) ethernet port (RJ45, 10/100Mbps), one (1) serial data port (RS-232) and one (1) system port for configuration and diagnostics. Radio to have the following additional specifications:
- .1 Operating temperature range: -20 to 60 deg. C.
 - .2 Power supply: 10 to 30 VDC.
 - .3 Transmit current: 750 mA nominal at 1W, 1600 mA at 5W.
 - .4 Receive current: <180 mA nominal at 13.8 VDC.
 - .5 Security features:
 - .1 Password protection.
 - .2 Minimum 128 bit AES encryption.
 - .6 Transmit power: 0.5 W to 5 W.
 - .7 Include radio programming/configuration software. Software to be Windows based.
- .3 Re-use existing directional /Yagi type Antenna, if compatible with the new radios; otherwise, supply new antennas.
- .4 Supply and install an Antenna Lightning Arrestor, Polyphaser Model 1S-50NX-C2 or approved equivalent.
- .5 Antenna cabling must be a flexible, low loss communications coaxial cable complete with UV resistant polyethylene jacket. The antenna cabling must be suitable for installation outdoors and be 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.
- .6 Reuse existing antenna masts and support structures.
- .7 Supply and install all grounding required by the manufacturer and as required by the latest edition of the Canadian Electrical Code.
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2.6 TERMINATION
JUNCTION BOXES

- .1 Generally, instrumentation and control cables will run directly from the field device to the associated RTU cabinet. Where junction boxes are indicated, or otherwise deemed necessary, they shall be provided as follows:
 - .1 Sufficient terminals shall be provided to accommodate all spare wires plus 20% additional unused terminals.
 - .2 Provide junction boxes with hinged covers.
 - .3 For junction boxes 200 mm square or less, boxes with screw or hinged covers may be used (die cast aluminum as a minimum).
 - .4 Minimum NEMA 4X enclosure rating (PVC or stainless steel).

2.7 INTERNET
SECURITY APPLIANCE

- .1 Provide a Comprehensive Multiport Security Appliance and mount adjacent to the incoming high speed internet connection. This equipment is to act as a Stateful packet Inspection Firewall with a Built-in IPSec & PPTP VPN Server. General Multiport Security Appliance specifications must be as follows:
 - .1 120VAX, 1 phase, 60 Hz power supply.
 - .2 Minimum of two (2) year warranty.
 - .3 Minimum of two (2) years of UTM (Unified Threat Management) software subscription as determined by the manufacturer.
 - .4 Capable of local setup, with diagnostics.
 - .5 Minimum of four (4) 100 Gb ethernet ports.
 - .6 Capable of PPTP and IPSEC VPN.
 - .7 MINimum Firewall Performance: 850 Mbps.
 - .8 VPN IPSEC Performance (Mbps): Minimum 100 Mbps.
 - .9 Application (UTM) (Mbps) minimum 145 Mbps.
 - .10 ICESA Security Certification.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install control panels and termination junction boxes.
- .2 Install and terminate cables and equipment per the drawings and the manufacturer's instructions.
- .3 Ground cabling, control panels, racks and equipment as per manufacturer's instructions (use minimum #6AWG).
- .4 Terminate each ethernet and serial communications cables with the appropriate connector and test. The

3.1 INSTALLATION
(Cont'd)

- .4 (Cont'd)
splitting of cable pairs between different jacks is not permitted.
- .5 Mount and position equipment, etc., in such a way as to allow for easy access for maintenance purposes.
- .6 Install new radios where indicated in accordance with the manufacturer's requirements.
- .7 Install and setup the internet security appliance and media converters (ethernet to serial, fire to ethernet, fibre to telephone) in accordance with the manufacturers instructions.
- .8 Store materials in a manner to ensure the preservation of their quality and fitness for the work, and to facilitate inspection by the Departmental Representative at any time. Keep equipment clean and protected against damages, dirt and moisture.

3.2 TESTING

- .1 The PLC and relay panel fabricator will 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 Setup, test and commission the radios as required for a fully functional and reliable system. Coordinate testing with the Owner's system integrator.
- .3 Refer to specification section 26 90 00 for additional testing.
- .4 Test communications system cables in accordance with manufacturer's requirements.
- .5 Test the internet security appliance and media converters to confirm acceptable operation.
- .6 Provide a hard copy of all test results.

PART 1 - GENERAL

- 1.1 WORK INCLUDED .1 This section specifies requirements for clearing, grubbing and disposal.
- 1.2 RELATED SECTIONS .1 Environmental Procedures: Section 01 35 43.
.2 Excavating, Trenching and Backfilling: Section 31 20 10.
- 1.3 DEFINITIONS .1 Clearing: cutting, burning, chipping and disposal of all designated trees and brush within rights-of-way and other areas as indicated including felled trees, previously up-rooted trees, and surface debris.
.2 Grubbing: excavation and disposal, removal of all stumps, roots, embedded timber, rock fragment, humus, rootmat and topsoil.
- PART 2 - PRODUCTS .3 Not applicable.

PART 3 - EXECUTION

- 3.1 GENERAL .1 Comply with conditions of all permits.
.2 Do not remove trees or brush from outside limits indicated except for any tree or branch considered unsafe.
.3 Cut trees and brush close to ground leaving no stump higher than 300mm.
.4 Grub out stumps and roots to not less than 200mm below ground surface.
.5 Grub out visible rock fragments and boulders, greater than 300mm in greater dimension, but less than 0.25 m³.
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3.2 REMOVAL AND
DISPOSAL

- .1 Remove cleared and grubbed material off-site.
- .2 Alternately, material may be disposed of by burying on-site, after obtaining necessary permits and written permission from the Departmental Representative.
 - .1 If permitted, bury by consolidating and covering with minimum 500mm soils and finishing surface.
- .3 If permitted, chip or mulch and stockpile or spread vegetation matter on-site as directed. Dispose of surplus chips off-site.

3.3 FINISHED
SURFACES

- .1 Leave ground surface in condition suitable for immediate grading operation.

PART 1 - GENERAL

- 1.1 RELATED SECTIONS .1 Environmental Procedures: Section 01 35 43
- 1.2 REFERENCES .1 ASTM D698-2012, Standard Test Methods for Laboratory Compaction Characteristics Of Soil Using Standard Effort (12,400 FT-LBF/FT³(600 KN-M/M³)).
- 1.3 DEFINITIONS .1 Unsuitable Material: all organic or other excavated material which is not suitable for use in work must be disposed of as defined by the Departmental Representative.
- .2 Rock: solid rock which requires drilling and blasting, wedging, sledging or barring or breaking up with power operated tools for its removal and boulders and pieces of concrete masonry exceeding one cubic metre (3m³) in volume.
- .3 Common: materials of whatever nature, which are not included under the definition of solid rock including dense tills, hardpan and partially cemented materials which can be ripped and excavated with heavy construction equipment.
- .4 Surplus material: excavated material not required for re-use.
- 1.4 PROTECTION OF EXISTING FEATURES .1 Existing buried utilities and structures:
.1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
.2 Prior to commencing excavation work, notify Departmental Representative or authorities having jurisdiction, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work.
.3 Confirm locations of buried utilities by careful test excavations.
.4 Maintain and protect from damage, water, sewer, gas, electric, telephone, process pipes and other utilities and structures encountered.
.5 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing. Advise

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- 1.4 PROTECTION OF EXISTING FEATURES (Cont'd)
- .1 (Cont'd)
- .5 (Cont'd)
- Departmental Representative of existing lines in area of excavation that require removal or relocation and cost for such work.
- .6 Record location of maintained, re-routed and abandoned underground lines.
- .2 Existing surface features:
- .1 Conduct, with Departmental Representative, a condition survey of existing buildings, lawns, fencing, pipe racks, wires, pavement, survey bench marks and monuments which may be affected by work.
- .2 Protect existing buildings and surface features from damage while work is in progress. In event of damage, immediately make repair to approval of the Departmental Representative.
- 1.5 EXISTING UNDERGROUND UTILITIES
- .1 Be aware that underground waterline, power and communications are located within site boundaries. Prior to starting any excavation work, review any available as-built information and review locations with Departmental Representative to identify these pipelines clearly in the field. Investigate and determine the presence of any underground utilities and repair any damage and/or pay all costs associated with damage to these existing utilities at no additional expense to the Contract.
- 1.6 SUPPORT OF EXCAVATION
- .1 Suitably slope or properly shore sides of excavations according to site conditions, all in accordance with local requirements. Provide use of support as necessary.
- .2 The choice of any method of support is the responsibility of the Contractor. However, drawings and calculations for the method of support selected, designed by a qualified professional engineer in accordance with the local safety requirements, are to be submitted to the Departmental Representative for review before its use.
- .3 If it is desirable that any support, other than that which may be shown on the Drawings, be left in the excavations, then the Departmental Representative will issue instructions accordingly.
- .4 Take every precaution against slips or falls, but if any should occur, at once make good the same. If any such slip or fall affects or may affect the stability
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1.6 SUPPORT OF EXCAVATION (Cont'd) .4 (Cont'd)
of the permanent work, execute such remedial work as necessary, including filling up of any space left by the slip or fall with approved granular material. Submit proposed remedial work to Departmental Representative for review.

1.7 PERMITS .1 Obtain any required excavation permits for all areas to be excavated prior to starting any excavation.

PART 2 - PRODUCTS

2.1 MATERIALS .1 Select Backfill Material: common which is free from stumps, trees, roots, sod, organics; rocks, boulders and masonry larger than 200mm in any dimension; and other deleterious materials.
.2 Clear stone: crushed and screened, hard, durable stone, free from clay and organic matter, and graded as follows:

Clear stone, 28mm:

<u>Sieve Designation (micrometre)</u>	<u>Cum. % Passing</u>
28 000	5-100
14 000	25-60
5 000	0-10

Clear Stone, 80mm:

<u>Sieve Designation (micrometre)</u>	<u>Cum. % Passing</u>
80 000	100
56 000	25-60
28 000	0-5

2.1 MATERIALS
(Cont'd)

.3 Granular Materials: crushed and screened rock or gravel, consisting of approved hard and durable stone particles, free from flat, elongated or other objectionable pieces. Gradation to be dense, uniform and as follows:

.1 Type 1:

<u>Sieve Size (micrometre)</u>	<u>Percent Passing</u>
20,000	100
14,000	50-85**
5,000	20-50
160	5-12
080	3-8*

.2 Type 2:

<u>Sieve Size (micrometre)</u>	<u>Percent Passing</u>
80,000	100
56,000	70-100
28,000	50-80
14,000	35-65
5,000	20-50
160	5-12
080	0-7*

* For gravel sources not classified as quarries the allowable percentage passing the 080 sieve shall be 3 to 5%.

** For gravel sources classified as quarries the allowable percentage passing the 14,000 sieve shall be 50 to 90%.

.4 Sand bedding: hard granular, sharp freshwater material, well-graded from coarse to fine, free of impurities, salt, chemicals, organic matter and graded as follows:

<u>Sieve Size (mm)</u>	<u>Cum. % Passing</u>
5.0	100
0.16	0-5

- 2.1 MATERIALS .5 Granular bedding materials: well graded, clear stone
(Cont'd) conforming to concrete aggregate as follows:

<u>Sieve Size (mm)</u>	<u>Cum. % Passing</u>
28	100
19	90-100
9.5	20-55
5	0-10
2.5	0-5

- .6 Structural Fill: crushed quarry-run material, nominal size 150mm or as determined by the Departmental Representative as conditions dictate.
- .7 Underground warning tape:
.1 Polyethylene, 3.5 mils thick, 75mm wide, clearly marked as follows:
.1 "CAUTION - BURIED ELECTRICAL CONDUIT", colour RED.

PART 3 - EXECUTION

- 3.1 STOCKPILING .1 Stockpile excavated materials for re-use in areas designated by Departmental Representative. Stockpile imported materials in manner to prevent segregation. Cover all materials to seal against rain.
- 3.2 SHORING AND BRACING .1 Construct temporary works to depths, heights and locations as approved by Departmental Representative.
- .2 During backfill operation:
.1 Unless otherwise as indicated or as directed by Departmental Representative, remove sheeting and shoring from excavations.
.2 Do not remove bracing until backfilling has reached respective levels of such bracing.
- .3 Upon completion of substructure construction:
.1 Remove shoring and bracing.
.2 Remove excess materials from site as directed by Departmental Representative.

3.3 EXCAVATION -
GENERAL

- .1 Advise Departmental Representative forty-eight (48) hours before starting earthworks.
 - .2 Excavate in all kinds of materials including rock encountered on Site and make own computations of amounts and nature of excavation required.
 - .3 Select method of excavation, support and dewatering suitable for the works. Submit proposed method to Departmental Representative for review.
 - .4 Protect property or structures above or below ground in accordance with the Contract.
 - .5 Where excavation is to be performed through pavement or concrete, cut along neat, straight lines.
 - .6 Bear foundations or underside of all structures including pipe surrounds on the material as shown on the Drawings and finish all bearing surfaces to the required levels and grades.
 - .7 Earth bottoms of excavations to be undisturbed soil, free from loose, soft, or organic matter. Remove any soil softened due to standing water prior to placing structures.
 - .8 Excavation to greater depth than is shown on the Drawings shall be at no additional cost to the Contract, unless ordered by the Departmental Representative. Make good trench bottom with approved granular material adequately compacted as approved by the Departmental Representative or with concrete as may be necessary for the safety or stability of the Works.
 - .9 Pile excavated material a safe distance away from sides of trench so it will not endanger personnel and the work, reduce sight distances, and obstruct roadways.
 - .10 Leave existing utility controls unobstructed and accessible at all times.
 - .11 Do not obstruct drainage ditches and natural watercourses.
 - .12 The Departmental Representative reserves the right to require surplus material to be placed for embanking, general grading or other improvement or use on site.
 - .13 Control grading so that the surface of the ground will be properly sloped to prevent water from running
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- 3.3 EXCAVATION - .13 (Cont'd)
GENERAL
(Cont'd)
- .14 Dispose of any excess fill from the project outside of Parks Canada boundaries and in an approved disposal site at no additional cost to the Contract.
- 3.4 DRAINING, .1 Keep excavations and trenches free of water. Control
PUMPING AND excavations to prevent surface water running into
THAWING excavated areas.
- .2 Do work in connection with dewatering and supply and maintain on the work, pumps, in number and capacity sufficient to keep bottom of excavations dry and free from water so placing of pipe, manholes, and concrete will be done in the dry. Operate equipment for as long as necessary.
- .3 Dispose of water removed from excavations in a manner that will prevent injuries to public health or private property or to any operation of the work completed or under construction. Do not pump water containing silt or other material in suspension into streams or drainage courses.
- .4 All disposal of water from excavations to be done in accordance with Section 01 35 43.
- .5 Confirm sub-drains, sump holes, wells or the like required for dewatering shall not endanger the stability of the Works. On completion of the work completely backfill and consolidate excavations.
- 3.5 STRUCTURE .1 Excavate to lines, grades, dimensions and elevations
EXCAVATION shown on Drawings.
- 3.6 TRENCH .1 Trenches for conduit, and related excavations must
EXCAVATION be of sufficient width and depth at all points to allow pipes to be laid, joints to be formed, and appurtenance structures to be built in a workmanlike manner, and when needed, to allow for sheeting and shoring, pumping, draining, and for removing and replacing all materials unsuitable for foundations.
- .2 Excavate trenches so conduit can be laid to the alignment and depth required. Excavation length to be not more than conduit length that can be laid and
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- 3.6 TRENCH EXCAVATION (Cont'd)
- .2 (Cont'd) backfilled in one day. Brace and drain trench so workers may work safely and efficiently.
- .3 Remove organic material and soft deposits to a depth where medium dense to dense materials are encountered as designated by the Departmental Representative.
- .4 Do not stockpile excavated materials alongside trench if the bearing soil will cause trench side failure or bottom uplift and affect pipe alignment.
- 3.7 UNSUITABLE MATERIAL EXCAVATION AND BACKFILLING
- .1 Notify Departmental Representative when materials unsuitable for use in the work are encountered and remove to depth and extent as directed by Departmental Representative.
- .2 Backfill excavations with foundation material or selected backfill material as directed by the Departmental Representative.
- .3 Dispose of unsuitable material off-site, at no additional cost to the Contract.
- 3.8 GRANULAR BEDDING & SURROUND
- .1 Place granular bedding material in uniform layers not exceeding 150mm compacted thickness to depth as indicated.
- .2 Shape bed true to grade to provide continuous uniform bearing surface for pipe. Do not use blocks when bedding pipe.
- .3 Shape transverse depressions in bedding as required to suit joints.
- .4 Carry bedding material across actual trench width. Mounding bedding shall not be permitted.
- .5 Compact each layer full width of bed to at least 95% of standard Proctor dry density.
- .6 Fill excavation below design elevation of bottom of specified bedding with compacted bedding material or foundation material as directed by the Departmental Representative.
- .7 After conduit installation, place and compact bedding to haunch line of conduit. Place and compact bedding material from haunch line of conduit to top of pipe in maximum 200mm layers. Place remaining
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- 3.8 GRANULAR BEDDING & SURROUND (Cont'd) .7 (Cont'd) bedding material to 300mm above top of pipe before further compaction. Compact to a density of 95% of standard Proctor density as determined by ASTM D698.
- 3.9 BACKFILLING-GENERAL .1 Do not proceed with backfilling operation until Departmental Representative has inspected and approved installations.
- .2 After conduit, and structures have been built, backfill trenches and other excavated areas with materials shown on Drawings or as specified. Remove timber and debris from excavation before backfilling is commenced. Do not cover up or put out of view any work until it has been examined, measured and approved by the Departmental Representative. If any work is covered without approval of the Departmental Representative it must, if required, be uncovered for examination at no extra cost.
- 3.10 BACKFILLING STRUCTURES .1 Excavation to be cleaned of trash and debris. Backfilling to consist of material shown on Drawings. Place material to meet following requirements and approval of the Departmental Representative.
- .1 Place backfill in horizontal layers not more than 300mm deep.
- .2 Compact each layer by rollers, mechanical tampers, or other suitable equipment to obtain a density of not less than 100% standard Proctor density, unless noted otherwise.
- 3.11 BACKFILLING TRENCHES .1 Backfill trench from top of bedding to top of subgrade using materials shown on Drawings.
- .2 Place backfill in 300mm layers and compact to 95% standard Proctor density. Thoroughly compact each layer before placing next layer.
- .3 Leave surface of backfill initially high and repair settlement of trench backfilling.
- 3.12 MARKER TAPE .1 Place marker tape and plank in trenches above electrical conduits and pipes, where indicated.
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- 3.13 REINSTATEMENT
- .1 Upon completion of work, remove surplus materials and debris, trim slopes, and correct defects as directed by Departmental Representative.
 - .2 Reinststate disturbed areas to condition, elevation and thickness equal to or better than that, which existed before excavation.
 - .3 Clean and reinststate areas affected by work as directed by Departmental Representative.

PART 1 - GENERAL

- 1.1 WORK INCLUDED .1 The Work under this Section consists of furnishing all materials, labour, tools and equipment and performing all operations necessary to complete all water and process piping, valves, chemical piping, and connection to equipment inside PH1 and reservoir.
- .2 The division of responsibility between interior piping, as specified herein, and yard piping is the first joint or fitting (the fitting would be specified under yard piping) outside the building or a maximum distance of 1500 mm.
- .3 The work includes, but is not necessarily limited to: the supply and installation of pipes, hangers and supports, fittings, valves, couplings, actuators, connections to equipment, pressure gauges, and all other appurtenances, disinfection of pipes, and carrying out of all hydrostatic and leakage tests.
- .4 Provide pipes and appurtenances in accordance with details shown on the Drawings. All installed items must be suitable for the purpose for which they are specified. Do not install any pipe until the manufacturer's name and test certificate have been submitted to the Departmental Representative for approval.
- 1.2 RELATED SECTIONS .1 Electrical: Division 26
- .2 Water main: 33 11 00
- 1.3 REFERENCES .1 ANSI/ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings. Class 25, 125, 250 and 800.
- .2 ASME B16.9-2012, Factory-Made Wrought Buttwelding Fittings.
- .3 ASTM A240-15A, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and General Applications.
- .4 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
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1.3 REFERENCES
(Cont'd)

- .5 ASTM A325-14, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- .6 ASTM A774-14, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- .7 ASTM A778-01(2009)e1, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- .8 ASTM A536-84(R2014), Standard Specification for Ductile Iron Castings.
- .9 ASTM A53-12, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- .10 ASTM D2564-12, Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.
- .11 AWWA C104-13, Cement Mortar Lining for Ductile Iron Pipe and Fittings.
- .12 AWWA C110-12, Ductile Iron and Gray-Iron Fittings for Water.
- .13 AWWA C115-11, Flanged Ductile Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges.
- .14 AWWA C151-09, Ductile Iron Pipe, Centrifugally Cast.
- .15 AWWA C606-15, Grooved and Shouldered Joints.
- .16 AWWA C900-08, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. to 12 In. for Water Transmission and Distribution.

1.4 INTENT

- .1 The intent of these specifications is to provide the Works fully complete in every detail for the purpose designated. Any apparatus, appliance, material or labour not herein specifically mentioned or included but requisite to the operation of the apparatus and equipment specified shall be furnished without additional expense to the Contract.

1.5 CONTRACT
DRAWINGS

- .1 The Drawings are not to be considered as detail or shop drawings but as a guide to the general intent based on the materials specified.

1.6 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Submit shop drawings to the Departmental Representative for review, showing the layout of piping, valving, special fittings and appurtenances he plans to furnish before ordering. Detail piping arrangements so as to relate specifically to the type of equipment and fittings to be installed. Layout information must also indicate the size, type and location of floor and wall penetrations for piping arrangements. Any changes in the layout of piping or equipment due to the acceptance of alternates must be submitted with dimensioned scaled drawings for approval by the Departmental Representative. Furnish shop drawings in accordance with Section 01 33 00.
- .3 Provide shop drawings for the following:
 - .1 Pipe and fittings.
 - .2 All valves, gates and actuators.
 - .3 Pressure gauges and accessories.
 - .4 Solenoid valves.
 - .5 Disinfection procedures and plan.

1.7 OPERATING AND
MAINTENANCE MANUAL
INSTRUCTIONS

- .1 Provide operating and maintenance data for incorporation into the Maintenance Manuals in accordance with Section 01 78 00 for the following items:
 - .1 All valves, gates and actuators.
 - .2 Pressure gauges and accessories.
 - .3 All piping materials and special fittings.
 - .2 Provide instructions including step-by-step directions for starting up and shutting down water systems, valves, turning on and off of motor switches, etc., step-by-step directions for minor troubleshooting, and periodic maintenance instructions such as cleaning, oiling, etc., for all equipment in this Contract, including type of lubricant.
 - .3 All bulletins must pertain to equipment installed on this job only. General bulletins describing items of equipment not installed on this job will be rejected.
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1.7 OPERATING AND
MAINTENANCE MANUAL
INSTRUCTIONS
(Cont'd)

- .4 Preface instructions by a simple description of the entire system, explaining its purpose and operation so that a person completely unfamiliar with the building can operate all systems by following the instructions.
- .5 Include preparation of such instructions and schematic diagrams as part of the work under this Section.
- .6 Each manufacturer to submit recommended list of spare parts with maintenance manuals.

1.8 CO-OPERATION
WITH OTHER TRADES

- .1 In areas where ducts, piping and electrical fixtures are in close proximity to each other, co-operate fully with the other trade in laying out the location of valves, piping and appurtenances.
- .2 Immediately report areas of conflict to the Departmental Representative for comments. No work may be installed until corrective measures are approved.
- .3 Take special care with structural coordination.
- .4 Prepare interference pipe layout drawings prior to construction and submit these to the Departmental Representative for review. These drawings must clearly indicate all necessary associated trade work such as light fixtures, cable trays, ducts, etc.

1.9 INSPECTION

- .1 All manufacturing operations and finished pipes, fittings and appurtenances will be subject to inspection by the Departmental Representative. Furnish all labour necessary to assist the Authority or their inspectors to inspect the materials.
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PART 2 - PRODUCTS

- 2.1 PIPE SYSTEMS .1 Stainless Steel (SS):
- .1 Pipe material: 304L stainless steel.
 - .2 All pipe and fittings must be manufactured to ASTM A778 or ASTM A774 from sheet and plate of domestic origin confirming to ASTM A240, A-304L. Sheet finish to be plate finish No. 1.
 - .3 Supply pipe and fittings for service up to 1350 kPa operating pressure and maximum 95°C in the following nominal wall thicknesses:
 - .1 Schedule 10.
 - .4 Fittings: elbows to 600 mm must be smooth flow Schedule 10 design.
 - .5 Stub-ends Type A: 304L stainless steel confirming to ASTM A240, pressed type Schedule 10S, supplied with bevelled ends to ASME B16.9.
 - .6 Vanstone Rings: 304L stainless steel conforming to ASTM A240, pressed type with minimum 11 USS gauge thickness.
 - .7 Backing flanges: carbon steel, hot dipped galvanized to ASME B16.1, class 150 suitable for 1040 kPa working pressure.
 - .8 Grooved end couplings are an acceptable alternative provided they are rigid style Victaulic Model No. 489 or approved equivalent.
 - .9 Gaskets: 3.2 mm thick Buna N composition or Neoprene suitably reinforced.
 - .10 Minimize field welding of pipe.
 - .11 Bolt assemblies to be stainless steel.
 - .12 Have welding in fabricator's shop and in the field performed by qualified welders to approved procedures. Welding rod or wire to be of the same composition or superior to the pipe and fitting material. Weld deposit at the seam to have a slight crown on both sides of the weld and no cracks or crevices will be allowed. Remove excessive weld deposits, slag, weld splatter and projections into interior of the pipe by grinding.
- .2 Flex Tubing:
- .1 Pipe material: linear low density polyethylene (LLDPE) pressure rated for above 100 psi. Certified to NSF61 (opaque).
 - .2 Fitting: body acetal copolymer or brass, compression type pressure rated for 1400 kPa. Use collars as recommended by manufacturer.

2.2 VALVES AND
MISCELLANEOUS
ITEMS

- .1 Check valves:
 - .1 Wafer check valves: for use in water service. Wafer style, 125 lbs, swing check valve. One piece ASTM A126 Class B cast iron body. Ductile iron disk with 316 stainless steel trim. Valve to have resilient O-ring seats installed in a metal seat pressed into the body to accommodate field replacement.
- .2 Ball valves:
 - .1 Fabricated from polyvinyl chloride with Teflon seats and EPDM seals. True union (Safe-Blocking Valve) connections.
- .3 Butterfly valves:
 - .1 Wafer type butterfly valves, flangeless, resilient seated, cast iron, wafer style body suitable for installation between ANSI B16.1 flanges. Seats of EPDM, suitable for use with potable water. Shafts to be one piece of 416 stainless steel, finish ground and polished with EPDM shaft seals. Provide shaft bushings above and below disk. Discs to be bronze. Disc to shaft connections to be type 316 stainless steel. Pins, shaft and disc of all valves must be individually machined and completely interchangeable.
 - .1 Equip valves with manual lever actuators.
 - .2 Provide operator extension as shown on drawings.
- .4 Pressure reducing valve:
 - .1 Body: brass.
 - .2 Spring: aluminum.
 - .3 Disc: Buna-N stainless steel.
 - .4 Diaphragm: reinforced Buna-N.
 - .5 Reduce pressure by minimum 50 psi at 1 Lpm.
 - .6 Allow for pressure drop adjustment.
- .5 Hose bibs:
 - .1 Angled brass globe valve complete with integral vacuum break and backflow protection.
 - .2 12mm male NPT x 18mm hose thread.
 - .3 Sill cock must be permanent and complete with tamper-proof protection. Disconnecting the vacuum breaker portion of the valve must make a hose connection impossible.
- .6 Pressure gauge:
 - .1 General: for pressure gauges and isolation cocks use the products of one (1) manufacturer.
 - .2 Pressure gauge: 115 mm size, black fibreglass reinforced case, filled with glycerine. Stainless steel bourdon tubes and sockets. Range 0-100 psi

2.2 VALVES AND
MISCELLANEOUS
ITEMS
(Cont'd)

- .6 Pressure gauge:(Cont'd)
 - .2 Pressure gauge:(Cont'd)
accuracy to within $\pm 0.5\%$ of span. Connections 1/2" NPT brass.
 - .3 Provide brass isolation cock between gauge seal and pipe connections.
 - .4 Identify sizes to match each instrument during shop drawing preparation.

PART 3 - EXECUTION

3.1 GENERAL

- .1 Install piping in the locations indicated, and to the elevations and lines as shown on the Drawings.
- .2 Fit pipes passing through concrete or masonry with sleeves, except as noted on the drawings. Each sleeve shall extend through the respective floor, wall or other structure, and will be cut flush to each surface, unless otherwise specified. The inside diameter of all pipe sleeves must be at least 25 mm larger than the outside diameter of the passing pipe or pipe covering. Sleeves to be carbon steel ASTM A53 unless otherwise noted.
- .3 Pipes entering concrete tanks, or structures must have puddle flanges embedded in the wall and be installed according to one of the methods shown on the Drawings.
- .4 Co-ordinate location and furnish embedded items for installation in poured-in-place concrete.
- .5 Cut pipes where necessary to obtain the exact location of fittings or valves. Make necessary adjustments to make shop fabricated process piping fit properly as required.
- .6 Run piping as directly as practical and make provisions for expansion, jarring, vibrations and settling.
- .7 In the installation of piping, do not cut girders, beams or other members of building in such a manner as to reduce strength of the girder, beam, or other member of the building below that required for the purpose for which it was intended.
- .8 Run pipes to avoid conflicts between pipes of different functions. Where conflicts between pipe locations occur, process pipe to have precedence over plumbing and heating pressure pipes, gravity pipes

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- 3.1 GENERAL .8 (Cont'd)
(Cont'd)
- will have precedence over pressure pipes and large diameter pressure pipes will have precedence over smaller diameter pipes. Notify the Departmental Representative of conflicts. The Departmental Representative will provide the resolution.
- 3.2 JOINTING OF PIPE AND FITTINGS .1
- Where pipe is to be connected to equipment, fit pipe so that neither pipe nor equipment is strained during the joining procedure.
- .2 Where flanged pipe and fittings are used, make joints with 3 mm Buna N or neoprene gaskets and bolts and nuts conforming to ASTM A307 for Grade B steel machine bolts and nuts. Tighten nuts alternately to a uniform torque to achieve even distribution of pressure on joint gasket and to avoid unequal stresses in flanges. Provide sleeve coupling, flanged adapter, victaulic coupling or vic-flange couple where shown on the Drawings or where required to install pipe or to permit future equipment or pipe removal for maintenance purposes.
- .3 Conduct where victaulic grooved pipe and fittings are used, jointing procedures in strict compliance with the manufacturer's instructions.
- .4 Install PVC pipe and fittings and join with solvent welding method in accordance with the manufacturer's instructions, using the correct solvent cement for the type of pipe used. Only use threaded joints at screwed end valves.
- .5 Screwed pipes to be NPT. Make joints with graphite and oil filler and adequate unions provided for ease of future uncoupling. Ream cut ends of pipe to remove burrs.
- .6 Orient valves for ease of operation. Obtain Departmental Representative's approval of a particular orientation before completing joints.
- .7 Install specialties and other like items in accordance with the manufacturer's instructions. Provide small piping, or tubing, with fittings where required for their proper operation and servicing whether shown on the Drawings or not.
- .8 Where PVC pipe joints or fitting joints have failed under test or during operation, the entire joint must be replaced and repaired with new material. Re-cementing failed joints will not be accepted.
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- 3.3 VALVES AND APPURTENANCES .1 Install valves and appurtenances in strict accordance with the manufacturer's instructions and as directed by the Engineer.
- 3.4 PIPE CLEANING AND TESTING .1 Flush and clean pipes upon completion.
- .2 Subject liquid pressure pipes to a pressure test. Fill the pipe under test with water or air to a pressure of 30 Psig. Examine pipe for leaks of water, or soap solution applied at all joints if an air test is used, and air leaks observed. Repair leaks. Remove and replace cracked or defective pipes, fittings or valves with sound material. The pipe work will be accepted when the applied test pressure of 200 kPa is maintained for two hours without loss.
- .3 Supply all equipment required to perform the above tests.
- 3.5 CLEANUP .1 Upon completion of testing, remove all test equipment and cap holes to satisfaction of the Departmental Representative.
- .2 Clean and refurbish all equipment and fixtures and leave in operating condition in preparation for final acceptance.
- 3.6 SUPERVISION INSPECTION AND START-UP FOR CONTROL VALVES .1 Provide for on-site skilled supervision. Have a representative of the Supplier or manufacturer for the control valves, the globe body pressure reduction and flow control valves, and the pressure relief valves present during installation and testing.
- .2 The representative must be present to check the complete installation, and for start-up of the equipment. Submit a written report signed by the representative 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 the commissioning or testing of the equipment.
- .2 That the equipment is now ready for permanent operation.
- .3 That operation, lubrication and maintenance instructions for the equipment have been presented to the Departmental Representative.
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- 3.6 SUPERVISION .2 (Cont'd)
INSPECTION AND .4 That the equipment has been properly lubricated
START-UP FOR with the correct lubricants.
CONTROL VALVES
(Cont'd) .3 A minimum period of three (3) days on site for
skilled supervision and instructions and a minimum of
two (2) trips to the site should be assumed by the
pre-selected control valve supplier. Provide as many
trips and days on site as necessary to complete the
installation and put the equipment into satisfactory
operation.
- .4 A minimum period of one (1) day on site for skilled
supervision and instructions should be assumed by the
globe body flow control valve and the pressure relief
valve supplier. Provide as many trips and days on
site as necessary to complete the installation and
put the equipment into satisfactory operation.
- 3.7 DISINFECTION .1 Before commencing disinfection, provide to the
Departmental Representative, for approval, a detailed
procedure for disinfection of the new piping system.
- .2 Conduct disinfection procedure in accordance with
AWWA C653.
- .3 Coordinate the piping disinfection work with other
water main and well piping disinfection works.
- .4 Cover all costs associated with water quality
testing during disinfection procedures. Turn over all
results to the Departmental Representative for
approval.
- 3.8 INSULATION .1 Provide pipe insulation where indicated on the
Drawing.
- 3.9 COMMISSIONING .1 Refer to section 01 91 13 for commissioning
requirements.

PART 1 - GENERAL

- 1.1 WORK INCLUDES .1 The Work of this section includes the design, supply, installation and commissioning of a complete and fully functional photovoltaic (PV) power system.
- .2 The purpose of the system is to provide 120 Vac, 1 phase, 60 Hz power to an RTU/PLC control panel and instruments. During sunny periods, photovoltaic (PV) panels will provide power to the control panel through an inverter, while simultaneously charging six (6) Batteries by way of a charge controller. During cloudy periods, the batteries will provide power to the control panel through the inverter. A receptacle will be connected to the inverter to allow a portable generator to be connected to the system to power the control panel and charge the batteries.
- .3 The system generally includes, but is not necessarily limited to the following components:
- .1 250W PV panels, quantity as required.
 - .2 Vertical roof mount supports for photovoltaic (PV) solar
 - .3 One (1) DC power distribution center
 - .4 One (1) charge controller complete with LCD display
 - .5 One (1) inverter
 - .6 One (1) remote battery temperature sensor
 - .7 One (1) LCD digital remote for inverter
 - .8 6V, 200Ah, sealed, maintenance free batteries, quantity as required
 - .9 Required cabling, wiring, and conduit
 - .10 PV system grounding
 - .11 Installation of all components
 - .12 Commissioning of all components
 - .13 Component and system approvals and warranties
 - .14 Shop drawings
 - .15 Operation and Maintenance manuals (minimum of 3)
- 1.2 RELATED SECTIONS .1 Metal Fabrications: Section 05 50 00.
- .2 Electrical: Division 26.
- 1.3 SUBMITTALS .1 Provide shop drawings and submittals in accordance with Section 01 33 00 showing:
- .1 Manufacturers printed product literature, specifications, and data sheets including product

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- 1.3 SUBMITTALS
(Cont'd)
- .1 (Cont'd)
 - .1 (Cont'd)
characteristics. Performance criteria, physical size, finish and limitations.
 - .2 Manufacturers installation instructions, special handling criteria, installation sequence and cleaning procedures.
 - .3 Schematic diagram of complete PV system including wiring and component interconnection.
- 1.4 CLOSEOUT
SUBMITTALS
- .1 Provide spare parts as recommended by the manufacturer.
 - .2 Provide an operation and maintenance manual in accordance with Section 01 78 00.
- PART 2 - PRODUCTS
- 2.1 SYSTEM DESIGN
REQUIREMENTS
- .1 Size the solar power system to provide power for 24 hours per day from April 1st to October 31st.
 - .2 System to power the Reservoir Valve House RTU/PLC control panel and new instruments as follows: one (1) submersible pressure transducer (loop powered) and one (1) free chlorine transmitter.
 - .3 Verify exact load requirements at the Reservoir Valve House with the equipment vendors. Allow for a minimum 25% spare capacity.
 - .4 Size the 12 VDC battery storage based on three (3) days of power autonomy without solar charging. Confirm the batteries are not discharged below the battery manufacturer's recommended value.
 - .5 System to allow connection of a 120 Vac, single phase portable generator.
 - .6 Electrical equipment, wiring, conduit and grounding to comply with Division 26 - Electrical.
- 2.2 SOLAR POWER
SYSTEM
- .1 Polycrystalline solar panel constructed using a tempered glass front with anti-reflective coating, EVA encapsulant, and composite sheet back cover.
 - .1 Minimum efficiency of 15.5%.
 - .2 Heavy duty aluminum frame.
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- 2.2 SOLAR POWER SYSTEM
(Cont'd)
- .1 (Cont'd)
 - .3 Galvanized steel, aluminum or stainless steel mounting frame suitable for mounting solar panels.
 - .4 Weather resistant junction box (NEMA3R).
 - .5 Power: 250W.
 - .6 Voltage at maximum power: 30.4V.
 - .7 Open circuit voltage: 37.7V.
 - .8 Operating Conditions:
 - .1 Operating temperature: -40 to 85 deg. C.
 - .2 Hail safety impact velocity: 25mm at 23 m/s.
 - .3 Static load wind/snow: 4000 Pa/7000 Pa.
 - .2 DC Power Distribution Center:
 - .1 Aluminum or painted steel enclosure.
 - .2 Hinged door.
 - .3 Moulded case circuit breaker for inverter unit, ampere rating to suit application.
 - .4 Din Rail.
 - .5 Two (2) moulded case circuit breakers for charge controller and PV panels (ampere rating to suit application), plus additional circuit breakers for internal components as required by system vendor.
 - .6 Copper ground bus bar.
 - .7 NEMA Type 12 enclosure.
 - .3 Charge Controller:
 - .1 12VDC charge controller.
 - .2 Maximum Power Point Tracking (MPPT) technology.
 - .3 Maximum output current rating: 60A with adjustable current limit.
 - .4 Maximum PV input voltage: 145VDC.
 - .5 Power conversion efficiency: 98.1% at 48V/60A output.
 - .6 Unit to be field programmable for local setup and troubleshooting.
 - .7 Unit to be complete with integral backlit LCD display for monitoring system performance (real time with data logging). Menu language to be English.
 - .8 Operating temperature range: -20 to 60 deg. C.
 - .4 Pure Sine Wave Inverter:
 - .1 Input battery voltage: 9 to 17VDC.
 - .2 Nominal AC output voltage: 120VAC \pm 5%.
 - .3 Output frequency and accuracy: 60Hz \pm 0.1%.
 - .4 Total Harmonic Distortion (THD) < 5%.
 - .5 1 m sec surge current: 38A AC.
 - .6 5 sec surge power (real watts): 1750.
 - .7 30 sec surge power (real watts) 1600.
 - .8 Inverter continuous power output at 25 deg. C: 1000VA.
 - .9 Charger continuous output at 25 deg. C: 50A DC.
 - .10 Maximum continuous input current: 133A DC.
 - .11 Inverter efficiency (peak): 87%.
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- 2.2 SOLAR POWER SYSTEM (Cont'd)
- .4 Pure Sine Wave Inverter:(Cont'd)
 - .12 Charger efficiency: minimum 84%.
 - .13 Transfer time: 16 msec.
 - .14 Waveform: Pure sine wave.
 - .15 Integral or remote control unit with LCD display and LED's for monitoring, setup and control. Menu language to be English.
 - .16 Operating Temperature: -20°C to 60°C.
 - .17 Operating Humidity: 0 to 95% RH non-condensing.
 - .18 Transfer relay for connection of generator power.
 - .19 Low/high battery voltage protection.
 - .20 Fan cooled.
 - .21 On-off switch.
 - .22 Current overload protection.
 - .23 Unit to be field programmable for local setup and trouble shooting.
 - .5 Batteries:
 - .1 VLRA (valve-regulated lead acid) type battery, sealed and enclosed.
 - .2 Long float life and long cyclic life.
 - .3 Voltage: 6V DC.
 - .4 Minimum capacity rating: 200Ah (per unit).
 - .5 Operating temperature range: 0°C to 30°C.
 - .6 Minimum fifteen (15) year service life at 20°C.
 - .7 Batteries complete with interconnecting cables and mounting rack.
 - .6 Solar power system to include general fault/alarm dry contact (rated 2A at 120 Vac) for remote monitoring by the PLC/RTU control system.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install all system components as indicated on the drawings and in accordance with the manufacturer's requirements.
 - .2 Install components within the Reservoir building in a NEMA 12 wall mounted enclosure (painted steel, stainless steel, PVC or fiberglass construction, continuously hinged doors, locking door handle, size as required). Include door mounted viewing windows to permit viewing the equipment without opening the door(s).
 - .3 Complete all electrical work in accordance with Division 26.

3.1 INSTALLATION
(Cont'd)

- .4 Install all wiring and associated conduit. Wiring and associated conduit will be sized, supplied and installed by the system Vendor. Size wiring such that the voltage drop across the system does not exceed 3%.
- .5 Provide trained personnel to commission all components of the system. Provide all necessary programming and testing, provide a letter certifying the system installation to the Departmental Representative upon completion.
- .6 Provide system training on the operation and maintenance of the system to the Owner's operating staff. Coordinate the time a minimum of one (1) week in advance. Utilize the operation and maintenance manuals as a reference during the training.