



**Public Works and  
Government Services Canada**

Requisition No. EZ108-170397

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**SPECIFICATIONS**

For  
EGD - SSES STANDBY POWER GENERATION SYSTEM  
Esquimalt Graving Dock,  
Victoria, BC  
Project No. R.057890.003      Tender May 6, 2016

**APPROVED BY:**

 2016-05-31  
Regional Manager, A&E Services      Date

 2016-05-31  
Construction Safety Coordinator      Date

**TENDER:**

 31-MAY-2016  
Project Manager      Date

**100% ISSUED FOR TENDER**

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ELECTRICAL

**8000 SERIES - PWGSC ESQUIMALT GRAVING DOCK (EGD) SSES - STANDBY GENERATION SYSTEM**

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**END OF SECTION 00 00 10**

**1.1 CODES**

- .1 Perform work to CURRENT Codes, Construction Standards and Bylaws, including Amendments up to the TENDER closing date.

**1.2 DESCRIPTION OF WORK**

- .1 Work of this Contract comprises installation of an electrical substation and associated civil works at the Esquimalt Graving Dock, and further identified as:  
**South Side Electrical Supply (SSES) – Standby Power Generation System, Esquimalt Graving Dock, Victoria, BC  
Job No. R.057890.003**
- .2 Work to be performed under this Contract includes, but is not limited to, the following items covered further in the Contract documents:
  - .1 Supply and installation of three 750kW diesel generators complete with sound attenuated enclosures, belly mounted fuels tanks and associated controls.
  - .2 Supply and installation of generator transfer, synchronizing and control equipment for providing transfer, open and closed transition switching between 600V and 12.5/25kV switchgear.
  - .3 Supply and installation of 3000/4000kVA liquid cooled pad mount step up transformer and associated controls, cabling and connections.
  - .4 Supply and installation of 25kV primary underground cabling from pad mount transformer to existing 25kV switchboard through existing ducts and conduits.
  - .5 Supply and installation of 600V air-cooled resistive load bank complete with automatic and remote controls.
  - .6 Supply and installation of associated generator power and control cabling between generators, controls, transformer and 25kV switchgear.
  - .7 Supply and installation of digital metering devices and integration to existing Powerlogic SCADA/Power metering system for automatic load control and monitoring.
  - .8 Supply and installation of interconnections, protection devices, communications and control wiring between existing 25kV switchgear, generators, digital metering and generator transfer/control equipment.
  - .9 Supply and verification of a towable/portable 75kW diesel generator assembly complete with connection cables and connector.
  - .10 Supervision and sign off of all fuel tank installations by an I.T.A. certified Petroleum Equipment Installer.
  - .11 Complete commissioning services; demonstration and training of personnel as directed by the Departmental Representative. Refer to Section 01 79 00 Demonstration and Training.
- .3 "Green" requirements:
  - .1 Use only environmentally responsible green materials/ products with no VOC emissions or minimum VOC emissions of indoor off-gassing contaminants for improved indoor air quality - subject of Departmental Representative's approval of submitted MSDS Product Data.

- .2 Diesel prime movers shall be EPA Tier 4 certified or better.
- .3 Use materials/products containing highest percentage of recycled and recovered materials practicable - consistent with maintaining cost effective satisfactory levels of competition.
- .4 Adhere to waste reduction requirement for reuse or recycling of waste materials, thus diverting materials from landfill.
- .4 Perform all work in accordance with National Building Code of Canada (NBC) 2012, WorkSafeBC/Workers' Compensation Board (WCB) Regulations and these Contract Documents. Where there is a conflict between Contract Documents and referenced standards, the most stringent will be applied.

### **1.3 CONTRACT DOCUMENTS**

- .1 The Contract documents, drawings and specifications are intended to complement each other, and to provide for and include everything necessary for the completion of the work.
- .2 Drawings are, in general, diagrammatic and are intended to indicate the scope and general arrangement of the work.

### **1.4 DIVISION OF SPECIFICATIONS**

- .1 The specifications are subdivided in accordance with the current 6-digit National Master Specifications System.
- .2 A division may consist of the work of more than 1 subcontractor. Responsibility for determining which subcontractor provides the labour, material, equipment and services required to complete the work rests solely with the Contractor.
- .3 In the event of discrepancies or conflicts when interpreting the drawings and specifications, the specifications govern.

### **1.5 TIME OF COMPLETION**

- .1 Completion of the "South Side Electrical Supply – Generator Installation" project to be twenty-four (24) weeks post contract award, including commissioning, final acceptance testing and closeout documentation.
- .2 Generator and transformer shop drawings must be submitted within two(2) weeks of award of contract.

### **1.6 HOURS OF WORK**

- .1 Restrictive as follows:
  - .1 Schedule deconstruction, removal and construction work after normal working hours of the building and during the day on weekends and/or holidays. Normal weekday working hours of the building are 0800 – 1630 hours, Monday to Friday.
  - .2 Notify Departmental Representative of all after hours work, including weekends and holidays.

### **1.7 WORK SCHEDULE**

- .1 Carry on work as follows:

- .1 Within 10 working days after Contract award, provide a "phasing bar chart" and a schedule showing anticipated progress stages and final completion of the work within the time period required by the Contract documents. Indicate the following:
  - .1 Submission of shop drawings, product data, MSDS sheets and samples.
  - .2 Delivery of major items to site.
  - .3 Installation and construction.
  - .4 Completion, testing and commissioning.
- .2 Do not change approved Schedule - without notifying Departmental Representative.
- .3 Interim reviews of work progress based on work schedule will be conducted as decided by Departmental Representative and schedule updated by Contractor in conjunction with and to approval of Departmental Representative.
- .4 This project is being tendered and will be awarded prior to completion of the facility to which this equipment will be installed. The project has been scheduled such that the facility will be substantially completed when delivery of major equipment to site should occur. It will be expected that this contractor will cooperate with the current contractors on site if preliminary reconnaissance or preparatory work is to be performed.

## **1.8 COST BREAKDOWN**

- .1 Before submitting the first progress claim, submit a breakdown of the Contract lump sum prices in detail as directed by the Departmental Representative and aggregating Contract price.
- .2 Provide a projection of project billing as proposed on a month by month basis accounting for expected delivery of equipment, project phasing and mobilisation.

## **1.9 CODES, BYLAWS, STANDARDS**

- .1 Perform work in accordance with the Canadian Electrical Code 2015, and other indicated Codes, Construction Standards and/or any other Code or Bylaw of local application.
- .2 Comply with applicable local bylaws, rules and regulations enforced at the location concerned.
- .3 Meet or exceed requirements of Contract documents, specified standards, codes and referenced documents.
- .4 In any case of conflict or discrepancy, the most stringent requirements shall apply.

## **1.10 DOCUMENTS REQUIRED**

- .1 Maintain 1 copy each of the following at the job site:
  - .1 Contract drawings.
  - .2 Contract specifications.
  - .3 Addenda to Contract documents.
  - .4 Copy of approved work schedule.

- .5 Reviewed/approved shop drawings.
- .6 Change orders.
- .7 Other modifications to Contract.
- .8 Field test reports.
- .9 Reviewed/approved samples.
- .10 Manufacturers' installation and application instructions.
- .11 One set of record drawings and specifications for "as-built" purposes.
- .12 Canadian Electrical Code 2015.
- .13 Current construction standards of workmanship listed in technical Sections.
- .14 Contractor Safety Plan.

**1.11 REGULATORY REQUIREMENTS**

- .1 Obtain and pay for - Building Permit, Certificates, Licenses and other permits required by regulatory municipal, provincial or federal authorities to complete the work.
- .2 Provide inspection authorities with plans and information required for issue of acceptance certificates.
- .3 Furnish inspection certificates in evidence that the work installed conforms with the requirements of the authority having jurisdiction.
- .4 Obtain the services of an I.T.A. certified Petroleum Equipment installer to supervise and approve the installation of all fuel tanks and associated equipment as part of this project.
- .5 A suitable Professional Engineer must approve, stamp and seal asbuilt drawings of all fuel tanks in this project prior to filling with fuel,

**1.12 CONTRACTOR'S USE OF SITE**

- .1 Use of site:
  - .1 Exclusive and complete for execution of work.
  - .2 Assume responsibility for assigned premises for performance of this work.
  - .3 Be responsible for coordination of all work activities on site, including the work of other contractors engaged by the Departmental Representative such as moving contractors and furniture installers.
- .2 Perform work in accordance with Contract documents. Ensure work is carried out in accordance with indicated phasing.
- .3 Do not unreasonably encumber site with material or equipment.
- .4 A 1-hour site safety orientation to be completed by all workers. Personnel that do not successfully complete the required training are not permitted to enter the site to perform work.
- .5 Limit use of premises for Work, for storage and for access to allow for continuous occupancy of building.
- .6 Co-ordinate use of premises under direction of the Departmental Representative.



- .7 Assume full responsibility for protection and safekeeping of Products under this Contract.
- .8 Do not use any other part of property unless approved in writing by the Departmental Representative.
- .9 Store materials and equipment only where directed by the Departmental Representative. Obtain and pay for use of additional storage and work areas if required.
- .10 Ensure access to assigned lay down or construction areas is maintained for fire and emergency access at all times.
- .11 Protect environment in accordance with requirements described in Section 01 35 43 - Environmental Procedures.
- .12 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .13 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work.
- .14 Condition of existing work at completion of operations to be equal to or better than that which existed before new work started.
- .15 Provide necessary protection and hoarding to prevent unauthorized entry into areas of work at all times by staff and public.
- .16 Inform the Departmental Representative 3 working days prior to performing work inside the building. Entry into areas of work will be by authorized personnel only and must be delineated during execution of work.
- .17 The contractor can have limited access to the site from 7:00 to 17:00. The Departmental Representative will provide and coordinate site access requirements with the Contractor at time of award.
- .18 Adjacent portions of building and property will remain in use during Work.
- .19 Co-operate with the Departmental Representative by scheduling operations to minimize conflict and to facilitate continuous use of building. Do not impede, restrict or obstruct use of building or adjacent portions of property.
- .20 Do work in a manner that will minimize creation of noise that would disturb day-to-day operation of building and adjacent property.
- .21 Locate stationary noise generating equipment as far away as practical from occupied parts of building, or where directed by the Departmental Representative.
- .22 Co-ordinate with the Departmental Representative for necessary shutdown of services affecting occupied parts of building and adjacent property where serviced from building. Provide 72 hours of notice prior to shutdown. Minimize occurrences and durations of shutdowns.
- .23 Co-ordinate with the Departmental Representative to ensure that construction activities do not compromise security of building and site.
- .24 Ensure that construction activities do not compromise other active systems within the building and site.

### **1.13 EXAMINATION**

- .1 Examine site and be familiar and conversant with existing conditions likely to affect work.

- .2 Provide photographs of surrounding properties, objects and structures liable to be damaged or be the subject of subsequent claims.

#### **1.14 LOCATION OF EQUIPMENT AND FIXTURES**

- .1 Location of equipment and devices indicated or specified are to be considered as approximate.
- .2 Locate equipment, devices and distribution systems to provide minimum interference and maximum usable space, and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Departmental Representative of impending installation and obtain his approval for actual location.
- .4 Submit field drawings or shop drawings to indicate the relative position of various services and equipment when required by the Departmental Representative and/or as specified.

#### **1.15 CUTTING AND PATCHING**

- .1 Cut existing surfaces as required to accommodate new work.
- .2 Remove items so shown or specified.
- .3 Do not cut, bore, or sleeve load-bearing members.
- .4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.
- .5 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture.
- .6 Making good is defined as matching construction and finishing materials and the adjacent surfaces such that there is no visible difference between existing and new surfaces when viewed from 1.5 metres in ambient light, and includes painting the whole surface to the next change in plane.
- .7 Provide temporary dust screens, barriers, warning signs in locations where renovation and alteration work is adjacent to areas used by public or government staff.
- .8 Protect adjacent surfaces. Make good or replace damaged surfaces and equipment to satisfaction of the Departmental Representative, at no cost to Contract.
- .9 Provide barricade warning tape to mark perimeter of work area, as directed by the Departmental Representative.

#### **1.16 SETTING OUT OF WORK**

- .1 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.
- .2 Provide devices needed to lay out and construct work.
- .3 Supply such devices as templates required to facilitate Departmental Representative's inspection of work.

#### **1.17 ACCEPTANCE OF SUBSTRATES**

- .1 Each trade shall examine surfaces prepared by others and job conditions which may affect his work, and shall report defects to the Departmental

Representative. Commencement of work shall imply acceptance of prepared work or substrate surfaces.

- .2 Suitable as-built or record drawings will be provided to the contractor upon award indicated existing or proposed existing conditions of the Service Entrance Substation (SES).

#### **1.18 QUALITY OF WORK**

- .1 Ensure that quality workmanship is performed through use of skilled tradesmen, under supervision of qualified journeyman.
- .2 The workmanship, erection methods and procedures to meet minimum standards set out in the National Building Code of Canada 2010 and local Construction Standards.
- .3 In cases of dispute, decisions as to standard or quality of work rest solely with the Departmental Representative, whose decision is final.

#### **1.19 WORKS COORDINATION**

- .1 Coordinate work of sub-trades:
  - .1 Designate one person to be responsible for review of contract documents and shop drawings and managing coordination of Work.
  - .2 Convene meetings between subcontractors whose work interfaces and ensure awareness of areas and extent of interface required.
    - .1 Provide each subcontractor with complete plans and specifications for Contract, to assist them in planning and carrying out their respective work.
    - .2 Develop coordination drawings when required, illustrating potential interference between work of various trades and distribute to affected parties.
      - .1 Pay particularly close attention to overhead work above ceilings and within or near to building structural elements.
      - .2 Identify on coordination drawings, building elements, services lines, rough-in points and indicate location services entrance to site.
    - .3 Facilitate meeting and review of coordination drawings. Ensure subcontractors agree and sign off on drawings.
    - .4 Publish minutes of each meeting.
    - .5 Plan and coordinate work in such a way to minimize quantity of service line offsets.
    - .6 Submit copy of coordination drawings and meeting minutes to Departmental Representative for information purposes.
  - .3 Submit shop drawings and order of prefabricated equipment or rebuilt components only after coordination meeting for such items has taken place.
  - .4 Work cooperation:
    - .1 Ensure cooperation between trades in order to facilitate general progress of Work and avoid situations of spatial interference.

- .2 Ensure that each trade provides all other trades reasonable opportunity for completion of Work and in such a way as to prevent unnecessary delays, cutting, patching and removal or replacement of completed work.
- .3 Ensure disputes between subcontractors are resolved.
- .5 Departmental Representative is not responsible for, or accountable for extra costs incurred as a result of Contractor's failure to coordinate Work.
- .6 Maintain efficient and continuous supervision.

**1.20 APPROVAL OF SHOP DRAWINGS, PRODUCT DATA AND SAMPLES**

- .1 In accordance with Section 01 33 00, submit the requested shop drawings, product data, MSDS sheets and samples indicated in each of the technical Sections.
- .2 Allow sufficient time for the following:
  - .1 Review of product data.
  - .2 Approval of shop drawings.
  - .3 Review of re-submission.
  - .4 Ordering of approved material and/or products - refer to Sections of Divisions 2 to 48.

**1.21 RELICS AND ANTIQUITIES**

- .1 Relics and antiquities and items of historical or scientific interest shall remain property of Department. Protect such articles and request directives from Departmental Representative.
- .2 Give immediate notice to Departmental Representative if evidence of archeological finds are encountered during excavation/construction, and await Departmental Representative's written instructions before proceeding with work in this area.

**1.22 SECURITY CLEARANCES**

- .1 Personnel employed on this project will be subject to security check. Obtain requisite clearances, as instructed, for each individual required to enter the premises.
- .2 Personnel will be checked at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.
- .3 Contractor shall be fully responsible for securing the premises and its contents throughout the construction period.

**1.23 PROJECT MEETINGS**

- .1 Departmental Representative will arrange project meetings and assume responsibility for setting times and recording and distributing minutes.

**1.24 TESTING AND INSPECTIONS**

- .1 The Contractor will appoint and pay for the services of the factory technical representative for the following:

- .1 Programming and testing of the digital metering/SCADA system software.
- .2 Testing, adjustment and verification of generators, controls and integration to existing distribution and controls.
- .3 All tests to be carried out by Contractor under the Commissioning Authority and Departmental Representative's supervision.
- .2 Contractor shall furnish labour and facilities to:
  - .1 Notify Departmental Representative in advance of planned testing.
- .3 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by Departmental Representative.
- .4 Provide Departmental Representative with 2 copies of testing and commissioning reports as soon as they are available.

#### **1.25 AS-BUILT DOCUMENTS**

- .1 The Departmental Representative will provide 2 sets of drawings, 2 sets of specifications, and 2 copies of the original AutoCAD files for "as-built" purposes.
- .2 As work progresses, maintain accurate records to show all deviations from the Contract documents. Note on as-built specifications, drawings and shop drawings as changes occur.

#### **1.26 CLEANING**

- .1 Daily conduct cleaning and disposal operations. Comply with local ordinances and anti-pollution laws.
- .2 **Ensure cleanup of the work areas each day after completion of work.**
- .3 Clean interior building areas when ready to receive finish painting and continue cleaning on an as-needed basis until building is sufficiently completed or ready for occupancy.
- .4 In preparation for interim and final inspections:
  - .1 Examine all sight-exposed interior and exterior surfaced and concealed spaces.
  - .2 Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces, including glass and other polished surfaces.
- .5 Use cleaning materials and methods in accordance with instructions of the manufacturer of the surface to be cleaned.

#### **1.27 DUST CONTROL**

- .1 Provide temporary dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of work and public.
- .2 Protect furnishings within work area with polyethylene film during construction. Remove film during non- construction hours and leave premises in clean, unencumbered and safe manner for normal daytime function.
- .3 Maintain and relocate protection until such work is complete.

**1.28 ENVIRONMENTAL PROTECTION**

- .1 Prevent extraneous materials from contaminating air beyond construction area, by providing temporary enclosures during work.
- .2 Do not dispose of waste or volatile materials into water courses, storm or sanitary sewers.
- .3 Ensure proper disposal procedures in accordance with all applicable territorial regulations.

**1.29 MAINTENANCE MATERIALS, SPECIAL TOOLS AND SPARE PARTS**

- .1 Specific requirements for maintenance materials, tools and spare parts are specified in individual technical sections of Divisions 02 to 48, where required.

**1.30 ADDITIONAL DRAWINGS**

- .1 The Departmental Representative may furnish additional drawings for clarification. These additional drawings have the same meaning and intent as if they were included with plans referred to in the Contract documents.
- .2 Upon request, Departmental Representative may furnish up to a maximum of 5 sets of Contract documents for use by the Contractor at no additional cost. Should more than 10 sets of documents be required the Departmental Representative will provide them at additional cost.

**1.31 BUILDING SMOKING ENVIRONMENT**

- .1 Smoking on the site is not permitted.

**1.32 SYSTEM OF MEASUREMENT**

- .1 The metric system of measurement (SI) will be employed on this Contract.

**1.33 FAMILIARIZATION WITH SITE**

- .1 Before submitting tender, visit site - as indicated in tender documents and become familiar with all **conditions likely to affect the cost of the work**.
- .2 As this project interfaces with several systems that are existing or currently under construction, any questions or concerns related to these systems must be suitably investigated or queried prior to submission of tender. Extra costs submitted related to coordination or interface with existing systems or devices will not be considered.

**1.34 SUBMISSION OF TENDER**

- .1 Submission of a tender is deemed to be confirmation of the fact that the Tenderer has analyzed the Contract documents and inspected the site, and is fully conversant with all conditions.

**END OF SECTION**

**Part 1        General**

**1.1        FACILITY OPERATIONS AND SECURITY PROCEDURES**

- .1 All construction staff shall become thoroughly familiar with and abide by all provisions and requirements of Esquimalt Graving Dock's Operations, Safety and Security Procedures and Restrictions.
  - .1 The parking area(s) to be used by construction employees will be designated by the Director of EGD. Parking in other locations will be prohibited and vehicles may be subject to removal.
  - .2 Speed limits are posted on site. Failure to abide by site speed limits may result in removal of employee and vehicle from site.
  - .3 EGD is under surveillance at all times on closed circuit TV. All activities are monitored internally for security purposes. All construction staff should be advised that they are being recorded.
  - .4 Director of EGD may require photographs to be taken for construction identification badges used to access the site.
  - .5 EGD enforces a zero tolerance policy for the following misbehavior:
    - .1 Appear to be under the influence of alcohol, drugs or narcotics.
    - .2 Behave in an unusual or disorderly manner.
    - .3 In possession of contraband.
- .2 Cooperate with and coordinate construction/demolition activities with Esquimalt Graving Dock.

**1.2        ACCESS AND EGRESS**

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant Federal, municipal, provincial and other regulations.
- .2 Provide hoarding, and scaffolding plan for Departmental Representative to review 5 business days prior to installation.
- .3 Refer to Appendix D of this specification for emergency access routes to be maintained.

**1.3        USE OF SITE AND FACILITIES**

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work, provide temporary means to maintain security as per Departmental Representatives direction.
- .4 Closures: protect work temporarily until permanent enclosures are completed.
- .5 The entire dockyard will be occupied by the public, government staff and other PWGSC construction contractors and other dock lease operations during entire construction period.

- .6 Coordinate with Departmental Representative in scheduling operations to minimize conflict and to facilitate use of space.

**1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

- .1 Execute work with least possible interference or disturbance to Esquimalt Graving Dock's operations, occupants, and normal use of the facility. Arrange with Departmental Representative to facilitate execution of work.

**1.5 EXISTING SERVICES**

- .1 Notify Departmental Representative of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 3 working days of notice for necessary interruption of civil, mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
  - .1 Optimize and plan shut-downs so that services are restored in time for normal facility operation hours. Coordinate all shut-downs with utility providers and facility users.
  - .2 Contractor shall be held responsible for damages to facility equipment as the result of service shut-downs.
  - .3 Contractor shall be held responsible for any and all unscheduled shut-downs of building utilities and services.
  - .4 Contractor will not be allowed to connect to Departmental Representative's existing data and communication services.
  - .5 Submit a "Fire Alarm Bypass" request to Departmental Representative 3 working days in advance for approval.
  - .6 Obtain permission from Departmental Representative for access to restricted areas outside the construction zones 3 working days in advance.
- .3 Provide for personnel and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

**1.6 BUILDING SMOKING ENVIRONMENT**

- .1 Comply with smoking restrictions. Smoking is not permitted within Esquimalt Graving Dock.

**1.7 NOISE CONTROL**

- .1 Comply with applicable provincial by-law for noise control.



**1.8 CONSTRUCTION PHASING**

- .1 To maintain Esquimalt Graving Dock operational during construction is of upmost priority. To achieve this goal, disruption of any existing roadway must be implemented after working hours or during weekends.

**1.9 PARALLEL PROJECTS**

- .1 Additional projects will be underway at the Esquimalt Graving Dock during completion of this project. The contractor shall work around and coordinate access, material deliveries, etc with other projects to ensure traffic congestion or delays do not occur.
- .2 Any additional delays, coordination or other costs shall be included by the contractor as part of this project.
- .3 Major projects expected on the site during this project include (but are not limited to):
  - .1 EGD – ESU – Service Entrance Substation and Pumphouse Substation Installation.
  - .2 EGD – NLW – Underground Utility Installation
  - .3 EGD – SSSR – South Side Switchgear Replacement
  - .4 EGD – SSES – South Side Electrical Service
  - .5 EGD – South Jetty Demolition and Water Lot Remediation
  - .6 EGD – PH Main Pump Refurbishment
  - .7 EGD – PH Structural Upgrades

**END OF SECTION**

**Part 1 General**

- .1 This section includes the following:
  - .1 Coordination of Work under administration of Departmental Representative.
  - .2 Scheduled Pre-construction and Site meetings.
  - .3 Project planning and construction schedule.
  - .4 Site progress monitoring and control.

**1.1 DESCRIPTION**

- .1 Coordinate and manage construction schedule, submittals, use of site, temporary utilities, construction facilities, quality control program, and construction Work, with progress of Work of subcontractors, other contractors and Departmental Representative.

**1.2 PRE-CONSTRUCTION MEETING**

- .1 Pre-construction Meeting:
  - .1 Within 10 days after award of Contract, Departmental Representative will arrange pre-construction meeting.
  - .2 Departmental Representative, Contractor and members of EGD Project Management Office (PMO) will be in attendance.
  - .3 Departmental Representative will establish time and location of meeting and notify parties concerned.
  - .4 The Departmental Representative will chair the meeting, record minutes and issue minutes to all attendees.
    - .1 Agenda of meeting is generally as follows:
      - .1 Project team introductions including main construction personnel, PWGSC personnel, EGP and consultants.
      - .2 Communication protocol for submittals.
      - .3 Start date on site.
      - .4 EGD security requirements.
  - .5 Construction Organization and Start-up:
    - .1 Comply with Departmental Representative's allocation of mobilization areas of site; for access, traffic, and parking facilities.
    - .2 During construction coordinate use of site and facilities through Departmental Representative's procedures for intra-project communications: Submittals, reports and records, schedules, coordination of drawings, recommendations, and resolution of ambiguities and conflicts.
    - .3 Comply with instructions of Departmental Representative for use of temporary utilities and construction facilities.
    - .4 Coordinate layout of construction barrier with Departmental Representative.

**1.3 PROJECT PLANNING**

- .1 Plan construction activities, submittals and field reviews ahead of time for efficient and effective management to ensure timely completion of project.

**1.4 SCHEDULES**

- .1 Submit preliminary construction schedule to Departmental Representative during Pre-Construction meeting.
- .2 After review, revise and resubmit schedule. Submit final full schedule within 2 weeks after Pre-Construction meeting.
- .3 During progress of Work revise and resubmit as directed by Departmental Representative.

**1.5 CONSTRUCTION SITE MEETINGS**

- .1 During course of Work and prior to project completion, Departmental Representative will request Construction Site Meetings as required.
- .2 Departmental Representative will record minutes of meetings and circulate to attending parties and affected parties not in attendance.
- .3 Agenda to include following:
  - .1 Review, approval of minutes of previous meeting.
  - .2 Review of Work progress since previous meeting.
  - .3 Field observations, problems, conflicts.
  - .4 Review of Health and Safety including any incidents, near misses, and WorkSafe BC visits.
  - .5 Problems which impede construction schedule.
  - .6 Review of off-site fabrication delivery schedules.
  - .7 Corrective measures and procedures to regain projected schedule.
  - .8 Revision to construction schedule.
  - .9 Progress schedule, during succeeding work period.
  - .10 Review submittal schedules: expedite as required.
  - .11 Update of Red Line As-Built Drawings.
  - .12 Maintenance of quality standards.
  - .13 Review proposed changes for effect on construction schedule and on completion date.
  - .14 Other business.

**1.6 WALK THROUGH FIELD REVIEW BY DEPARTMENTAL REPRESENTATIVE**

- .1 Departmental Representative will carry out the following:
  - .1 Walk-through field review of the work with contractor's representatives.
  - .2 Preparation and distribution of the Walk-through field review Reports. Reports will be distributed within 5 days of field review.

**1.7 SUBMITTALS**

- .1 Submit requests for interpretation of Contract Documents, and obtain instructions through Departmental Representative.
- .2 Process substitutions through Departmental Representative.
- .3 Deliver closeout submittals for review and inspections, for transmittal to Departmental Representative.

**1.8 CLOSEOUT PROCEDURES**

- .1 Notify Departmental Representative when Work is considered Substantially Complete. Contractor to prepare list of defects, deficiencies and incomplete work prior to inspection by Departmental Representative. Follow procedures as outlined in Section 01 78 00 – Closeout Submittals.
- .2 Accompany Departmental Representative on preliminary inspection to determine items listed for completion or correction.
- .3 Comply with Departmental Representative's instructions for correction of items of Work listed in deficiency list. completion or correction.
- .4 Notify Departmental Representative of instructions for completion of items of Work determined in Departmental Representative's final inspection.

**END OF SECTION**

**Part 1        General**

**1.1            ADMINISTRATIVE**

- .1 Schedule and administer site meetings throughout the progress of the work on a regular basis or at the call of Departmental Representative.
- .2 Prepare and distribute agenda at least three (3) days prior to the meetings.
- .3 Distribute written notice of each meeting seven (7) days in advance of meeting date to Departmental Representative.
- .4 Meeting space can be held in the meeting room in the EGD administration building or operation trailer. Book meeting or room in advance through Departmental Representative.
- .5 Preside at meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within five (5) days after meetings and transmit to meeting participants and affected parties not in attendance, Departmental Representative and Consultants.
- .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

**1.2            PRE- CONSTRUCTION MEETING**

- .1 Within 15 days after award of Contract: Departmental Representative will request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Attendance will include, but is not limited to, the Departmental Representative, members of the EGD Project Management Office (PMO) and Contractor.
- .3 Departmental Representative to establish time and location of preconstruction meeting, Contractor to notify parties concerned a minimum of 4 working days before meeting.
- .4 Departmental Representative will chair the meeting, record minutes and issue minutes.
- .5 Agenda to include:
  - .1 Introduction of official representative of participants in the Work.
  - .2 Start date on site.
  - .3 Communication Protocol for submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 51 00 - Temporary Facilities.
  - .5 EGD Security requirements.
  - .6 Site safety in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

- .7 Communication Protocol for proposed changes, change orders, procedures, and approvals required.
- .8 Owner's Work.
- .9 Record drawings in accordance with Section 01 78 00 - Closeout Submittals.
- .10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .12 Monthly progress claims, administrative procedures, photographs, hold backs.
- .13 Appointment of inspection and testing agencies or firms.

**1.3 PROGRESS MEETINGS**

- .1 During course of Work and two weeks prior to Project Completion, schedule progress meetings bi-weekly.
- .2 Attendance to include but is not limited to Departmental Representative, members of the EGD Project management Office (PMO) and Contractor.
- .3 Contractor responsible to record minutes of meetings and circulate to attending parties and affected parties not in attendance within five (5) days after meeting.
- .4 Record next meeting dates in the meeting minutes or notify parties minimum of seven (7) days in advance for other ad-hoc meetings.
- .5 Agenda to include, at a minimum, the following:
  - .1 Review, approval of minutes of previous meeting.
  - .2 Review of Health and Safety including any incidents, near misses, and WorkSafe BC visits.
  - .3 Review of Work progress since previous meeting.
  - .4 Coordination discussions with EGD.
  - .5 Construction schedule review.
  - .6 Review of off-site fabrication delivery schedules.
  - .7 Corrective measures and procedures to regain projected schedule.
  - .8 Request for Information (RFI) log review.
  - .9 Engineering Disciplines Reviews.
    - .1 Structural
    - .2 Mechanical
    - .3 Electrical
  - .10 Change order log review.
  - .11 Review submittal schedule.
  - .12 Review updated as built.
  - .13 Review and resolve site issues.
  - .14 New business.

**END OF SECTION**

**1.1 SCHEDULES REQUIRED**

- .1 Submit schedules as follows.
  - .1 Construction progress schedule.
  - .2 Submittal schedule for shop drawings and product data.
  - .3 Product delivery schedule.

**1.2 FORMAT**

- .1 Prepare schedule in form of horizontal bar chart (GANTT).
- .2 Provide a separate bar for each major item of work, trade or operation.
- .3 Provide horizontal time scale identifying first work day of each week.
- .4 Format for listings: chronological order of start of each item of work.
- .5 Identification of listings: by Specification subjects or system descriptions.

**1.3 SUBMISSION**

- .1 Submit initial schedule within 7 working days after award of Contract.
- .2 Submit minimum of 3 copies to be retained by the Departmental Representative.
- .3 The Departmental Representative will review schedule and return review copy within 7 working days after receipt.
- .4 Re-submit finalized schedule within 3 working days after return of review copy.
- .5 Submit revised progress schedule with each application for payment.
- .6 Distribute copies of revised schedule to:
  - .1 Subcontractors.
  - .2 Other concerned parties.
- .7 Instruct recipients to report to Contractor within 5 working days, any problems anticipated by timetable shown in schedule.

**1.4 SCHEDULING**

- .1 Include complete sequence of construction activities.
- .2 Include dates for commencement and completion of each major element of construction as follows.
- .3 Show expected delivery of major components including generators, transformer and transfer controller.
- .4 Show projected percentage of completion of each item as of first day of week.
- .5 Indicate progress of each activity to date of submission schedule.
- .6 Show changes occurring since previous submission of schedule:
  - .1 Major changes in scope.
  - .2 Activities modified since previous submission.
  - .3 Revised projections of progress and completion.
  - .4 Other identifiable changes.
- .7 Provide a narrative report to define:
  - .1 Problem areas, anticipated delays and impact on schedule.
  - .2 Corrective action recommended and its effect.

**1.5 PROGRESS REPORTS**

- .1 Maintain accurate record of the progress of the Work. Submit progress reports at times requested by the Departmental Representative.
- .2 Include in reports dates of commencement and percentage of work completed for different parts of the Work.

**1.6 STAFFING AND OVERTIME**

- .1 Cease work at any particular point and transfer workers to other designated points, when so directed, should the Departmental Representative judge it necessary to expedite the Work.
- .2 Should the Work fail to progress according to the approved progress schedule, work such additional time (including weekends and holidays), employ additional workers, or both, as may be required to bring the Work back on schedule, at no additional cost to Contract.

**1.7 SUBMITTALS SCHEDULE**

- .1 Include schedule for submitting shop drawings, product data and samples.
- .2 Indicate dates for submitting, review time, re-submission time, and last date for meeting fabrication schedule.
- .3 Include dates when reviewed submittals will be required from the Departmental Representative.

**END OF SECTION**



## **1.1 APPROVALS**

- .1 Approval of shop drawings and samples: Refer to Section 01 11 55 - General Instructions.

## **1.2 GENERAL**

- .1 This Section specifies general requirements and procedures for Contractor's submissions of shop drawings, product data, samples and other requested submittals to Departmental Representative for review. Additional specific requirements for submissions are specified in individual technical sections.
- .2 Present shop drawings, product data and samples in SI Metric units.
- .3 Where items or information is not produced in SI Metric units, converted values are acceptable.
- .4 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submissions.
- .5 Notify Departmental Representative in writing at time of submission, identifying deviations from requirements of Contract documents and stating reasons for deviations.
- .6 Contractor's responsibility for deviations in submission from requirements of Contract documents is not relieved by Departmental Representative's review of submission unless Departmental Representative gives written acceptance of specific deviations.
- .7 Make any changes in submissions which Departmental Representative may require consistent with Contract documents and resubmit as directed by Departmental Representative.
- .8 Notify Departmental Representative in writing, when resubmitting, of any revisions other than those requested by Departmental Representative.
- .9 Do not proceed with work until relevant submissions are reviewed and approved by Departmental Representative.

## **1.3 SUBMISSION REQUIREMENTS**

- .1 Co-ordinate each submission with requirements of work and Contract documents. Individual submissions will not be reviewed until all related information is available.
- .2 Allow 10 working days for Departmental Representative's review of each submission, unless noted otherwise.
- .3 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 Other pertinent data.

- .4 Submissions to include:
  - .1 Date and revision dates.
  - .2 Project title and number.
  - .3 Name and address of:
    - .1 Subcontractor.
    - .2 Supplier.
    - .3 Manufacturer.
    - .4 Contractor's stamp, signed by Contractor's authorized representative, certifying approval of submissions, verification of field measurements and compliance with Contract documents.
- .5 Details of appropriate portions of work as applicable.
  - .1 Fabrication.
  - .2 Layout, showing dimensions (including identified field dimensions and clearances).
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.
- .6 After Departmental Representative's review, distribute copies.

#### **1.4 SHOP DRAWINGS**

- .1 Shop drawings: original drawings or modified standard drawings provided by Contractor to illustrate details of portion of work which are specific to project requirements.
- .2 Maximum sheet size: 850 x 1050 mm.
- .3 Submit 6 prints of shop drawings for each requirement requested in specification sections and/or as requested by Departmental Representative.
- .4 Cross-reference shop drawing information to applicable portions of Contract documents.

#### **1.5 SHOP DRAWINGS REVIEW**

- .1 Review of shop drawings by Department Representative is for the sole purpose of ascertaining conformance with the general concept.
- .2 This review will not mean the Department Representative approves detail design inherent in shop drawings, responsibility for which remains with Contractor submitting same.
- .3 This review will not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting all requirements of construction and Contract documents.

- .4 Without restricting the generality of the foregoing, Contractor is responsible for:
  - .1 Dimensions to be confirmed and correlated at job site.
  - .2 Information that pertains solely to fabrication processes or to techniques of construction and installation.
  - .3 Co-ordination of work of all sub-trades.

**1.6 PRODUCT DATA**

- .1 Product data: manufacturers' catalogue sheets, MSDS sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactured products or any other specified information.
- .2 Delete information not applicable to project.
- .3 Supplement standard information to provide details applicable to project.
- .4 Cross-reference product data information to applicable portions of Contract documents.
- .5 Submit 6 copies of product data.

**1.7 SAMPLES**

- .1 Samples: examples of materials, equipment, quality, finishes and workmanship.
- .2 Where colour, pattern or texture is a criterion, submit a full range of samples.
- .3 Reviewed and accepted samples will become standard of workmanship and material against which installed work will be verified.

**1.8 PROGRESS SCHEDULE**

- .1 Submit work schedule and cost breakdown as required in Section 01 11 55 - General Instructions.

**1.9 SUSTAINABLE (GREEN) REQUIREMENTS SUBMITTALS**

- .1 Provide submittals to show compliance with waste management and disposal requirements in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Submit 6 copies of documentation.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Government of Canada.
  - .1 Canada Labour Code - Part II
  - .2 Canada Occupational Health and Safety Regulations.
- .2 National Building Code of Canada (NBC 2010):
  - .1 Part 8, Safety Measures at Construction and Demolition Sites.
- .3 Canadian Standards Association (CSA as amended):
  - .1 CSA Z797-2009 Code of Practice for Access Scaffold
  - .2 CSA S269.1-1975 (R2003) Falsework for Construction Purposes
  - .3 CSA S350-M1980 (R2003) Code of Practice for Safety in Demolition of Structures
- .4 Fire Protection Engineering Services, HRSDC:
  - .1 FCC No. 301, Standard for Construction Operations.
  - .2 FCC No. 302, Standard for Welding and Cutting.
- .5 American National Standards Institute (ANSI):
  - .1 ANSI A10.3, Operations – Safety Requirements for Powder-Actuated Fastening Systems.
- .6 Province of British Columbia:
  - .1 Workers Compensation Act Part 3-Occupational Health and Safety.
  - .2 Occupational Health and Safety Regulation
- .7 Current B.C. Electrical Code

**1.2 RELATED SECTIONS**

- .1 Construction Progress Schedule Bar (GANTT) Chart      Section 01 32 17
- .2 Submittal Procedures      Section 01 33 00
- .3 Temporary Facilities      Section 01 51 00
- .4 Temporary Barriers and Enclosures      Section 01 56 00

**1.3 WORKERS' COMPENSATION BOARD COVERAGE**

- .1 Comply fully with the Workers' Compensation Act, regulations and orders made pursuant thereto, and any amendments up to the completion of the work.
- .2 Maintain Workers' Compensation Board coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

**1.4 COMPLIANCE WITH REGULATIONS**

- .1 PWGSC may terminate the Contract without liability to PWGSC where the Contractor, in the opinion of PWGSC, refuses to comply with a requirement of the Workers' Compensation Act or the Occupational Health and Safety Regulations.

- .2 It is the Contractor's responsibility to ensure that all workers are qualified, competent and certified to perform the work as required by the Workers' Compensation Act or the Occupational Health and Safety Regulations.

## 1.5 SUBMITTALS

- .1 Submit to Departmental Representative submittals listed for review. In accordance with Section 01 33 00.
- .2 Work effected by submittal shall not proceed until review is complete.
- .3 Submit the following:
  - .1 Health and Safety Plan.
  - .2 Copies of reports or directions issued by Federal and Provincial health and safety inspectors.
  - .3 Copies of incident and accident reports.
  - .4 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Material Information System (WHMIS) requirements.
  - .5 Emergency Procedures.
- .4 The Departmental Representative will review the Contractor's site-specific project Health and emergency procedures, and provide comments to the Contractor within 2 days after Receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.
- .5 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.
- .6 Submission of the Health and Safety Plan, and any revised version, to the Departmental Representative is for information and reference purposes only. It shall not:
  - .1 Be construed to imply approval by the Departmental Representative.
  - .2 Be interpreted as a warranty of being complete, accurate and legislatively compliant.
  - .3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

## 1.6 RESPONSIBILITY

- .1 Assume responsibility as the Prime Contractor for work under this contract.
- .2 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.
- .3 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.

**1.7 HEALTH AND SAFETY COORDINATOR**

- .1 The Health and Safety Coordinator must:
  - .1 Be responsible for completing all health and safety training, and ensuring that personnel that do not successfully complete the required training are not permitted to enter the site to perform work.
  - .2 Be responsible for implementing, daily enforcing, and monitoring the site-specific Health and Safety Plan.
  - .3 Be on site during execution of work.

**1.8 GENERAL CONDITIONS**

- .1 Provide safety barricades and lights around work site as required to provide a safe working environment for workers and protection for pedestrian and vehicular traffic.
- .2 Ensure that non-authorized persons are not allowed to circulate in designated construction areas of the work site.
  - .1 Provide appropriate means by use of barricades, fences, warning signs, traffic control personnel, and temporary lighting as required.
  - .2 Secure site at night time as deemed necessary to protect site against entry.

**1.9 PROJECT/SITE CONDITIONS**

- .1 The Esquimalt Graving Dock is a dry dock and ship repair facility. It is an industrial site wherein industrial, manufacturing, fabrication, heavy construction, and like works are conducted by a variety of contractors and sub-trades for a variety of owners and/or the Departmental Representative.
- .2 Work at site will involve a number of hazards known to PWGSC as noted in the Preliminary Job hazard Analysis in Appendix B attached. This site may involve contact with hazardous and/or toxic materials and substances such as but not limited to:
  - .1 Waste sandblast grit.
  - .2 Paint spray, including solvents and mineral spirits.
  - .3 Waste water.
  - .4 Contaminated soils and debris
  - .5 Petroleum products
- .3 Other safety hazards or risks which may be encountered include, but are not limited to:
  - .1 Contact with traveling and mobile cranes, forklifts, man lifts and other motorized vehicles.
  - .2 Overhead hazards such as that created by material transported by cranes.
  - .3 Fall hazards.
  - .4 Drowning hazards.
  - .5 Confined space hazards.
  - .6 Electrical hazards.

- .7 Contact with operating mechanical, electrical, electronic, pneumatic, thermal, and hydraulic machinery and equipment.
- .8 Fire hazards.

#### **1.10 REGULATORY REQUIREMENTS**

- .1 Comply with specified codes, acts, bylaws, standards and regulations to ensure safe operations at site.
- .2 In event of conflict between any provision of the above authorities, the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, the Departmental Representative will advise on the course of action to be followed.

#### **1.11 WORK PERMITS**

- .1 Obtain specialty trade permits related to project before start of work.

#### **1.12 FILING OF NOTICE**

- .1 The General Contractor is to complete and submit a Notice of Project as required by Provincial authorities.
- .2 Provide copies of all notices to the Departmental Representative.

#### **1.13 HEALTH AND SAFETY PLAN**

- .1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.
- .2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:
  - .1 Primary requirements:
    - .1 Contractor's safety policy.
    - .2 Identification of applicable compliance obligations.
    - .3 Definition of responsibilities for project safety/organization chart for project.
    - .4 General safety rules for project.
    - .5 Job-specific safe work, procedures.
    - .6 Inspection policy and procedures.
    - .7 Incident reporting and investigation policy and procedures.
    - .8 Occupational Health and Safety Committee/Representative procedures.
    - .9 Occupational Health and Safety meetings.
    - .10 Occupational Health and Safety communications and record keeping procedures.
  - .2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.
  - .3 List hazardous materials to be brought on site as required by work.

- .4 Indicate Engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
  - .5 Identify personal protective equipment (PPE) to be used by workers.
  - .6 Identify personnel and alternates responsible for site safety and health.
  - .7 Identify personnel training requirements and training plan, including site orientation for new workers.
- .3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.
  - .4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.
  - .5 Departmental Representative's review: the review of Health and Safety Plan by Public Works and Government Services Canada (PWGSC) shall not relieve the Contractor of responsibility for errors or omissions in final Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

#### **1.14 EMERGENCY PROCEDURES**

- .1 List standard operating procedures and measures to be taken in emergency situations. Include an evacuation plan and emergency contacts (i.e. names/telephone numbers) of:
  - .1 Designated personnel from own company.
  - .2 Regulatory agencies applicable to work and as per legislated regulations.
  - .3 Local emergency resources.
  - .4 Departmental Representative and site staff.
- .2 Include the following provisions in the emergency procedures:
  - .1 Notify workers and the first-aid attendant, of the nature and location of the emergency.
  - .2 Evacuate all workers safely.
  - .3 Check and confirm the safe evacuation of all workers.
  - .4 Notify the fire department or other emergency responders.
  - .5 Notify adjacent workplaces or residences which may be affected if the risk extends beyond the workplace.
  - .6 Notify Departmental Representative and site staff.
- .3 Provide written rescue/evacuation procedures as required for, but not limited to:
  - .1 Work at high angles.
  - .2 Work in confined spaces or where there is a risk of entrapment.
  - .3 Work with hazardous substances.
  - .4 Underground work.
  - .5 Work on, over, under and adjacent to water.
  - .6 Workplaces where there are persons who require physical assistance to be moved.
- .4 Design and mark emergency exit routes to provide quick and unimpeded exit.



- .5 Revise and update emergency procedures as required, and re-submit to the Departmental Representative.

### **1.15 HAZARDOUS PRODUCTS**

- .1 Comply with requirements of Workplace Hazardous Materials Information system (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labeling and provision of material Safety Data Sheets (MSDS) acceptable to the Departmental Representative and in accordance with the Canada Labour Code.
- .2 Where use of hazardous and toxic products cannot be avoided:
  - .1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS and WHMIS documents as per Section 01 33 00.
  - .2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when Esquimalt Graving Dock Staff have left the building.
  - .3 Provide adequate means of ventilation in accordance with Section 01 51 00.

### **1.16 ELECTRICAL SAFETY REQUIREMENTS**

- .1 Comply with authorities and ensure that, when installing new facilities or modifying existing facilities, all electrical personnel are completely familiar with existing and new electrical circuits and equipment and their operation.
  - .1 Before undertaking any work, coordinate required energizing and de-energizing of new and existing circuits with Departmental Representative.
  - .2 Maintain electrical safety procedures and take necessary precautions to ensure safety of all personnel working under this Contract, as well as safety of other personnel on site.

### **1.17 ELECTRICAL LOCKOUT**

- .1 Develop, implement and enforce use of established procedures to provide electrical lockout and to ensure the health and safety of workers for every event where work must be done on any electrical circuit or facility.
- .2 Prepare the lockout procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request/ authorization form. Have procedures available for review upon request by the Departmental Representative.
- .3 Keep the documents and lockout tags at the site and list in a log book for the full duration of the Contract. Upon request, make such data available for viewing by Departmental Representative or by any authorized safety representative.

### **1.18 OVERLOADING**

- .1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

### **1.19 CONFINED SPACES**

- .1 Carry out work in confined spaces in compliance with Occupational Health and Safety Regulation, Part 9.

#### **1.20 POWDER-ACTUATED DEVICES**

- .1 Use powder-actuated devices in accordance with ANSI A10.3 only after receipt of written permission from the Departmental Representative.

#### **1.21 FIRE SAFETY AND HOT WORK**

- .1 Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.
- .2 Hot work includes cutting/melting with use of torch, flame heating roofing kettles, or other open flame devices and grinding with equipment which produces sparks.

#### **1.22 FIRE SAFETY REQUIREMENTS**

- .1 Store oily/paint-soaked rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
- .2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

#### **1.23 FIRE PROTECTION AND ALARM SYSTEM**

- .1 Fire protection and alarm systems shall not be:
  - .1 Obstructed.
  - .2 Shut off.
  - .3 Left inactive at the end of a working day or shift.
- .2 Do not use fire hydrants, standpipes and hose systems for purposes other than firefighting.
- .3 Be responsible/liable for costs incurred from the fire department, the building owner and the tenants, resulting from false alarms.

#### **1.24 UNFORESEEN HAZARDS**

- .1 Should any unforeseen or peculiar safety-related factor, hazard or condition become evident during performance of the work, immediately stop work and advise the Departmental Representative verbally and in writing.

#### **1.25 POSTED DOCUMENTS**

- .1 Post legible versions of the following documents on site:
  - .1 Health and Safety Plan.
  - .2 Sequence of work.
  - .3 Emergency procedures.
  - .4 Site drawing showing project layout, locations of the first-aid station, evacuation route and marshalling station and the emergency transportation provisions.
  - .5 Notice of Project.
  - .6 Floor plans or site plans.

- .7 Notice as to where a copy of the Workers' Compensation Act and Regulations are available on the work site for review by employees and workers.
- .8 Workplace Hazardous Materials Information System (WHMIS) documents.
- .9 Material Safety Data Sheets (MSDS).
- .10 List of names of Joint Health and Safety Committee members, or Health and Safety Representative, as applicable.
- .2 Post all Material Safety Data Sheets (MSDS) on site, in a common area, visible to all workers and in locations accessible to tenants when work of this Contract includes construction activities adjacent to occupied areas.
- .3 Postings should be protected from the weather, and visible from the street or the exterior of the principal construction site shelter provided for workers and equipment, or as approved by the Departmental Representative.

**1.26****MEETINGS**

- .1 Attend health and safety pre-construction meeting and all subsequent meetings called by the Departmental Representative.

**1.27****CORRECTION OF NON-COMPLIANCE**

- .1 Immediately address health and safety non-compliance issues identified by the Departmental Representative.
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance with health and safety issues identified.
- .3 The Departmental Representative may issue a "stop work order" if non-compliance of health and safety regulations is not corrected immediately or within posted time. The General Contractor/subcontractors will be responsible for any costs arising from such a "stop work order".

**END OF SECTION**

**Part 1          General**

**1.1            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.

**1.2            SUBMITTALS**

- .1    Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
- .3    Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4    Environmental protection plan to include:
  - .1    Names of persons responsible for ensuring adherence to Environmental Protection Plan.
  - .2    Names and qualifications of persons responsible for manifesting contaminated soils and hazardous waste to be removed from site.
  - .3    Names and qualifications of persons responsible for training site personnel.
  - .4    Descriptions of environmental protection personnel training program.
- .5    Erosion and sediment control plan which identifies 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, Federal, Provincial, and Municipal laws and regulations.
- .6    Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.
- .7    Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
- .8    Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

- .9 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.
- .10 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .11 Waste water management plan that identifies 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.

### **1.3 FIRES**

- .1 Fires and burning of rubbish on site is not permitted.

### **1.4 DISPOSAL OF WASTES**

- .1 Do not bury rubbish and waste materials on site.
- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways.

### **1.5 DRAINAGE**

- .1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.
- .2 Do not pump water containing suspended materials into waterways, sewer or drainage systems.
- .3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

### **1.6 WORK ADJACENT TO WATERWAY**

- .1 Do not dump excavated fill, waste material or debris in waterways.

### **1.7 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 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

### **1.8 HISTORICAL/ARCHAEOLOGICAL CONTROL**

- .1 Give immediate notice to the Departmental Representative if evidence of archaeological finds are encountered during construction and await written instructions before proceeding with work in the vicinity of any such finds.
- .2 Relics, antiquities and items of historical or scientific interest shall remain the property of the Crown. Protect such articles and request directives from the Departmental Representative.

## **1.9 NOTIFICATION**

- .1 Departmental Representative will notify Contractor in writing of observed non-compliance 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.
- .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.

## **1.10 SPILLS OR RELEASE OF DELETERIOUS SUBSTANCES**

- .1 Measures to be implemented to prevent, control or mitigate spills or release of deleterious substances:
  - .1 Contractor shall take due care to ensure no deleterious materials enter any surface drainage pathways located in the project area.
  - .2 Emergency response procedure for spills of deleterious substances must be in place. In the event of a spill, the contractor will immediately implement their Spill Response Protocol.
  - .3 The Contractor is responsible for all costs associated with a spill or release as a result of their actions. This will include but not limited costs of spill response equipment and materials, associated sampling, analysis and any required restoration of the impacted area.
  - .4 Response equipment to be on site at all times (i.e. spill kits) and workers trained in their location and use. The resources on hand must be sufficient to respond effectively and expediently to any spill that could occur on site.
  - .5 All construction equipment brought onto the site will be clean and properly maintained.
  - .6 Any equipment maintenance must occur in a designated area and must be conducted away from any surface water drains or collection points.
  - .7 Any equipment remaining on site overnight shall have appropriately placed drip pans.
  - .8 Waste generated will be prevented from entering the environment.
  - .9 Prevent discharges containing asphalt, grout, concrete or other waste materials from reaching storm drains or the marine environment. This includes, but is not limited to:
    - .1 Cleaning equipment off site; and
    - .2 Protection of any other drainage structures not identified here with filter fences and/or silt socks, if required.
  - .10 Protection of the roadways from tracking of mud, soil and debris needs to be maintained throughout the work.

- .11 Limit of work activities to normal business hours to minimize noise outside of those hours. Ensure that equipment and machinery is properly maintained to minimize unnecessary noise pollution. Consider local municipal noise bylaws when mobilizing equipment.
- .12 All utilities must be located prior to excavation.

**1.11 IMPORT OF FILL MATERIAL**

- .1 Prior to import of any material used for surfacing, backfilling or any other use requiring fill material the Contractor will provide sufficient documentation, as agreed on by Departmental Representative, to ensure that the imported material meets the Canadian Council of Ministers of the Environment (CCME) Residential/Parkland (RL/PL) Land Usage Soil Quality Guidelines.
- .2 Environmental characterization of fill material must be conducted in accordance with the following: British Columbia, Ministry of Environment, Technical Guidance Document #1 – Site Characterization and Confirmation Testing.
- .3 Prior to import of any material the Contractor must inform the Departmental representative of the proposed fill source(s) and identify the nature of current and historic activities conducted at the source.
- .4 The Departmental Representative reserves the right to request additional testing of imported material at the source and at the deposit site to satisfy their requirements. All testing will be done at the Contractor's cost.
- .5 All material brought to the site that does not meet the CCME RL/PL Guidelines will be removed from the property immediately at the Contractors cost.

**END OF SECTION**

## **1.1 INSPECTION**

- .1 Be responsible for quality control during execution of Work.
- .2 Allow the 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.
- .3 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by the Departmental Representative's instructions, or law of Place of Work.
- .4 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.
- .5 The 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, Canada will pay cost of examination and replacement.

## **1.2 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.

## **1.3 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 the 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.
- .3 If in opinion of the Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, the Departmental Representative may deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by the Departmental Representative.

## **1.4 REPORTS**

- .1 Submit 3 copies of inspection and test reports to the Departmental Representative.
- .2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

**END OF SECTION**



**Part 1        General**

**1.1            ACCESS AND DELIVERY**

- .1        Only the designated entrance may be used for access to the site. The designated entry and exit will be via the Main Esquimalt Graving Dock gate on Admirals Road, along the North Main Entrance Roadway, and along the north side of the dry dock. Access to the south side of the dock will be only by special permission from the Departmental Representative.
- .2        Vehicular movement in and out of the Esquimalt Graving Dock will pass through check points and be monitored by EGD security. All Contractor's and Subcontractor's staff must carry current photo identification and a PWGSC security pass.
- .3        Contractor is required to use only the designated entrance to access the work site, for deliveries to site, and as the exit for offsite disposal.
  - .1        Maintain for duration of contract.
  - .2        Make good damage resulting from Contractor's use.
- .4        Use of the Esquimalt Graving Dock facility will be granted to the Contractor through the Departmental Representative.
  - .1        The contractor's work site is to be used for loading and unloading purposes.
- .5        Provide and maintain access roads, sidewalk crossing ramps and construction runways as may be required for access to the work. All roadways and walkways outside of the Contractor's work site must be kept clear of materials and equipment at all times.
- .6        Provide and maintain competent flag operators, traffic signals, barricades and flares, lights or lanterns as may be required to perform work and protect other users of the Esquimalt Graving Dock.

**1.2            CONSTRUCTION PARKING**

- .1        Construction staff shall be responsible for their own parking in nearby private facilities.

**1.3            STORAGE FACILITIES**

- .1        Confine work and operations of employees to areas indicated on Contract Documents. Do not unreasonably encumber premises with products. Storage space to be limited to the area of construction.
- .2        Do not load or permit to load any part of Work with weight or force that will endanger Work or existing structure or elements.
- .3        Provide and pay for all off-site storage as required. Note that storage space is limited on site. Refer to site plan for location of Contractor's site storage and lay-down area.

#### **1.4 POWER**

- .1 Contractor to provide connection to existing 120/208V distribution board for connection of temporary power for office trailer. Contractor shall install a revenue approved energy meter suitable for measuring kWh consumed. Temporary construction power shall be drawn from this metered source. A 100 amps, three phase, 120/208VAC circuit breaker will be available for contractor use in the Service Entrance Substation (SES).
- .2 Contractor will be charged power at a standard BC hydro rate typical for this service size (BC Hydro Schedule 1220).

#### **1.5 SANITARY FACILITIES**

- .1 Contractor will provide their own portable sanitary facilities. Maintain in a safe and sanitary condition. Construction staff will not be allowed to use Esquimalt Graving Dock's washrooms.

#### **1.6 HEATING AND VENTILATION**

- .1 Do not begin work until arrangements have been made with the Departmental Representative for protection of heating, ventilating and air conditioning.
- .2 If there is any dirt in the heating and ventilation system, at the completion of work, it will be the Contractor's responsibility to return system to its original state in accordance with the Departmental Representative's directions.
- .3 Prevent dust and odour migration to other occupied areas.
  - .1 Do not deactivate HVAC system to occupied floors. Purge air from construction floors only when directed by Departmental Representative, where dust and fumes will be generated.
  - .2 Change filters in existing HVAC system frequently.

#### **1.7 SCAFFOLDING**

- .1 Construct and maintain scaffolding in rigid, secure and safe manner.
- .2 Erect scaffolding independent of walls. Remove promptly when no longer required.

#### **1.8 HOISTING**

- .1 Provide, operate and maintain hoists required for moving of workers, materials and equipment. Make financial arrangements with Sub-contractors for their use of hoists.
- .2 Hoists shall be operated by qualified operator.

#### **1.9 HOARDING**

- .1 Prior to all demolition and construction, install plywood hoarding or protective barrier as detailed. Maintain in safe and clean condition throughout duration of project. Submit hoarding plan to Departmental Representative for approval.
- .2 Erect and maintain safety barricades around all openings and other danger areas as required by Building Code and WCB.

- .3 Installation of hoarding must not create permanent damage to existing wall cladding or flooring finish which is of heritage value.

**1.10 SITE OFFICE**

- .1 Contractor to provide their own trailer as temporary site office on the north side of the Service Entrance Substation.
- .2 Contractor shall clear and remove site office at end of project, including complete removal of all temporary utilities.

**1.11 REMOVAL OF TEMPORARY FACILITIES**

- .1 Remove temporary facilities from site when directed by the Departmental Representative.

**1.12 SIGNS AND NOTICES**

- .1 Signs and notices for safety and instruction shall be in both official languages or graphic symbols conforming to CAN/CSA-Z321.
- .2 Maintain approved signs and notices in good condition for duration of Project, and dispose of offsite on completion of Project when directed by Departmental Representative.

**1.13 CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt of mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.
- .5 At completion of Project: Remove and dispose of all debris, thoroughly clean and restore site to condition found at commencement of Work. Repair and make good to all damage caused by construction activities.

**END OF SECTION**

**Part 1 General****1.1 RELATED SECTIONS**

.1 N/A

**1.2 REFERENCES**

.1 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: 2012-01-18.

**1.3 INSTALLATION AND REMOVAL**

.1 Provide temporary controls in order to execute Work expeditiously.

.2 Remove from site all such work after use.

**1.4 GUARD RAILS AND BARRICADES**

.1 Provide secure, rigid guard rails and barricades around deep excavations.

**1.5 ACCESS TO SITE**

.1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

**1.6 PUBLIC TRAFFIC FLOW**

.1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

**1.7 FIRE ROUTES**

.1 Maintain access to property including overhead clearances for use by emergency response vehicles.

**1.8 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY**

.1 Protect surrounding private and public property from damage during performance of Work.

.2 Be responsible for damage incurred.

**1.9 PROTECTION OF BUILDING FINISHES**

.1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.

.2 Provide necessary screens, covers, and hoardings.

.3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.

.4 Be responsible for damage incurred due to lack of or improper protection.

**1.10 WASTE MANAGEMENT AND DISPOSAL**

.1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

**Part 2            Products**

**2.1                NOT USED**

.1                Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1                Not Used.

**END OF SECTION**

**1.1 PRODUCTS/MATERIAL AND EQUIPMENT**

- .1 Use NEW products/material and equipment unless otherwise specified. Term "products" is referred to throughout specifications.
- .2 Use products of one (1) manufacturer for material and equipment of same type or classification unless otherwise specified.
- .3 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.
- .4 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer instructions. Departmental Representative will designate which document is to be followed.
- .5 Provide metal fastenings and accessories in same texture, colour and finish as base metal in which they occur.
  - .1 Prevent electrolytic action between dissimilar metals.
  - .2 Use non-corrosive fasteners, anchors and spacers for securing exterior work.
- .6 Fastenings which cause spalling or cracking are not acceptable.
- .7 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .8 Use heavy hexagon heads, semi-finished unless otherwise specified.
- .9 Bolt threads shall not project more than 1 diameter beyond nuts.
- .10 Types of washers as follows:
  - .1 Plain type washers: use on equipment and sheet metal.
  - .2 Soft gasket lock type washers: use where vibrations occur.
  - .3 Resilient washers: use with stainless steel items and fasteners.
  - .4 FRP fibre reinforced plastic washers: use with FRP items and fabrications.
- .11 Deliver, store and maintain packaged material and equipment with manufacturer seals and labels intact.
- .12 Prevent damage, adulteration and soiling of products during delivery, handling and storage. Immediately remove rejected products from site.
- .13 Store products in accordance with supplier instructions.
- .14 Touch up damaged factory finished surfaces to Departmental Representative's satisfaction:
  - .1 Use primer or enamel to match original.
  - .2 Do not paint over nameplates.

**1.2 QUALITY OF PRODUCTS**

- .1 Products, materials and equipment (referred to as products) incorporated into work to be new, not damaged or defective and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.

- .2 Defective products will be rejected regardless of previous inspections.
  - .1 Inspection does not relieve responsibility, but is precaution against oversight or error.
  - .2 Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .3 Retain purchase orders, invoices and other documents to prove that all products utilized in this Contract meet requirements of specifications. Produce documents when requested by Departmental Representative.
- .4 Should any dispute arise as to quality or fitness of products, the decision rests strictly with Departmental Representative based upon requirements of Contract documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

### **1.3 AVAILABILITY OF PRODUCTS**

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any items.
- .2 If delays in supply of products are foreseeable, notify Departmental Representative of such in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of work.
- .3 In event of failure to notify Departmental Representative at start of work and should it subsequently appear that work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in either Contract price or Contract time.

### **1.4 MANUFACTURER INSTRUCTIONS**

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer instructions.
  - .1 Do not rely on labels or enclosures provided with products.
  - .2 Obtain written instructions directly from manufacturer.
- .2 Notify Departmental Representative in writing of conflicts between specifications and manufacturer instructions so that Departmental Representative may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in either Contract price or Contract time.

### **1.5 CONTRACTOR'S OPTIONS FOR SELECTION OF PRODUCTS FOR TENDERING**

- .1 Products are specified by "Prescriptive" specifications: select any product meeting or exceeding specifications.

- .2 Products specified under "Acceptable Products" (used for complex Mechanical or Electrical Systems): select any one of the indicated manufacturers, or any other manufacturer meeting or exceeding Prescriptive specifications and indicated Products.
- .3 Products specified by performance and referenced standard: select any product meeting or exceeding referenced standard.
- .4 Products specified to meet particular design requirements or to match existing materials: use only material specified Approved Product. Alternative products may be considered provided full technical data is received in writing by Departmental Representative in accordance with "Special Instructions to Tenderers".
- .5 When products are specified by referenced standard or by Performance specifications, upon request of Departmental Representative obtain from manufacturer and independent laboratory report showing that product meets or exceeds specified requirements.
- .6 Existing products, systems or equipment are noted specifically with brand or manufacturers information to ensure that any and all equipment or services supplied as part of this contract are completely compatible. Additional costs related to compatibility or integration of proposed systems to the existing equipment will not be considered and complete conformance to the requirements of the contract documents is expected.

#### **1.6 SUBSTITUTION AFTER CONTRACT AWARD**

- .1 No substitutions are permitted without prior written approval of Departmental Representative.
- .2 Proposals for substitution may only be submitted after Contract award. Such request must include statements of respective costs of items originally specified and proposed substitution.
- .3 Proposals will be considered by Departmental Representative if:
  - .1 Products selected by tenderer from those specified are not available;
  - .2 Delivery date of products selected from those specified would unduly delay completion of Contract, or
  - .3 An alternative product to that specified, which is brought to attention of Departmental Representative is considered by Departmental Representative as equivalent to product specified and will result in a credit to Contract amount.
- .4 Should the proposed substitution be accepted either in part or in whole, assume full responsibility and costs when substitution affects other work on project. Pay for design or drawing changes required as result of substitution.
- .5 Amounts of all credits arising from approval of substitutions will be determined by Departmental Representative and Contract price will be reduced accordingly.

**END OF SECTION**



**Part 1            General**

**1.1                EXISTING SERVICES**

- .1        Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.

**1.2                LAYOUT**

- .1        Confirm all project requirements prior to starting work.
- .2        Make no changes or relocations without prior written notice to Departmental Representative.
- .3        Confirm all structural, electrical, civil and mechanical work prior to starting construction.

**1.3                LOCATION OF EQUIPMENT AND FIXTURES**

- .1        Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2        Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3        Inform Departmental Representative of impending installation and obtain approval for actual location.
- .4        Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

**1.4                RECORDS**

- .1        Maintain a complete, accurate log of work as it progresses.
- .2        Record locations of maintained, re-routed and abandoned service lines.

**Part 2            Products**

**2.1                NOT USED**

- .1        Not Used.

**Part 3            Execution**

**3.1                NOT USED**

- .1        Not Used.

**END OF SECTION**

## 1.1 SUBMITTALS

- .1 Submit written request in advance of cutting or alteration that affects any of following.
  - .1 Structural integrity of any part of Project.
  - .2 Efficiency, maintenance or safety of any operational element.
  - .3 Visual qualities of sight-exposed elements.
  - .4 Interior and exterior building finishes.

## 1.2 INCLUDE IN REQUEST:

- .1 Identification of Project.
- .2 Location and description of affected Work.
- .3 Statement on necessity for cutting or alteration.
- .4 Description of proposed Work and products to be used.
- .5 Alternatives to cutting and patching.
- .6 Effect on work of Other Contractor.
- .7 Written permission of affected Other Contractor.
- .8 Date and time of work that will be executed.

## 1.3 MATERIALS

- .1 Required for original installation.

## 1.4 PREPARATION

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Cover adjacent surfaces and finishes with clean and dry drop sheets, kraft paper, cardboard or other suitable coverings during minor demolition.

## 1.5 EXECUTION

- .1 Execute cutting, fitting and patching required to perform work. Perform minor demolition required for alterations with care not to damage adjacent construction, fittings, fixtures, surfaces and finishes scheduled to remain.
- .2 Obtain Departmental Representative's approval before cutting, boring or sleeving load-bearing members
- .3 Fit several parts together, to integrate with other work.
- .4 Uncover work to install ill-timed work, at no cost to Contract.
- .5 Remove and replace defective and non-conforming work, at no cost to Contract.
- .6 Execute work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing. Make cuts with clean, true, smooth edges.

- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Restore work with new products in accordance with requirements of Contract Documents.
- .9 Include cost of making good all surfaces, substrates and work disturbed by removal of existing work and by installation of new work.

#### **1.6 MATCHING TO EXISTING WORK**

- .1 Make new work in existing areas and all alteration/renovation work match in every respect similar items in existing areas.
- .2 Use new materials to match existing items. Where perfect matches cannot be made as to quality, texture, colour and pattern remove existing materials and replace with new materials of comparable quality selected by the Departmental Representative, to extent directed by the Departmental Representative.
- .3 Execute Work carefully wherever existing work is being re-used. Make repairs to such reused items after re-installation to properly restore them. Where proper restoration is impractical, such items will be rejected and replaced to the Departmental Representative's approval.
- .4 After removal of reusable items, carefully patch and repair original location.
- .5 Wherever existing work is being altered to make way for new work, perform such cutting and patching neatly and make finished installations equal to quality and appearance.
- .6 Where new work is a continuation or an extension of existing work take care to blend both together with complete regard to appearance. Obvious joints and visible patches not acceptable.

#### **1.7 SETTING OUT OF WORK**

- .1 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.
- .2 Provide devices needed to lay out and construct work.
- .3 Supply such devices as straight edges and templates required to facilitate the Departmental Representative's inspection of work.
- .4 Review layouts with the Departmental Representative prior to commencement of work.

#### **1.8 LOCATION OF EQUIPMENT AND FIXTURES**

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform the Departmental Representative of impending installation and obtain his approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by the Departmental Representative.

**END OF SECTION**

## **1.1 PROJECT CLEANLINESS**

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .2 Remove waste materials from site at regularly scheduled times or dispose of as directed by the Departmental Representative. Refer to Section 01 35 43 - Environmental Procedures for additional requirements.
- .3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4 Provide on-site containers for collection of waste materials and debris. Locate where directed by the Departmental Representative.
- .5 Provide and use clearly marked separate bins for recycling wherever facilities are available. Refer to Section 01 74 21 - Waste Management and Disposal for additional requirements.
- .6 Remove waste material and debris from site and deposit in waste containers at end of each working day.
- .7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8 Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.
- .9 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

## **1.2 FINAL CLEANING**

- .1 When Work is substantially completed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris.
- .3 Prior to final review, remove surplus products, tools, construction machinery and equipment.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Remove stains, spots, marks and dirt from decorative work, electrical/mechanical fixtures, furniture fitments; walls, floors and ceilings.
- .6 Clean lighting reflectors, lenses and other lighting surfaces.
- .7 Vacuum clean and dust room interiors.
- .8 Sweep and power wash pavement around building and all pavement parking/storage areas used by Contractor to remove all traces of construction spillage, stains and residue. Do not blast dirty water onto adjacent buildings and site features.

**END OF SECTION**

- 1.1** .1 **RELATED WORK**  
Refer to every technical section for waste management and disposal requirements.
- 1.2** **DEFINITIONS**
- .1 Waste Reduction Work plan: written report that addresses opportunities for reduction, re-use or recycling of materials.
- .2 Materials Source Separation Program: consists of series of ongoing activities to separate re-usable and recyclable waste material into material categories from other types of waste at point of generation.
- 1.3** **MATERIALS SOURCE SEPARATION**
- .1 Before project start-up, prepare Materials Source Separation Program. Provide separate containers for re-usable and/or recyclable materials of following:
- .1 Construction waste: including but not limited to following types.
- .1 Uncontaminated packaging (wood, metal banding, cardboard, paper, plastic wrappings, polystyrene).
- .2 Wood pallets (recycle or return to shipper).
- .3 Metals (pipe, conduit, ducting, wiring, miscellaneous cuttings)
- .4 Wood (uncontaminated).
- .5 Paint, solvent, oil.
- .6 Other materials as indicated in technical sections.
- .2 Administration/worker waste (uncontaminated): including but not limited to following types.
- .1 Paper, cardboard.
- .2 Plastic containers and lids marked types 1 through 6.
- .3 Glass and aluminum drink containers (recycle or return to vendor).
- .2 Implement Materials Source Separation Program for waste generated on project in compliance with approved methods and as approved by Departmental Representative.
- .3 Locate containers in locations, to facilitate deposit of materials without hindering daily operations.
- .4 Locate separated materials in areas which minimize material damage.
- 1.4** **DIVERSION OF MATERIALS**
- .1 Create list of materials to be separated from general waste stream and stockpiled in separate containers, to approval of Departmental Representative and consistent with applicable fire regulations.
- .1 Mark containers.
- .2 Provide instruction on disposal practices.

**1.5 STORAGE, HANDLING AND APPLICATION**

- .1 Do work in compliance with Waste Reduction Workplan.
- .2 Handle waste materials not re-used, salvaged, or recycled in accordance with appropriate regulations and codes.
- .3 Materials in separated condition: collect, handle, store on site and transport off-site to approved and authorized recycling facility.
- .4 Materials must be immediately separated into required categories for re-use or recycling.
- .5 Unless specified otherwise, materials for removal become Contractor's property.
- .6 On-site sale of salvaged/recyclable material is not permitted.
- .7 On-site burning of material is not permitted.
- .8 Provide Departmental Representative with receipts indicating quantity of material delivered to landfill.
- .9 Provide Departmental Representative with receipts indicating quantity and type of materials sent for recycling.

**END OF SECTION**

**1.1 INSPECTION AND DECLARATION**

- .1 Contractor's inspection: Contractor and all Subcontractors will conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
  - .1 Notify the Departmental Representative in writing of satisfactory completion of Contractor's inspection and that corrections have been made.
  - .2 Request the Departmental Representative's inspection.
- .2 The Departmental Representative's inspection: the Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor will correct Work accordingly.
- .3 Completion: submit written certificate that following have been performed:
  - .1 Work has been completed and inspected for compliance with Contract Documents.
  - .2 Defects have been corrected and deficiencies have been completed.
  - .3 Certificates required by authorities having jurisdiction have been submitted.
  - .4 Work is complete and ready for Final Inspection.
- .4 Final inspection: when items noted above are completed, request final inspection of Work by the Departmental Representative and Contractor. If Work is deemed incomplete by the Departmental Representative, complete outstanding items and request re-inspection.

**END OF SECTION**

## 1.1 SUBMISSION

- .1 Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- .2 Revise content of documents as required before final submittal.
- .3 Phasing of submission:
  - .1 5 working days before substantial performance of work submit to Departmental Representative 4 final copies of operation and maintenance manuals.
  - .2 5 working days before substantial performance of work submit to Departmental Representative 4 final copies of supplements to operation and maintenance manuals for each subsequent phase.
- .4 Ensure that spare parts, maintenance materials and special tools provided are new, neither damaged nor 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 defective products at no cost to Contract.

## 1.2 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 size with spine and face pockets.
- .3 Cover: identify each binder with typed or printed title "Project Record Documents"; list title of project and identify subject matter of contents.
- .4 Arrange content by systems under section numbers and sequence of Specifications Index.
- .5 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .6 Text: manufacturer's printed data, or typewritten data.
- .7 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

## 1.3 CONTENTS, EACH VOLUME

- .1 Table of contents - provide the following:
  - .1 Title of project.
  - .2 Date of submission.
  - .3 Names, addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
  - .4 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system, 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 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.

#### **1.4 RECORD DOCUMENTS**

- .1 Contract drawings and shop drawings: legibly mark each item to record actual construction, including:
  - .1 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .2 Field changes of dimension and detail.
  - .3 Changes made by change orders.
  - .4 Details not on original Contract drawings.
  - .5 References to related shop drawings and modifications.
- .2 Contract specifications: legibly mark each item to record actual "Workmanship of Construction", including;
  - .1 Manufacturer, trade name and catalogue number of each "Product/Material" actually installed, particularly optional items and substitute items.
  - .2 Changes made by addenda and change orders.
- .3 Recording information:
  - .1 Record changes in red ink.
  - .2 Mark on one (1) set of drawings, specifications and shop drawings with changes during progress of work.
  - .3 Provide one (1) set of CDs in AutoCAD dwg. file format with all as-built information on the CDs.
  - .4 Submit all sets for the Departmental Representative.

#### **1.5 EQUIPMENT AND SYSTEMS**

- .1 Operating procedures - include the following:
  - .1 Start-up, break-in, and routine normal operating instructions and sequences.
  - .2 Regulation, control, stopping, shutdown, and emergency instructions.
  - .3 Summer, winter and any special operating instructions.
- .2 Provide servicing schedule required.
- .3 Include manufacturer printed operation and maintenance instructions.
- .4 Include sequence of operation by controls manufacturer.
- .5 Provide original manufacturer parts list, illustrations, assembly drawings and diagrams required for maintenance.
- .6 Provide installed control diagrams by controls manufacturer.
- .7 Additional requirements: as specified in individual specification Sections.

**1.6 MANUFACTURER DOCUMENTATION REPORTS**

- .1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and system, instruct Departmental Representative's indicated facility personnel and provide detailed written report that demonstration and instructions have been completed.
- .2 Departmental Representative will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed upon times.

**1.7 SPARE PARTS**

- .1 Provide spare parts in quantities specified in individual specification Sections.
- .2 Provide items of same manufacture and quality as items in work.
- .3 Deliver to on-site location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to the Departmental Representative. Include approved listings in maintenance manual.
- .5 Obtain receipt for delivered products and submit to Departmental Representative.

**1.8 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 Provide all software, licenses, interface and cabling devices required to setup or maintain all equipment as installed in this project, whether specifically requested or not. Software shall be fully operational and not time-limited or demonstration versions. All passwords, keys or hardware locks will be provided to the Owner.
- .4 Deliver to on-site location as directed; place and store.
- .5 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in maintenance manual.
- .6 Obtain receipt for delivered products and submit to Departmental Representative.

**1.9 WARRANTIES, BONDS, TEST REPORTS, INSPECTION REPORTS**

- .1 Obtain Warranties, Bonds, and Test Results, Inspection Reports executed in duplicate by subcontractors, suppliers, manufacturers and inspection agencies within 10 working days after completion of applicable item of work.
- .2 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until date of substantial performance is determined.
- .3 Verify that documents are in proper form, contain full information and are notarized.
- .4 Co-execute submittals when required.
- .5 Retain warranties and bonds until time specified for submittal.

**1.10 COMPLETION**

- .1 Submit written certificate that following have been performed:
  - .1 Work has been completed and inspected for compliance with Contract documents.
  - .2 Defects have been corrected and deficiencies have been completed.
  - .3 Equipment and systems have been tested and adjusted and are fully operational.
  - .4 Certificates required by BC Electrical Safety Authority has been submitted.
  - .5 Work is complete and ready for final inspection.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Procedures for demonstration and instruction of equipment and systems to Owner's personnel.

**1.2 RELATED SECTIONS**

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Section 01 91 13 – General Commissioning (Cx) Requirements.
- .3 Section 01 91 31 –Commissioning (Cx) Plan.
- .4 Section 01 91 33 – Commissioning: Forms.
- .5 Section 01 91 41 – Commissioning: Training.

**1.3 DESCRIPTION**

- .1 Demonstrate operation and maintenance of equipment and systems to Departmental Representative two weeks prior to date of final inspection.
- .2 Owner 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 Owner's 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 and each system two weeks prior to designated dates, for Departmental Representative's approval.
- .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 Manufacturer's recommendations.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.7 PREPARATION**

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

**1.8 DEMONSTRATION AND INSTRUCTIONS**

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals 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 manuals when the need for additional data becomes apparent during instructions.
- .5 Training and demonstration will be performed by manufacturers representative and will include actual interaction with all systems requiring software or computer interface.
- .6 There shall be multiple training sessions for several pieces of equipment, with the training oriented specifically to that audience. For example, maintenance procedures and training on the generator will be different for the mechanics than it would be for the electrical staff.

**1.9 TIME ALLOCATED FOR INSTRUCTIONS**

- .1 Contractor shall provide for a total of 5 working days of demonstration and training for all systems in the project, including but not limited to ( note that this does NOT include preliminary reviews or commissioning ):
  - .1 Primary Voltage Switchgear
  - .2 Primary Voltage Cables
  - .3 Transformers
  - .4 Protection Relays
  - .5 Air Circuit Breakers
  - .6 Moulded Case Circuit Breakers
  - .7 Digital Metering
  - .8 Generators and controls
  - .9 Transfer equipment, control and interface
  - .10 Digital Metering and Power Systems SCADA
  - .11 Resistive Load bank and associated controls

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 GENERAL****1.1 SUMMARY**

- .1 Section Includes:
  - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to Performance Verification of components, equipment, sub-systems, systems, and integrated systems.
- .2 Related Sections:
  - .1 Section 01 33 00 - Submittal Procedures
  - .2 Section 01 45 00 - Quality Control.
  - .3 Section 26 05 00 - Common Work Results - Electrical.
  - .4 Section 26 05 14 - Power Cables (1001V-27kV & 125VDC)
  - .5 Section 26 05 27 - Grounding – Primary
  - .6 Section 26 05 33 - Static Resistive Exterior Load Bank
  - .7 Section 26 05 44 - Installation of Cables in Trenches and Ducts
  - .8 Section 26 12 13 - Liquid Filled, Medium Voltage Transformers
  - .9 Section 26 13 18 - Primary Switchgear Assembly to 27kV
  - .10 Section 26 28 16 - Air Circuit Breakers
  - .11 Section 26 28 18 - Ground Fault Protection Equipment
  - .12 Section 26 28 21 - Moulded Case Circuit Breakers
  - .13 Section 26 29 05 - Protective Relays
  - .14 Section 26 29 23.01 - Digital Metering
  - .15 Section 26 32 10 - Diesel Electric Generating Units - Liquid Cooled
  - .16 Section 26 32 10-01 - Towable Diesel Generator
  - .17 Section 26 36 01 - Generator Switchboard to 600V
  - .18 Section 26 36 23 - Automatic Transfer Switches
  - .19 Section 26 36 23.01 - Manual Transfer Switches
- .3 Acronyms:
  - .1 AFD - Alternate Forms of Delivery, service provider.
  - .2 BMM - Building Management Manual.
  - .3 Cx - Commissioning.
  - .4 EMCS - Energy Monitoring and Control Systems.
  - .5 O&M - Operation and Maintenance.
  - .6 PV - Performance Verification.
  - .7 TAB - Testing, Adjusting and Balancing.
  - .8 CxA – Commissioning Authority.
  - .9 DC – Design Consultant.
  - .10 PWGSC – Public Works and Government Services Canada.

- .11 ECxC – Electrical Commissioning Coordinator.
- .12 MCxC – Mechanical Commissioning Coordinator.
- .13 QCM - .Quality control Manger.
- .14 ECA – Electrical Commissioning Agent.
- .15 MCA – Mechanical Commissioning Agent.
- .16 O&M – Operations and Maintenance.

## 1.2 REFERENCE

- .1 CSA Standards for Building Commissioning Z320-11.
- .2 ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.

## 1.3 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
  - .2 Ensure appropriate documentation is compiled into the BMM.
  - .3 Effectively train O&M staff.
- .2 Cx is to be performed by an independent third party professional Cx Agent(s) after work is completed and prior to energizing any equipment. The independent third party must have performed similar HV work for a minimum of 5 years. Qualifications of Cx Agent submitted by General Contractor shall be reviewed by Commissioning Authority and can only be hired after acceptance by Departmental Representative.
- .3 General Contractor to retain the services of an independent third party professional Cx Agent to carry out the tests and calibration as required herein. Testing Agency shall be familiar with NETA Standards as specified herein and shall have accreditation equivalent to a full NETA member company:
  - .1 This project shall only be undertaken by firms familiar with and having a long and demonstrable successful track record in the field of switchgear and transformer modification and installation, protection and control, and arc flash mitigation. The proponent shall be experienced in working with an industrial type primary voltage distribution system using parallel feeders. Provide documented experience on projects of this type.
  - .2 All protection settings must be reviewed by a Professional Engineer registered in British Columbia who is an employee of Cx Agency. Provide documentation naming this individual along with their credentials.
  - .3 All work must be performed by qualified technicians/electricians with applicable accreditation for the appropriate permitting required. Provide a list of all personnel and their qualifications.

- .4 Provide three references, including contact information for completed projects similar to this in scope and technical content.
- .5 Qualifications of the Cx Agency must be submitted and reviewed by Departmental Representative and only after acceptance will the Testing Agency be allowed to perform the work.
- .4 Furnish Independent Cx agency professional engineer's letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions. The letter is to be submitted stamped by a Professional Engineer, registered in BC, and provided to the Commissioning Authority.
- .5 Employ only personnel who are qualified and experienced in high voltage work. Personnel must be familiar with the equipment and procedures necessary to complete the work as specified herein.
- .6 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems must interact with each other as intended in accordance with Contract Documents and design criteria.
  - .2 During these checks, adjustments will be made to enhance performance to meet environmental or user requirements.
- .7 Design Criteria: as per client's requirements or determined by designer to meet Project functional and operational requirements.

#### **1.4 COMMISSIONING OVERVIEW**

- .1 Cx to be a line item of General Contractor's cost breakdown.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes the transfer of critical knowledge to facility operational personnel.
- .4 Complete all start-up and verification of systems prior to review by Commissioning Agent.
  - .1 To bring mechanical, electrical and building architectural systems and components from a state of static completion to a state of dynamic operation.
  - .2 To verify conformance to contract requirements.
  - .3 To confirm installations meet requirements of Contract Documents.
  - .4 To provide all testing documents and records.
  - .5 To ensure completed facility meets contract requirements.
  - .6 To provide a documented operator training program.
  - .7 To verify accuracy of project record drawings and operating and maintenance manuals.



- .5 Departmental Representative will issue Certificate of Substantial Completion when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Commissioning Authority.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M staff training has been completed.

## 1.5 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the un-functional system, including related systems as deemed required by Commissioning Authority, Commissioning Authority to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by General Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

## 1.6 PRE-CX REVIEW

- .1 Before Construction:
  - .1 Review contract documents, confirm by writing to Commissioning Authority.
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
  - .1 Co-ordinate provision, location and installation of provisions for Cx.
  - .2 Develop Commissioning Plan, checklists and test sheets for approval by Commissioning Authority.
- .3 Before start of Cx:
  - .1 Have completed Cx Plan up-to-date.
  - .2 Ensure installation of related components, equipment, sub-systems, and systems is complete.
  - .3 Fully understand Cx requirements and procedures.
  - .4 Have Cx documentation shelf-ready.
  - .5 Understand completely design criteria and intent and special features.
  - .6 Submit complete start-up documentation to Departmental Representative.
  - .7 Have Cx schedules up-to-date.
  - .8 Ensure systems have been cleaned thoroughly.
  - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
  - .10 Submit factory testing report of Electrical Equipment to Departmental Representative for review and approval.
  - .11 Ensure "As-Built" system schematics are available.

- .12 Conduct coordination and protection study of upstream breakers, as indicated in drawings, to determine if trip settings are adequate for additional demand. Determine trip setting adjustments and where required, re-set breaker parameters accordingly. The study shall be performed at both 12.5 kV and 25 kV distribution voltages.
- .13 Factory test each generator, transfer controller, transformer and switchgear assemblies and all accessories. Notify Commissioning Authority 7 days in advance of tests and confirm 2 days in advance. Commissioning Authority and Engineer will attend/witness tests. Tests must be conducted in the Lower Vancouver Island area of British Columbia. Alternatively, if tests are conducted elsewhere, pay the costs of travel time (at \$130/hour) and all travel/living expenses for two attendees (at actual cost) associated with Commissioning Authority and engineer's attendance at factory tests and at repeat tests if necessary.
- .4 Inform Commissioning Authority in writing of discrepancies and deficiencies on finished works.

## 1.7 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

## 1.8 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit no later than 4 weeks after award of Contract:
    - .1 Name of Contractor's Cx agent.
    - .2 Draft Cx documentation.
    - .3 Preliminary Cx schedule.
  - .2 Request in writing to Commissioning Authority for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
  - .3 Submit proposed Cx procedures to Commissioning Authority where not specified and obtain written approval at least 8 weeks prior to start of Cx.
  - .4 Provide additional documentation relating to Cx process required by Commissioning Authority, specifically;
    - .1 Cx Plan and Schedule
    - .2 Accepted Shop drawings
    - .3 Completed PI forms
    - .4 Approved TAB report
    - .5 Approved PV forms
    - .6 Approved O&M manuals
    - .7 Approved System and Integrated System Test Report
    - .8 Approved Factory testing reports

- .9 Approved Training and Attendance forms
- .10 Accepted "As-built" Plans and Specifications
- .11 Final Cx Report

## **1.9 COMMISSIONING DOCUMENTATION**

- .1 General Contractor to review and approve Cx documentation submitted by Cx Agent prior to submission to Departmental Representative for review.
- .2 The Commissioning Agent, with assistance from the appropriate contractors and vendors shall provide all proposed checklist and test sheets to the Commissioning Authority for review and approval prior to usage.
- .3 Provide completed and approved Cx documentation to Commissioning Authority.

## **1.10 COMMISSIONING SCHEDULE**

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart).
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
  - .1 Approval of Cx reports.
  - .2 Verification of reported results.
  - .3 Repairs, retesting, re-commissioning, re-verification.
  - .4 Training.

## **1.11 COMMISSIONING MEETINGS**

- .1 Convene Cx meetings following project meetings: Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart) and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart). General Contractor to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
  - .1 Review duties and responsibilities of General Contractor and subcontractors, addressing delays and potential problems.
  - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by General Contractor with their Commissioning Agent, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

**1.12 STARTING AND TESTING**

- .1 General Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

**1.13 WITNESSING OF STARTING AND TESTING**

- .1 Provide 14 days' notice prior to commencement.
- .2 Commissioning Authority to witness of start-up and testing.
- .3 General Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.
  - .1 Minimum of 5 years experience in design, installation and operation of equipment and systems.
  - .2 Ability to interpret test results accurately.
  - .3 To report results in clear, concise, logical manner.

**1.14 PROCEDURES**

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and general testing in following distinct phases
  - .1 Included in delivery and installation
    - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
    - .2 Visual inspection of quality of installation.
  - .2 Prior to start-up:
    - .1 Insulation resistance test and continuity test of all new cables and all cables with connections changed during construction
    - .2 All high voltage terminations tested with infrared imaging. Spot temperature readings are not acceptable.
    - .3 600V equipment shall be tested with infrared imaging while running full loading. Spot temperature readings are not acceptable.
    - .4 Refer to the NETA Acceptance Testing specifications for detailed commissioning requirements for the following equipment:
      - .1 Switchgear and Switchboard Assemblies
      - .2 Cables, Low Voltage, 600 volt maximum.
      - .3 Transformers, Liquid Filled
      - .4 Switches, Air, Low Voltage
      - .5 Circuit Breakers, Air, Insulated/Molded Case
      - .6 Circuit Breakers, Air, Low-Voltage Power
      - .7 Instrument Transformers
      - .8 Metering Devices, Microprocessor-Based
      - .9 Protective Relays, Microprocessor-Based

- .10 Motor Control, Motor Starters, Low-Voltage
  - .11 Grounding Systems
  - .12 Rotating Machinery, Synchronous Generators
  - .13 Emergency Systems, Engine Generator
  - .14 Emergency Systems, Automatic Transfer Switches
  - .5 Start-up: follow accepted start-up procedures.
  - .6 Operational testing: document equipment performance.
  - .7 System PV: include repetition of tests after correcting deficiencies.
  - .8 Post-substantial performance verification: to include fine-tuning.
- .3 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
- .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Generators: Load testing, transient stability, synchronizing and load shedding.
  - .6 Transfer Equipment: Open/closed transition switching; load shedding and reinstatement.
  - .7 Systems: fire alarm system communications.
  - .8 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Megger 600-2.4kV circuits, feeder and equipment with a 5000V instrument.
    - .4 Check resistance to ground before energizing.
- .4 Correct deficiencies and obtain approval from Commissioning Authority after distinct phases have been completed and before commencing next phase.
- .5 Document required tests on approved PV forms.
- .6 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Commissioning Authority. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
  - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Commissioning Authority.

- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
  - .1 Rejected equipment to be removed from site and replace with new.
  - .2 Subject new equipment/systems to specified start-up procedures.

#### **1.15 START-UP DOCUMENTATION**

- .1 Assemble start-up documentation and submit to Commissioning Authority for approval before commencement of commissioning.
  - .1 Start-up documentation to include:
    - .1 Factory and on-site test certificates for specified equipment.
    - .2 Pre-start-up inspection reports.
    - .3 Signed installation/start-up check lists.
    - .4 Start-up reports,
    - .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

#### **1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS**

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of Certificate of Substantial Performance.

#### **1.17 TEST RESULTS**

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

#### **1.18 START OF COMMISSIONING**

- .1 Notify Commissioning Authority at least 4 weeks prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

#### **1.19 INSTRUMENTS / EQUIPMENT**

- .1 Submit to Commissioning Authority for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, and calibration expiry date and calibration accuracy.

- .2 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.
  - .3 Equipment as required to complete work.
  - .4 Fuel for generators

## **1.20 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx:
  - .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
  - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 Power Systems SCADA trending to be available as supporting documentation for performance verification.

## **1.21 WITNESSING COMMISSIONING**

- .1 Departmental Representative to witness activities and verify results.

## **1.22 AUTHORITIES HAVING JURISDICTION**

- .1 Where start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Departmental Representative within 5 days of test and with Cx report.
- .4 Authorities having jurisdiction in this project include Township of Esquimalt and BC Safety Authority.

## **1.23 EXTRAPOLATION OF RESULTS**

- .1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Commissioning Authority in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

## **1.24 SUNDRY CHECKS AND ADJUSTMENTS**

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

**1.25 DEFICIENCIES, FAULTS, DEFECTS**

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Commissioning Authority.
- .2 Report problems, faults or defects affecting Cx to Commissioning Authority in writing. Stop Cx until problems are rectified. Proceed with written approval from Commissioning Authority.

**1.26 COMPLETION OF COMMISSIONING**

- .1 Upon completion of Cx, leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities, complete Cx prior to issuance of Certificate of Substantial Performance.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Commissioning Authority.

**1.27 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

**1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS**

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

**1.29 OCCUPANCY**

- .1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

**1.30 INSTALLED INSTRUMENTATION**

- .1 Use instruments installed under Contract for TAB and PV if:
  - .1 Accuracy complies with these specifications.
  - .2 Calibration certificates have been deposited with Commissioning Authority.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

**1.31 PERFORMANCE VERIFICATION TOLERANCES**

- .1 Application tolerances:
  - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.
- .2 Instrument accuracy tolerances:
  - .1 To be of higher order of magnitude than equipment or system being tested.



- .3 Measurement tolerances during verification:
  - .1 Unless otherwise specified actual values to be within +/- 2% of recorded values.

**1.32 OWNER'S PERFORMANCE TESTING**

- .1 Performance testing of equipment or system by Commissioning Authority will not relieve Contractor from compliance with specified start-up and testing procedures.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 SUMMARY**

- .1 Section Includes:  
This Section specifies roles and responsibilities of Commissioning Training.
- .2 Related Sections:
  - .1 General Commissioning Cx Requirements Section 01 91 13

**1.2 TRAINEES**

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Departmental Representative, building operators, maintenance staff, security staff, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

**1.3 INSTRUCTORS**

- .1 Commissioning Authority will provide:
  - .1 Descriptions of systems.
  - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
  - .1 Start-Up, operation, shut-down of equipment, components and systems.
  - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
  - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
  - .1 Start-up, operation, maintenance and shut-down of equipment they have installed and connected, after completion of static verification, start-up and functional performance testing.

**1.4 TRAINING OBJECTIVES**

- .1 Training to be detailed and duration to ensure:
  - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
  - .2 Effective on-going inspection, measurements of system performance.
  - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
  - .4 Ability to update documentation.
  - .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

## **1.5 TRAINING MATERIALS**

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
  - .1 "As-Built" Contract Documents.
  - .2 Operating Manual.
  - .3 Maintenance Manual.
  - .4 Management Manual.
  - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Authority and Departmental Representative will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement ARV training materials:
  - .1 Transparencies for overhead projectors.
  - .2 Multimedia presentations.
  - .3 Manufacturer's training videos.
  - .4 Equipment models.

## **1.6 SCHEDULING**

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be 8 hours in length.
- .3 Training to be completed prior to acceptance of facility.

## **1.7 RESPONSIBILITIES**

- .1 Be responsible for:
  - .1 Implementation of training activities,
  - .2 Coordination among instructors,
  - .3 Quality of training, training materials.
- .2 Commissioning Authority will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Commissioning Authority.

## **1.8 ELECTRICAL SYSTEM TRAINING**

- .1 Organize and conduct training courses to instruct the Departmental Representative in the operation and preventative maintenance of equipment and systems provided at the completion of the project.
- .2 Provide services of qualified personnel, including each sub-trade, each major equipment supplier and design engineer to and instruct on their equipment or systems.

- .3 One-person day shall be eight hours including one half hour for breaks, and one-person week shall be five person days.
- .4 Submit sessions schedule and list of representatives to the Commissioning Authority for approval 30 days prior to course starting date. Confirm attendance of course by written notification to all participants, followed by verbal confirmation just prior to course starting date.
- .5 Submit final copies of record drawings and operating and maintenance manuals to Commissioning Authority. Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.
- .6 Systems Course: Allow a minimum of 24 hours of instruction (three 8-hour training sessions) to conduct systems training courses addressing but not limited to the following topics:
  - .1 Site Civil Works, Manholes and Infrastructure.
    - .1 Review: Duct banks.
  - .2 Medium Voltage Cables, Transformers and Distribution Equipment.
    - .1 Review: Medium voltage cable installation, single line diagram and medium voltage distribution equipment.
    - .2 Review: transformer inspection and maintenance requirements; operations; interlocking.
  - .3 Medium Voltage Protection and Control, Metering and SCADA Systems.
    - .1 Review: Protective relays, metering systems, SCADA systems maintenance and operation.
  - .4 Low Voltage Distribution Systems.
    - .1 Review: Switchboards, breakers, transformers, grounding and bonding.
  - .5 Low Voltage Distribution Systems – Specialized Equipment.
    - .1 Review: Transfer switches, transfer controller and controlled breakers.
  - .6 Communications Systems:
    - .1 Review SCADA systems infrastructure, distribution, and software.
  - .7 Power Metering Systems:
    - .1 Review system design and infrastructure.
    - .2 Review system programming, data capture and troubleshooting.
    - .3 Review of HMI screens, trending functions, alarm operations.
    - .4 Refer to Section 26 29 23.02 for additional requirements.

- .8 Diesel Generators and associated equipment
  - .1 Review operation of systems and equipment.
  - .2 Review of settings and adjustment.
  - .3 Review of control software and programming setup.
  - .4 Review and demonstrate basic maintenance and troubleshooting.
- .9 Resistive Load-bank
  - .1 Review operation of systems and equipment.
  - .2 Review of settings and adjustment.
  - .3 Review regular maintenance requirements.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-2015, Canadian Electrical Code, Part 1 (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
  - .2 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.2 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

**1.3 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.
  - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .5 Submit copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction.

- .6 If changes are required, notify Departmental Representative of these changes before they are made.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control. Provide CSA certified equipment and material.
  - .1 Where CSA certified material is not available, submit such material to authority having jurisdiction for special approval before delivery to site.
  - .2 Submit test results of installed electrical systems and instrumentation.
  - .3 Permits and fees: in accordance with General Conditions of contract.
  - .4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .4 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

## 1.5 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid "FSR-A" Contractor license or apprentices in accordance per the conditions of Provincial Act respecting manpower vocational training and qualification.
- .3 Site Meetings:
  - .1 In accordance with Section 01 32 17 - Construction Progress Schedule - Bar (GANTT) Charts.
  - .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.
    - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of Work, after cleaning is carried out.
- .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## 1.7 SYSTEM STARTUP

- .1 Instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

## **1.8 OPERATING INSTRUCTIONS**

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
  - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  - .3 Safety precautions.
  - .4 Procedures to be followed in event of equipment failure.
  - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

## **Part 2 Products**

### **2.1 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

### **2.2 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of inspection authorities.
- .2 Decal signs, minimum size 175 x 250 mm.

### **2.3 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

### **2.4 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core.
  - .2 Sizes as follows:



**NAMEPLATE SIZES**

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

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

**2.5 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

**2.6 CONDUIT AND CABLE IDENTIFICATION**

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .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 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

**2.7 FINISHES**

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

**Part 3 Execution****3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

**3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

**3.3 CONDUIT AND CABLE INSTALLATION**

- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

**3.4 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

**3.5 CO-ORDINATION OF PROTECTIVE DEVICES**

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

**3.6 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems.
  - .5 Insulation resistance testing:

- .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
  - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
  - .3 Megger 5001-25kV circuits, feeders and equipment with a 5000 V instrument.
  - .4 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
  - .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
  - .5 Manufacturer's Field Services:
    - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
    - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
    - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.7****CLEANING**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

**END OF SECTION**

**Part 1      General**

**1.1      SECTION INCLUDES**

- .1      This section specifies materials and installation for seismic restraint systems for electrical installations.

**1.2      REGULATORY REQUIREMENTS**

- .1      Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.
- .2      The Seismic Engineer shall be able to provide a proof of professional insurance and the related practice credentials, upon request. The Seismic Engineer shall be familiar with SMACNA, ECABC & NFPA guidelines as well as the BC Building Code requirements.
- .3      The Contractor's Seismic Engineer shall submit original signed BC Building Code "Letters of Assurance" "Model Schedules S-B and S-C" to the Prime Consultant or Electrical Consultant.
- .4      The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

**1.3      SCOPE**

- .1      It is the responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.
- .2      Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.
- .3      Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.
- .4      The total electrical seismic restraint design and field review and inspection will be by a B.C. registered professional structural engineer who specializes in the restraint of building elements. Contractor to allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This Engineer, herein referred to as the Seismic Engineer, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.
- .5      The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.
- .6      The Seismic Engineer shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.

- .7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.
- .8 The Seismic Engineer shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.
- .9 Include all costs associated with the Seismic installation and certification in the base tender.

#### **1.4 SHOP DRAWINGS & SUBMITTALS**

- .1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic Engineer.
- .2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Engineer.

#### **Part 2 Products**

##### **2.1 SLACK CABLE SYSTEMS**

- .1 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90° to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45° to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45° pull.
- .2 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the engineer and inspection authority having jurisdiction.
- .3 Coordinate requirements of slack cables with suppliers prior to installation.

#### **Part 3 Execution**

##### **3.1 GENERAL**

- .1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

##### **3.2 CONDUITS**

- .1 Provide restraint installation information and details on conduit and equipment as indicated below:
- .2 Vertical Conduit:
  - .1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring.

- Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.
- .2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m [30 ft] o.c.
  - .3 Riser joints shall be braced or stabilized between floors.
- .3 Horizontal Conduits:
- .1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
  - .2 EMT tubing - tubing shall be supported at approximately 1.2 m [4 ft] intervals for tubing.
  - .4 Provide transverse bracing at 12.2 m [40 ft] intervals maximum unless otherwise noted. Provide bracing at all 90° bend assemblies, and pull box locations.
  - .5 Provide longitudinal bracing at 24.4 m [80 ft] intervals maximum unless otherwise noted.
  - .6 Do not brace conduit runs against each other. Use separate support and restraint system.
  - .7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.
  - .8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.
  - .9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
  - .10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.
  - .11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic Engineer and submit shop drawings to consultants for their reference.

### 3.3 FLOOR/SLAB MOUNTED EQUIPMENT

- .1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment that may be subject to resonances, use a nominal 1.0 g seismic force.
- .2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

**END OF SECTION**

**Part 1 General****1.1 DESCRIPTION**

- .1 The purpose of this section is to guide the electrical contractor with responsibilities in the commissioning process, which are being directed by the Commissioning Authority. Other electrical systems testing is as specified in other electrical sections.
- .2 Commissioning requires the participation of the Electrical Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in the Commissioning Authority's Commissioning Plan. The Electrical Contractor shall be familiar with all parts of the commissioning plan issued by the Commissioning Authority, and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- .3 Electrical systems requiring testing and commissioning include the following:

	Commission for Commissioning Authority	Commission Under General Contract
.1 Transformers	Yes	Yes
.2 Generators and controls	Yes	Yes
.3 Transfer Equipment	No	Yes
.4 Distribution equipment	No	Yes
.5 Digital Metering System and SCADA	Yes	Yes
.6 Resistive Loadbank	No	Yes
.7 DC Emergency Lighting	No	Yes

**1.2 RESPONSIBILITIES**

- .1 Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows (*all references apply to commissioned equipment only*):
- .1 Construction and Acceptance Phases
- .1 Include the cost of commissioning in the contract price.
- .2 In each purchase order or subcontract written, include requirements for submittal data, O&M data, and training.
- .3 Attend a commissioning scoping meeting and other necessary meetings scheduled by the Commissioning Authority to facilitate the commissioning process.
- .4 Electrical shop drawings to be reviewed by the Consultants and forwarded to the Commissioning Authority via the Architect.
- .5 Provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Authority for development of start-up and functional testing procedures.

- .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, performance expectations, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  - .2 The Commissioning Authority may request further documentation necessary for the commissioning process.
  - .3 This data request may be made prior to normal submittals.
  - .4 Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, to the Consultant, who will review and reject or approve, then forward the approved manual to the Commissioning Authority for review and approval.
  - .5 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - .6 Provide to the Consultant and the Commissioning Authority the specific functional performance test procedures required for the commissioning. Subs shall review test procedures to ensure feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.
  - .7 Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to Commissioning Authority for review.
- .6 Conduct and Record Equipment and System Commissioning:
- .1 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present in accordance with the agreed-upon schedules, and for sufficient duration, to complete the necessary tests, adjustments and problem solving.
  - .2 During the startup and initial checkout process, execute and document the electrical-related portions of the pre-functional checklists for all commissioned equipment.



- .3 Perform and clearly document all completed startup and system operational checkout procedures, and provide a completed and signed copy to the Consultant and the Commissioning Authority.
  - .4 Address current A/E punch list items before functional testing.
  - .5 Perform functional performance testing under the direction of the Consultant and the Commissioning Authority for the specified equipment. Assist the Consultant and Commissioning Authority in interpreting the monitored data and test results, as necessary.
  - .6 Correct deficiencies (differences between specified and observed performance) as interpreted by the Consultant and the Commissioning Authority, PM and A/E and retest the equipment.
  - .7 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original equipment, performance and sequences of operation to as-built conditions.
  - .8 Prepare red-line, as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
  - .9 Provide training of the Owner's operating personnel as specified.
  - .10 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - .11 Prior to Final Completion of the Work, the responsible contractors shall certify that they have provided all the materials, installation and/or services specified in the Contract Documents, Addendums and Change Orders. Completion of the following sheet, with signatures of the contractually responsible parties, is required and represents such certification.
- .2 Warranty Period
    - .1 Execute seasonal or deferred functional performance testing, witnessed by the Commissioning Authority, according to the specifications.
    - .2 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## Part 2 PRODUCTS

### 2.1 TEST EQUIPMENT

- .1 The Electrical Contractor shall provide all test equipment necessary to fulfil the testing requirements of this Division.

**Part 3 EXECUTION****3.1 SUBMITTALS**

- .1 The Electrical Contractor shall provide the required commissioning submittal documentation to the Consultant and the Commissioning Authority, as indicated and requested by the Commissioning Authority.

**3.2 STARTUP**

- .1 The electrical contractors shall follow the start-up and initial checkout, as approved by the Commissioning Authority. The Electrical Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design and performance objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the Commissioning Authority. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

**3.3 FUNCTIONAL PERFORMANCE TESTS**

- .1 Perform function performance tests for all electrical systems.

**3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS**

- .1 Provide testing documentation as required by the Consultant and Commissioning Authority.
- .2 Collect shop drawings for equipment, maintenance procedures and recommended maintenance schedules for equipment, switchgear schedules, and warranties from all contractors.
- .3 Compile 3 copies of all the items mentioned in the preceding sentence. Enclose these in labelled 3-ring binders. Submit 3 copies to Consultant for review. Make modifications until consultant and Commissioning Authority approve these O&M Manuals.

**3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS**

- .1 The Electrical Contractor shall compile and prepare documentation for all equipment and systems covered in the Electrical contract for inclusion in the O&M manuals.
- .2 The Commissioning Authority shall receive a copy of the O&M manuals (after approval by the Consultant) for review.

**3.6 TRAINING OF OWNER PERSONNEL**

- .1 The Commissioning Authority and the Consultant and shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment or systems.

- .2 Electrical Contractor. The electrical contractor shall have the following training responsibilities:
- .1 Provide the Commissioning Authority with a training plan two weeks before the planned training.
  - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - .3 Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, are required. More than one party may be required to execute the training.
  - .6 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - .7 Training shall include:
    - .1 Use the printed installation, operation, and maintenance instruction material included in the O&M manuals.
    - .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance; special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover, and any emergency procedures.
    - .3 Discuss relevant health and safety issues and concerns.
    - .4 Discuss warranties and guarantees.
    - .5 Cover common troubleshooting problems and solutions.
    - .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
    - .7 Discuss any peculiarities of equipment installation or operation.
    - .8 Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and maintenance of all pieces of equipment.
    - .9 The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.

- .8 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 National Electrical Manufacturers' Association (NEMA)/Insulated Cable Engineers Association (ICEA)
  - .1 ICEA S-93-639/NEMA WC74-06, 5-46 KV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Provide manufacturer's printed product literature, specifications, data sheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 CONCENTRIC NEUTRAL POWER CABLES (5001 - 25000 V)**

- .1 Concentric neutral power cable: to ICEA S-93-639/NEMA WC74.
- .2 Single copper conductor, size as indicated.
- .3 Semi-conducting strand shield.
- .4 Compact round stranding.
- .5 Insulation: cross-linked thermosetting polyethylene material rated 90 degrees C and 25 kV for 100 % voltage level.
- .6 Semi-conducting insulation shielding layer.
- .7 Copper neutral wires applied helically over insulation shield equivalent to 33 % full capacity.
- .8 Separator tape over neutral wires.
- .9 Extruded PVC jacket rated minus 40 degrees C.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install power cable in ducts and manholes as indicated and in accordance with manufacturer's instructions.
- .2 Provide supports and accessories for installation of high voltage power cable.
- .3 Install stress cones, terminations and splices in accordance with manufacturer's instructions
- .4 Install grounding in accordance with local inspection authority having jurisdiction.
- .5 Provide cable identification tags and identify each phase conductor of power cable.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Use of qualified tradespersons for installation, splicing, termination and testing of high voltage power cables.
- .3 Engage an independent testing agent to test high voltage power cable. Submit test result and inspection certificate.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies the materials and installation for wire and box connectors, rated to 1000V.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2 No.18 latest edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2 No.65 latest edition, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2, latest edition, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

**Part 2 Products****2.1 MATERIALS**

- .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
  - .1 Connector body and stud clamp for stranded copper conductors.
  - .2 Clamp for stranded copper conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors.
  - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2 No.18.

**Part 3 Execution****3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2 Install mechanical pressure type connectors and tighten screws. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .3 Install fixture type connectors and tighten. Replace insulating cap.
  - .4 Install bushing stud connectors in accordance with NEMA.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        This section specifies copper conductors rated 0-1000 Volts and the most common electrical insulation and covering materials.
- .2        This section does not include fire rated building wire to ULC S139 and CSA C83, marine, hazardous, mining, instrumentation, communication and fire alarm wiring.

**1.2                REFERENCES**

- .1        CSA C22.2 No .0.3 latest edition, Test Methods for Electrical Wires and Cables.
- .2        CAN/CSA-C22.2 No. 131 latest edition, Type TECK 90 Cable.

**1.3                GENERAL REQUIREMENTS**

- .1        Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.
- .2        Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.
- .3        Flexible AC90 armoured cabling (BX) shall not be used for the general wiring system other than final drops to recessed light fixtures in concealed locations.
- .4        Provide all control wiring except HVAC controls as specified in Mechanical Divisions.
- .5        Refer to Equipment Schedule(s) for detailed responsibilities.

**Part 2            Products**

**2.1                WIRE AND CABLE GENERAL**

- .1        Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.
- .2        Insulation to be 600 volt RW90XLPE (X link) for the general building wiring in conduit.
- .3        Use RW90XLPE for underground installations.
- .4        Increase wiring size for lengthy and/or loaded circuits so that system will not exceed the maximum voltage drop as recommended by the Canadian Electrical Code CSA 22.1, latest edition.
- .5        Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.
- .6        Armoured AC90 (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. Use anti-short connectors. Cable from luminaire to luminaire is discouraged. Allow nominally 900mm extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.
- .7        TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes.
- .8        Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8



gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors not to be painted.

## **2.2 TECK CABLE**

- .1 Cable: to CAN/CSA-C22.2 No. 131 latest edition.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
  - .1 Type: ethylene propylene rubber.
  - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking galvanized steel or aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 1000 mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
  - .1 Watertight approved for TECK cable.

## **2.3 ARMoured CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.

## **2.4 CONTROL CABLES**

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with TWH over each conductor and overall covering of PVC jacket.
- .3 600 V type: stranded copper conductors, sizes as indicated with R90 (x-link) ethylene-propylene rubber insulation type over each conductor and overall covering of PVC jacket.

**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 In underground ducts in accordance with Section 26 05 34.
  - .3 All wires are to be pulled in together in a common raceway, using liberal amounts of lubricant.
  - .4 No combining of circuits onto common neutral will be permitted. Use 2 pole or 3 pole breakers for combined circuits, no connector clips will be allowed.
  - .5 Ensure that all single phase loadings are reasonably closely balanced over the main feeders.

**3.2 INSTALLATION OF TECK CABLE 0 -1000 V**

- .1 Install cables.
  - .1 Group cables wherever possible on channels or in cable trays.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

**3.3 INSTALLATION OF ARMoured CABLES**

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

**3.4 INSTALLATION OF CONTROL CABLES**

- .1 Control cable and conduit will be supplied and installed by Mechanical Contractor. Controls wiring must be installed in conformance with Electrical Specifications. Install control cables in conduit.
- .2 Ground control cable shield.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for connectors and terminations.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

**1.4 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal all packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative

**Part 2 Products**

**2.1 CONNECTORS AND TERMINATIONS**

- .1 Copper long barrel compression connectors to CSA C22.2 as required sized for conductors.
- .2 Stress cones shall be factory-made hot or cold shrink, rated for voltage and insulation systems as noted. Tape or field build up stress cones or terminations will not be accepted.
- .3 Dead break style elbow terminations shall be complete with all required and indicated accessories for a complete and functional termination. Only 600 amp size deadbreak elbows shall be used, along with corresponding connections on equipment; 200 amp elbows shall not be used.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2 No.41.
- .3 Test all stress cones as part of cable testing.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE 837-02, Qualifying Permanent Connections Used in Substation Grounding.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Quality assurance submittals: provide in accordance with Section 01 45 00 - Quality Control.
  - .1 Manufacturer's Instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, cleaning procedures.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Conductors: bare, stranded soft annealed copper wire, size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.
- .2 Conductors: bare, pvc insulated coloured green, stranded soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
- .3 Conductors: pvc insulated coloured green, stranded soft annealed copper wire No. 10 AWG for grounding meter and relay cases.
- .4 Bolted removable test links.
- .5 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Bonding jumpers, straps.
  - .5 Pressure wire connectors.

- .6 Wire connectors and terminations: as indicated.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install continuous grounding system including, electrodes, conductors, connectors and accessories as indicated and to requirements of local authority having jurisdiction.
- .2 Install connectors and irreversibly connect in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors during and after construction. Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermite process or permanent mechanical connectors to ANSI/IEEE 837.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Use No. 4/0 AWG bare copper cable for main ground bus of substation and No. 2/0 AWG bare copper cable for taps on risers from main ground bus to equipment.

#### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections as indicated to typical station equipment including: metallic water main, line sky wire, neutral, gradient control mats. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cut-out bases. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. Sub-station fences, pothead bodies. Outdoor lighting.
- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.
- .3 Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station.

#### **3.3 NEUTRAL GROUNDING**

- .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.
- .2 Interconnect electrodes and neutrals at each grounding installation.
- .3 Connect neutral of generator transformer to ground bus with tap of same size as secondary neutral.
- .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.

#### **3.4 GROUNDING IN MANHOLES**

- .1 Install conveniently located grounding stud, electrode with copper conductor in each manhole. Install ground rod with lug for grounding connection in each manhole so that top projects through bottom of manhole.

**3.5 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect grounding equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 EQUIPMENT**

- .1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .2 Insulated grounding conductors: green, copper conductors, size as indicated.
- .3 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Bonding jumpers, straps.
  - .5 Pressure wire connectors.



**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermite process or permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .8 Connect building structural steel and metal siding to ground by welding copper to steel.
- .9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

**3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral.

**3.4 EQUIPMENT GROUNDING**

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

**3.5 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

- .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 installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 This section specifies U shape support channels.

**Part 2 Products**

**2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41mm, 2.5mm thick, surface mounted, suspended, or set in poured concrete walls and ceilings.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Secure equipment to poured concrete with expandable inserts.
- .2 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .5 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at 1.5m on centre spacing.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies materials and installation for splitters, junction boxes, pull boxes and cabinets.

**1.2 PRODUCT DATA**

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings for custom manufactured items showing materials, finish, dimensions, accessories, layout, and installation details.

**Part 2 Products****2.1 SPLITTERS**

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

**2.2 JUNCTION AND PULL BOXES**

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

**2.3 CABINETS**

- .1 Sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood backboard (if required) for surface or flush mounting as required.
- .2 Include filtered vents and/or fan-cooling when enclosed equipment is heat producing.

**Part 3 Execution****3.1 SPLITTER INSTALLATION**

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

**3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal blocks as required.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

**3.3 IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 20 05 00 – Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase, as appropriate to clearly indicate the enclosure use.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies rigid and flexible fasteners, fittings and installation.

**Part 2 Products****2.1 OUTLET AND CONDUIT BOXES - GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

**2.2 SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. Larger 102 mm square x 54mm deep outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.
- .2 For larger boxes use GSB solid type as required.
- .3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.
- .4 Lighting fixture outlets: 102 mm square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).
- .5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

**2.3 SURFACE CONDUIT BOXES**

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

**2.4 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 35 mm. Use pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution****3.1 INSTALLATION**

- .1 Typical outlet box mounting heights are indicated in Section 26 05 00 or refer to wiring device and communication specification sections and to architectural layouts for particular mounting heights of outlet boxes where indicated.
- .2 Support boxes independently of connecting conduits.

- .3 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.
- .4 Fill open boxes with paper, sponges, foam or similar approved material to prevent entry of construction material. Remove upon completion of work.
- .5 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not to be used.
- .7 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.
- .8 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.
- .9 No sectional or handy boxes to be installed.
- .10 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.
- .11 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.
- .12 Outlets installed back to back in party stud walls to be off-set by one stud space.
- .13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.
- .14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.
- .15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

**END OF SECTION**

**Part 1 General****1.1 SCOPE OF WORK**

- .1 This specification contains the requirements for a fixed, resistive AC load bank with variable load steps and automatic controls.

**Part 2 PRODUCTS****2.1 RATINGS**

- .1 The total capacity of the load bank shall be 1000KW at 600 Volts, 3 Phase. 60 Hertz, with 1000 amps per phase with unity power factor with 50KW minimum load step resolution.
- .2 The duty cycle shall be continuous and the load bank shall operate in an ambient temperature of -28°C to 49°C.

**2.2 CONSTRUCTION**

- .1 The load bank shall be constructed of heavy gauge aluminized steel per ASTM A463 or coated mild steel that meets or exceeds physical and chemical performance of polyurethane enamel coatings. Galvanized steel has a low corrosion threshold and shall not be used for exterior load bank construction.
- .2 The main input load bus, load step relays, fuses and blower/control relays shall be located within the load bank enclosure. A thermostatically controlled heater shall be located within the control section to protect control devices from the effects of moisture and condensation.
- .3 The load bank shall be outdoor weatherproof construction. All exterior fasteners shall be stainless steel. The load bank shall include forklift channels in the base for lifting. Mounting provisions shall be included for securely affixing the load bank to a concrete base.
- .4 For maximum protection and reliability in an outdoor environment, airflow shall be horizontal screened air intake and fixed louver shall be provided at the exhaust.
- .5 The exterior of the load bank shall be painted with polyurethane enamel paint at a minimum 2 MILS dry film thickness with a spatter finish.
- .6 Load elements shall be contained in one or more resistor cases or trays. Each can be removed in their entirety as a unit if service becomes necessary.

**2.3 RESISTIVE LOAD ELEMENTS**

- .1 Load elements shall be helically wound chromium alloy de-rated to operate at approximately 50% of maximum continuous rating of the wire. Elements must be fully supported across the entire length within the air stream by segmented ceramic insulators on a stainless steel rod. Element supports will be designed that should a wire break, it will not short to adjacent conductors or to ground.
- .2 The change in resistance due to temperature shall be minimized by maintaining conservative watt densities. The overall tolerance of the load bank shall be -0% to +5% KW at rated voltage. A -5%, +5% rating allows the load bank to deliver less than rated KW and shall not be used. The load bank must deliver rated KW at rated voltage.
- .3 A minimum of 20 load steps shall be provided.



**2.4 COOLING**

- .1 The load bank shall be cooled by an integral TEFC motor which is direct coupled to the cooling fan blade. The fan motor must be electrically protected against overload using a motor overload device and short circuit protected using three (3) current limiting fuses with an interrupting rating of 200K A.I.C.
- .2 The fan motor must be rigidly supported by formed steel or structural members which attach to the frame of the load bank.

**2.5 PROTECTIVE DEVICES**

- .1 A differential pressure switch shall be provided to detect air loss. The switch shall be electrically interlocked with the load application controls to prevent load from being applied if cooling air is not present.
- .2 An overtemperature switch shall be provided to sense the load bank exhaust. The switch shall be electrically interlocked with the load application controls to prevent load from being applied.
- .3 To provide for major fault protection, branch fuses shall be provided on all three phases of switched load steps above 50KW. Branch fuses shall be current limiting type with an interrupting rating of 200K A.I.C.
- .4 The exterior of the load bank shall have appropriate warning/caution statements on access panels.

**2.6 CONTROL PANEL**

- .1 The control panel shall be a remote mounted panel designed for indoor use. It shall contain a power ON/OFF switch, a power ON indication light, blower START/STOP pushbuttons, Blower ON light, and blower FAILURE light. Load selection shall include a master load ON/OFF switch and individual load step switches (one for each load step).
- .2 In the event of a legitimate utility failure, load bank shall do one of two things (dependant on position of selector switch);
  - .1 Load dump. When utility failure occurs and load bank is in use, all load bank loads are released.
  - .2 Load Regulate. When utility failure occurs, load bank will add load to maintain total generator loading (sum of building loads and load bank loads) to a prescribed power band.
- .3 The control panel shall contain a digital metering assembly that will connect via Ethernet TCP using ION, ModBUS or a similar communications protocol to provide metering status, loading, and remote control of the load bank to the SCADA system.

**2.7 QUALITY CONTROL**

- .1 The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohm value. These test results shall be supplied as part of the closeout submittals. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame. Tests of all safety circuits shall be performed to verify conformance to the specification.
- .2 The Load Bank Shall Be c U.L. Listed.

**Part 3**

**EXECUTION**

- .1 The load bank shall be securely mounted to the cast in place concrete slab as noted. Mounting means shall be designed and signed off by the contractor's Seismic Engineer.
- .2 Connect all conduits to control and power sources.
- .3 Mount remote load bank control panel in SES. Connect to load bank with control wiring as required by manufacturer for control of fans, all elements, feedback, faults, metering and status indication.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies rigid and flexible conduits, fasteners, fittings and installation.

**1.2 REFERENCES**

- .1 Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware: to CSA C22.2 No. 18.
- .2 Rigid metal conduit (RMC): to CSA C22.2 No. 45.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit (FMC): to CSA C22.2 No. 56.

**1.3 BASIC WIRING METHODS**

- .1 Underground or in concrete exterior to building:
  - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .2 Concrete walls and slabs interior to building:
  - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .3 Partition walls and ceilings:
  - .1 All wiring to be run in EMT conduit for:
    - .1 Branch circuits.
    - .2 Fire alarm.
    - .3 Low voltage systems.
    - .4 Distribution feeders and sub-feeders.
    - .5 Surface wiring in electrical and mechanical rooms.
- .4 Motors, transformers and all vibrating equipment:
  - .1 Short (600mm to 1200mm) PVC jacketed flexible conduit with liquid tight connectors shall be used. Allow sufficient slack to avoid strain on connectors at extreme extension of equipment movement.
- .5 Surface raceways - interior:
  - .1 All surface raceways shall be EMT, except if located without protection in areas susceptible to damage, which shall be rigid steel conduit.
- .6 Surface raceways - exterior:
  - .1 All surface raceways shall be UV compensated Schedule 40 RPVC conduit, protected from damage and excessive heating to the Consultant's satisfaction.

**1.4 LOCATION**

- .1 Electrical drawings are diagrammatic and do not show all conduits, wire, cable, etc. Electrical contractor to provide conduit, wire cable, etc., for a complete operating job to meet in all respects the intent of the drawings and specifications.
- .2 Outlet positions shown on architectural drawings (plans and elevations) to take precedence over locations and mounting heights indicated on electrical plans or in specifications.

- .3 Locate electrical devices on walls with regard given for convenience of operation and conservation of wall space. Switches, receptacles, fire alarm pull stations, etc. generally to be vertically lined up where items are in the same general location. Adjacent common devices to be installed in common outlet box.
- .4 Review the exact location criteria of each electrical outlet and device with the Architect and Consultant prior to rough-in. Relocate any item installed without architectural confirmation as required by the architect or Consultant at no cost to the owner as long as the relocation is within 3m of the location originally shown on the electrical drawings.
- .5 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.
- .6 All outlets located on exterior walls to be complete with moulded plastic vapour barriers to maintain integrity of wall vapour barrier system.
- .7 All raceways and wiring shall be installed concealed in building fabric, except for mechanical and electrical rooms where they shall be installed on the surface.
- .8 All outlet boxes, junction boxes, and cabinets to hold electrical devices shall be mounted so the equipment can be flush mounted unless indicated otherwise.
- .9 All junction boxes and other raceway access devices shall be mounted to avoid being visible from public areas. Obtain approval from Architect or Consultant for any and all junction boxes that, due to the building design, cannot be concealed.
- .10 All junction boxes mounted, out of necessity, on surface of solid walls shall be painted to match adjacent surface, with junction boxes painted to match designated systems.

## **Part 2 Products**

### **2.1 RIGID PVC RACEWAY SYSTEM**

- .1 Rigid PVC fittings shall be of the same manufacturer as the conduit.
- .2 PVC boxes and covers shall be "F" Series or equivalent complete with all components and adaptors.
- .3 PVC junction boxes exceeding the size of "F" Series shall be "JB" Series boxes and be complete with junction box adaptors.
- .4 All fittings with removable covers shall be complete with VC gaskets and brass securing screws and inserts. All metal components shall be brass or stainless steel.
- .5 All Rigid PVC conduit installed below grade or in a duct bank shall use long radius, "street" type bends with bending radius of 750mm minimum.

### **2.2 EMT RACEWAY**

- .1 Electrical Metallic Tubing (EMT) shall be galvanized steel of sufficient quality and thickness to allow smooth field formed bends.
- .2 EMT couplings, connectors and fittings shall be steel. Cast type units shall not be used on this installation.

### **2.3 PVC JACKETED FLEXIBLE CONDUIT**

- .1 PVC jacketed flexible conduit (liquid tight) shall be interlocking spiral aluminum conduit with continuous extruded PVC jacket.

- .2 Conduit fittings shall be steel liquid tight type that fit over PVC jacket and seal uniformly all round.

## 2.4 FLEXIBLE ELECTRIC NON-METALLIC (ENT) TUBING

- .1 Flexible electrical non-metallic tubing (ENT) **shall not** be used on this project.

## 2.5 OUTLET BOXES AND JUNCTION BOXES

- .1 Except as noted for rigid PVC raceways, all outlet boxes and junction boxes shall be one piece formed or welded.
- .2 Outlet boxes to be galvanized steel.
- .3 Junction boxes to be galvanized steel or aluminum.

## 2.6 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1500mm oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

## 2.7 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

## 2.8 FISH CORD

- .1 Polypropylene.

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.
- .4 Use rigid PVC conduit underground, in corrosive areas, and surface mounted in wet areas not subject to damage.
- .5 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19mm.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

- .9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .10 Install fish cord in empty conduits.
- .11 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .12 Dry conduits out before installing wire.
- .13 Conduits shall be installed mechanically continuous from outlet to outlet and without pockets. All the necessary standard bushings, elbows and bends shall be provided. All conduit bends shall have a radius of not less than six (6) times the internal diameter of the conduit and in no case shall the equivalent of more than four quarter bends from outlet to outlet be made. For all conduit sizes to be used for low voltage raceway, the conduits shall have a minimum bending radius of 230mm.
- .14 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.
- .15 On surface wall runs, all conduit shall be installed in true vertical or horizontal direction and on ceilings in true 90 degree angles or parallel to the walls. Crossings of conduits shall also be made at 90 degree angles. Parallel running conduit shall be kept on equal spacing on the entire length of run including bends.
- .16 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).
- .17 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all manufacturer's fittings to secure channel to structure and to conduit.
- .18 Raceways extending out concrete slabs shall be securely protected using rebar stubs or similar material. All duct stubs are to be kept sealed during construction

### **3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Run conduits in flanged portion of structural steel.
- .3 Group conduits wherever possible on suspended or surface channels.
- .4 Do not pass conduits through structural members except as indicated.

### **3.3 CONCEALED CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

### **3.4 CONDUITS IN CAST-IN-PLACE CONCRETE**

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.

- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

**3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE**

- .1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.
- .2 Do not install conduits in slabs/concrete floors in lab areas.

**3.6 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC accepted) with heavy coat of bituminous paint.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            This section specifies wireways, auxiliary gutters and associated fittings and installation.

**1.2                REFERENCES**

- .1            Canadian Standards Association (CSA International)
  - .1            CSAC22.2No.26-R1999, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

**1.3                PRODUCT DATA**

- .1            Submit product data in accordance with Section 26 05 00 Common Work Results - Electrical.

**Part 2            Products**

**2.1                WIREWAYS**

- .1            Wireways and fittings: to CSA C22No.26.
- .2            Sheet steel with hinged and latched cover to give uninterrupted access.
- .3            Finish: baked grey enamel.
- .4            Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1            Install wireways and auxiliary gutters.
- .2            Keep number of elbows, offsets, connections to minimum.
- .3            Install supports, elbows, tees, connectors, fittings.
- .4            Install barriers where required.
- .5            Install gutter to full length of equipment.

**END OF SECTION**



**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 This section specifies the installation of direct buried cables and cables in ducts including protection, markers and testing.

**1.2 REFERENCES**

- .1 Canadian Standards Association, (CSA International)
- .2 Insulated Cable Engineers Association, Inc. (ICEA)

**Part 2 Products**

- .1 Not Applicable.

**Part 3 Execution**

**3.1 CABLE INSTALLATION IN DUCTS**

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

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
  - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour and conductors not under test.

- .3 High Potential (Hipot) Testing.
  - .1 Conduct hipot testing at 90% of original factory test voltage in accordance with manufacturer's recommendations.
- .4 Leakage Current Testing.
  - .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
  - .2 Hold maximum voltage for specified time period by manufacturer.
  - .3 Record leakage current at each step.
- .7 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

**Part 1 General****1.1 RELATED WORK**

- .1 Installation of anchors: Section 26 05 01

**1.2 REFERENCES**

- .1 CAN/CSA-C88-M90 (R2009) Power Transformers and Reactors
- .2 CAN/CSA-C50-97 (R2001) Insulating Oil, Electrical for Transformers and Switches
- .3 CAN/CSA-C802.3-01 Maximum Losses for Power Transformers
- .4 Spec Note - Use CSA C2-M91 (R2007) for pole-mount distribution {utility} type transformers
- .5 Spec Note – Use CSA C227.4-M1978 (R2005) for dead-front {insulated connectors} pad-mounted {bottom entry w/ doors} distribution type transformers
- .6 ANSI/IEEE C57.12.90-1999 Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

**1.3 SOURCE QUALITY CONTROL**

- .1 Submit to Engineer standard factory test certificates of each transformer and type test of each transformer with high voltage accessories in accordance with CSA C88.

**1.4 SHOP DRAWINGS**

- .1 Submit shop drawings for transformer within two (2) weeks of contract award to ensure timely coordination and completion of associated civil works.
- .2 Indicate:
  - .1 Anchoring method and dimensioned foundation template.
  - .2 Dimensioned cable entry locations.
  - .3 Dimensioned cable termination height.
  - .4 Identified internal and external component layout on assembly drawing.
  - .5 Insulating liquid capacity.

**1.5 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for power transformers for incorporation into manual.
- .2 Include insulating liquid maintenance data.

**Part 2 Products****2.1 TRANSFORMER CHARACTERISTICS**

- .1 Three phase power transformers: to CAN/CSA-C88.
- .2 Liquid cooled, outdoor, power transformers, type KNAN/KNAF, with fan cooling, complete with primary and secondary cable compartments, sealed tank, options and accessories to form complete factory assembled, self contained, steel fabricated unit, for mounting on concrete pad.

- .3 High voltage bushing wells for connection to distribution system through dead front.
- .4 Spade type low voltage terminals cable of support all conductors noted in drawings. Wood or similar cable supports to ensure that there is not any excessive downward force on the spade terminals.
- .5 Integration of 600V circuit breakers and bussing as noted in drawings.
- .6 Primary voltage: dual voltage, 24,490/12,470V, 60Hz, wye connected, 3 phase, 4 wire, neutral solidly grounded.
- .7 Secondary voltage: 347/600V, wye connected, 3 phase, 4 wire, neutral solidly grounded.
- .8 Capacity: 3000 kVA KNAN, 4000 kVA KNAF.
- .9 Temperature rise: 65 Deg. C.
- .10 Polarity: Additive
- .11 Basic impulse level: 125 kV.
- .12 Maximum rms short-circuit: 20 times base current for 120 cycles.
- .13 Impedance: not less than 5% and not more than 7.5% per CSA C802.3.
- .14 No load losses not to exceed CSA C802.3 requirements.
- .15 Full load losses not to exceed CSA C802.3 requirements.
- .16 Sound rating: shall meet average of 62 dBA, with taps in normal position and KNAN operation.
- .17 Windings: copper.
- .18 Voltage Taps: Four-2.5% taps, 2-FCAN, 2-FCBN.
- .19 Tap Changer: Externally operated off-load tap changer, with indicator and provision for padlocking.
- .20 Insulating Liquid: Insulating liquid: non-flammable R-Temp or other organic based, biodegradable liquid.

## 2.2 ACCESSORIES

- .1 Liquid temperature thermometer (Celsius), drag hand for maximum indication, two sets of contacts: fan start, pre-set alarm.
- .2 Magnetic liquid level gauge with two sets of contacts.
- .3 Pressure gauge with fault contact.
- .4 Winding temperature indicator and analog signal sensor.
- .5 Pressure relief device.
- .6 25 mm drain valve.
- .7 25 mm filler plug.
- .8 Cooling fans with automatic control for fans based on top liquid temperature.

## 2.3 GROUNDING

- .1 Copper grounding bus.
- .2 Connectors for grounding conductors.

## 2.4 FINISH

- .1 Finish exterior of unit in rust-resistant primer and two coats of finish enamel, grey to EEMAC 2Y-1. Supply two spray cans of touch up paint.

**2.5 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with CSA C88.

**2.6 WARNING SIGNS**

- .1 Provide warning signs in accordance with Section 26 05 00 - Common Work Results - Electrical. Include warnings for tap changer operation and automatic operation of fans.

**Part 3 Execution****3.1 INSPECTION**

- .1 Check factory made connections of transformer unit for mechanical security and electrical continuity.
- .2 Check transformer insulating liquid for correct quantity and specification according to manufacturer's instructions.

**3.2 INSTALLATION**

- .1 Ensure concrete pad is fully cured before transformer is installed.
- .2 Set and secure transformer unit in place, rigid, plumb and square.
- .3 Make connections.
- .4 Connect transformer unit ground bus to system ground.
- .5 Wire one set of contacts on liquid temperature thermometer to activate cooling fans.
- .6 Set taps to produce rated secondary voltage at no-load.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 40 Deg.C.
  - .1 High voltage to ground with secondary grounded for duration of test.
  - .2 Low voltage to ground with primary grounded for duration of test.
  - .3 High to low voltage.
- .3 Inspect primary and secondary connections for tightness and for signs of overheating.
- .4 Inspect and clean bushings and insulators.
- .5 Check oil level and temperature indicators.
- .6 Set transformer taps to rated voltage as specified.
- .7 Inspect for oil leaks and excessive rusting.
- .8 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for [electrical cabinets and enclosures] and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect electrical cabinets and enclosures from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 MATERIALS**

- .1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2, size as indicated.

- .2 Where located outdoors, enclosure material shall be 5000 series, copper free aluminum or 316 stainless steel.
- .3 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m<sup>2</sup> area without rupture of material.
- .4 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8 Door interlocks: prevent opening of doors without suitable electrical isolation of internal equipment.
- .9 Enclosure construction such as to allow configuration of single or ganged enclosures.
- .10 Enclosure capable of being shipped in knocked-down condition.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 INSTALLATION**

- .1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.
- .2 Mount equipment in enclosure.
- .3 Label electrical cabinets and enclosure to Section 26 05 00 - Common Work Results for Electrical.
- .4 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .5 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .6 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 This Section specifies switches, receptacles, wiring devices, cover plates and their installation.

**1.2 PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA-C22.2 No.42.1, Cover Plates for Flush Mounted Wiring Devices.
  - .3 CSA-C22.2 No.55, Special Use Switches.
  - .4 CSA-C22.2 No.111, General Use Snap Switches.

**Part 2 Products**

**2.1 COLOUR**

- .1 All devices to be Decora style white.

**2.2 SWITCHES**

- .1 Heavy duty specification grade.
- .2 20 A, 120 V, single pole, double pole, three-way, four-way switches as indicated.
- .3 Manually-operated general purpose ac switches as indicated and with following features:
  - .1 Terminal holes approved for No.10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine molding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 White toggle (red toggle for emergency power circuits).
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.
- .5 Switches of one manufacturer throughout project.

**2.3 RECEPTACLES – GENERAL**

- .1 Heavy duty specification grade.
- .2 Duplex receptacles, CSA type L5-15 R, 125 V, 15 A, U ground, with following features:
  - .1 White nylon molded housing (red for emergency power circuits)
  - .2 Suitable for No.10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.



- .5 Triple wipe contacts and non riveted grounding contacts.
- .3 Receptacles of one manufacturer throughout project.

## 2.4 RECEPTACLES – PARTICULAR APPLICATION

- .1 Surge Suppression TVSS 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, blue face, parallel blade, U ground, and impact resistant nylon face audible and LED alarm.
- .2 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button.
- .3 20 Amp Receptacles (Housekeeping) Duplex receptacles – T-slot type CSA type L5-20R 125V. 20 Amp u ground with features matching 15 Amp rated Receptacles.
- .4 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.

## 2.5 COVER PLATES

- .1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. Outlets in labs or as indicated in the drawings or specifications.
- .2 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.
- .3 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.
- .4 All plates to be beveled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.
- .5 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Cover plates to fasten to box by four screws.
- .7 Gaskets: resilient rubber or close cell foam urethane.
- .8 Cover plates for all wiring devices to be from one manufacturer throughout project.

## Part 3 Execution

### 3.1 INSTALLATION GENERAL

- .1 Mount wiring devices to height specified in Section 26 05 00 or as indicated.
- .2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.
- .3 All plates to be installed parallel or perpendicular to building lines.

### 3.2 INSTALLATION PARTICULAR

- .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.
- .2 Receptacles:
  - .1 Install all receptacles in the vertical plane unless otherwise noted.
  - .2 Generally install the L5-15/20R U ground pin down unless otherwise noted. Neutral up when receptacle in mounted horizontal.
  - .3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
  - .4 Surge suppression duplex receptacles to be provided for all communication and computer terminal equipment backboards and cabinets including fire alarm, telephone, public address, door security, nurse call, central dictation, RF television, security television, etc. Provide dedicated neutral conductors for each surge suppression receptacle.
  - .5 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.
- .3 Cover plates:
  - .1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 This Section specifies the materials, components, operational features and installation for air circuit breakers.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/IEEE C37.13-1993, Low Voltage AC Power Circuit Breakers Used in Enclosures.
  - .2 Canadian Standards Association (CSA International)
    - .1 CSA C22.2 No. 5- latest issue, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

**1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current phase protection coordination characteristic curves for breakers.
- .3 Provide complete wiring diagrams for all auxiliary contacts, controls and communications interfaces.

**Part 2 Products**

**2.1 AIR CIRCUIT BREAKER**

- .1 Air circuit breaker to: to ANSI/IEEE C37.13 and CSA C22.2 No.5.
- .2 Drawout or Fixed type ( as noted in drawings ), 600 V class or as indicated.
- .3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid state trip unit and self-powered trip actuator. Equipped with long, short, instantaneous, ground fault function and phase overload and ground fault indication.
- .4 Breakers with normal stored energy, motorized opening and closing mechanism to provide quick-make operation for all ratings.
- .5 Breakers with on-off indicator and spring charged/discharged indicator.
- .6 Interlocks to prevent circuit breaker drawout when in closed position and to prevent closing unless fully engaged or in test position.
- .7 Supply manufacturers' secondary current injection tester compatible with all air circuit breakers used in this project. Device shall be capable of confirming correct time and current operation for all long, short, instantaneous and ground fault elements of these circuit breakers. Tester shall provide time and current levels ( not just a pass/fail result ) for all tests performed. Provide all required cables, interface, documents and training required for operation.

## **2.2 ADDITIONAL FEATURES**

- .1 Shunt trip.
- .2 Auxiliary switches: 2 N.O., 2 N.C.
- .3 Motor operator for open, closing and charging breaker.
- .4 Alarm switch.
- .5 Pilot light.
- .6 Key interlock ( where noted in drawings ).
- .7 Remote open and close.
- .8 Lockout devices.
- .9 Padlocking provision.
- .10 Operation counter.
- .11 Integral energy, harmonics and phase current/voltage metering where noted in drawings.
  - .1 RS485 serial interface using MODbus or compatible communications protocol to integrate air circuit breaker overcurrent, control and metering functions to SCADA using single SCADA software system.
- .12 Secondary injection current testing equipment and accessories.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install air circuit breakers as indicated.
- .2 Connect remote open/close signals.
- .3 Connect remote status contacts.
- .4 Connect power source to breaker auxiliary controls.
- .5 Connect serial interface from SCADA to breaker.
- .6 Program SCADA system to tightly integrate breaker functionality and feedback into SCADA system for logging, auditing and monitoring purposes.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 Equipment, fabrication and installation for ground fault protection.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 26 05 00 - Common Work Results – Electrical
- .3 Section 26 12 16 - Dry Type, Medium Voltage Transformers
- .4 Section 26 23 00 - Low Voltage Switchgear.

**1.3 REFERENCES**

- .1 CAN/CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.

**1.4 SUBMITTALS**

- .1 Refer to Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and shop drawings.
- .3 Submit test report for field testing of ground fault equipment to Departmental Representative and a certificate that system as installed meets criteria specified.

**Part 2 Products****2.1 EQUIPMENT**

- .1 Ground fault monitoring and protection equipment as indicated: components of one manufacturer.

**2.2 480 V HIGH-RESISTANCE GROUNDED SYSTEM (GFM)**

- .1 Provide a ground fault monitoring alarm and protection system on 480 V, 3-phase, 3-wire high-resistance grounded system.
  - .1 Unit shall be self-contained, mounted inside the low voltage switchgear section, in a fully enclosed metal compartment. Coordinate space requirements for GFM directly with the manufacturer of switchgear. GFM shall be factory integrated with switchgear assembly prior to arrival on site.
  - .2 A neutral grounding resistor (NGR) rated for continuous duty with 375°C temperature rise over 40°C ambient, at maximum 5 A, a pulsing system for fault tracing, and zero sequence CT for ground fault monitoring.
  - .3 The NGR elements shall be of nickel chromium wire, wound onto high quality porcelain cores. Resistance shall vary less than 10% throughout the temperature range.
  - .4 An alarm resistor unit for connection to the main 480 V system.
  - .5 Toroidal zero sequence current sensors as indicated, with a window opening sized for actual conductors used in transformer.
  - .6 Rack mounted monitoring system with a control module, test module and minimum of six feeder module spaces. Provide the required number of feeder modules as shown, plus one spare feeder module in each rack.

- .7 Each feeder module shall include one SPDT relay coordinated with the shunt trip coil rating of each feeder breaker for tripping, and one alarm relay to provide indication at respective digital meters as shown.
- .8 The test module shall include all the test functions of the feeder and control modules, including trip and alarm function tests.
- .9 The control module shall include the main alarm detection and indication circuits, alarm sensitivity controls, ground current indicating meter, and status lights.
- .10 All control circuitry shall operate on 120 VAC.
- .11 A red indicating light shall signify that a ground fault is presently active in the electrical system.
- .12 A test function shall be provided to ensure correct operation of all indicator lamps.
- .13 A reset button on the front panel shall reset the ground fault system.
- .14 The unit shall cyclically pulse from 100% let-through current to 75% let-through current to 50% let-through current when the pulsing has been activated and a ground fault is presently active. The timing of the pulsing shall be controlled by a programmable relay that can vary the pulse duration.

**Part 3****Execution****3.1****INSTALLATION**

- .1 Install phase conductors through zero sequence transformer.
- .2 Install ground fault protection system.
- .3 Make connections as indicated and in accordance with manufacturer's recommendations.
- .4 Confirm priority tripping levels with Departmental Representative prior to final programming and testing.

**3.2****FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Arrange for field testing of ground fault equipment by the Contractor's independent testing agency before commissioning for service.
- .3 Demonstrate simulated ground fault tests that will provide priority tripping of all loads.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials for moulded-case circuit breakers, circuit breakers, and ground-fault circuit-interrupters.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 23 00 - Low Voltage Switchgear.
- .4 Section 26 28 18 - Ground Fault Equipment Protection.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

**1.4 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 100A and over.
- .3 Include product information and manuals for secondary current injection test equipment to be provided for ongoing testing and verification of molded case circuit breakers. This documentation shall include operating instructions, product information and data for verification of correct operation of all molded case circuit breakers supplied as part of this project.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Separate for recycling all waste in accordance with Waste Management Plan.

**Part 2 Products**

**2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips as noted.
- .5 Circuit breakers with interchangeable trips as indicated.

- .6 Circuit breakers to have minimum 10kA symmetrical rms interrupting capacity rating or as noted in drawings or panel schedules.

## **2.2 THERMAL MAGNETIC BREAKERS**

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

## **2.3 SOLID STATE TRIP BREAKERS**

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and/or ground fault short circuit protection.
- .2 All circuit breakers with a frame rating of 200 amps or greater shall be equipped with connection ports suitable for using secondary injection type test equipment suitable for testing all time and current levels for all trip functions.
- .3 Supply manufacturers' secondary current injection tester compatible with all molded case circuit breakers used in this project. Device shall be capable of confirming correct time and current operation for all long, short, instantaneous and ground fault elements of these circuit breakers. Tester shall provide time and current levels (not just a pass/fail result) for all tests performed. Provide all required cables, interface, documents and training required for operation.

## **2.4 OPTIONAL FEATURES**

- .1 Refer to drawings, single lines and panel schedules for features to be included on moulded case breakers.
- .2 Include:
  - .1 Shunt trip.
  - .2 Auxiliary switch.
  - .3 Motor-operated open/close mechanism
  - .4 Integral metering device with RS485 communications link
  - .5 On-off locking device.
  - .6 Handle mechanism.
  - .7 Secondary injection current testing equipment and accessories.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install circuit breakers in switchboard or panel board assemblies as noted in drawings.

**END OF SECTION**



**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1            Section 26 29 23.02 Power System SCADA.

**1.2                REFERENCES**

- .1            National Electrical Manufacturers Association (NEMA)
  - .1            NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2            Product Data:
  - .1            Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3            Shop Drawings:
  - .1            Include schematic, wiring, interconnection diagrams.
  - .2            Include all propose programming, modifications or software packages.
  - .3            Provide Riser Diagrams showing interface of all new and existing equipment as well as intermediate wiring, wiring devices, signal conditioners and measuring devices.

**1.4                QUALITY ASSURANCE**

- .1            Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

**1.5                CLOSEOUT SUBMITTALS**

- .1            Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2            Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

**1.6                DELIVERY, STORAGE AND HANDLING**

- .1            Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2            Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3            Storage and Handling Requirements:
  - .1            Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2            Store and protect control devices from nicks, scratches, and blemishes.
  - .3            Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 AC CONTROL RELAYS**

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.
- .2 Fixed contact plug-in type: heavy duty 2,3 or 4 poles. Coil rating: 120 VAC or 120VDC as noted. Contact rating: 120V, 3A.
- .3 Relays to include indicator LED and tab for manually actuating the relay.

### **2.2 RELAY ACCESSORIES**

- .1 Plug in relay bases with vibration clips.

### **2.3 PUSHBUTTONS**

- .1 Illuminated and/or Heavy duty. Operator extend type, as indicated, color as noted with 1-NO and 1-NC contacts rated at 120 V, 10 A, AC labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position labelled "emergency stop".

### **2.4 SELECTOR SWITCHES**

- .1 Maintained or Spring return to center, positions as indicated heavy duty operators knob contact arrangement as indicated, rated 120 V, 10A, AC.

### **2.5 INDICATING LIGHTS**

- .1 Heavy duty full voltage, LED type, push-to-test, lens colour: indicated], supply voltage: 120V AC/DC, lamp voltage: 120V AC/DC, labels as indicated.

### **2.6 CONTROL AND RELAY PANELS**

- .1 CSA Type 1 sheet steel enclosure with hinged pad lockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

### **2.7 CONTROL CIRCUIT TRANSFORMERS**

- .1 Single phase, dry type.
- .2 Primary: as noted, 60 Hz ac.
- .3 Secondary: 120 V, AC.
- .4 Rating: 250VA.
- .5 Secondary fuse: amps as required.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Contractor is required to carefully review all documents provided.

**3.2 INSTALLATION**

- .1 Confirm correct and reliable transmission of all data values via ModBUS to PSS and ensure that full scale readings are possible and correct.
- .2 Confirm that all design performance values for the PSS have been met for inputs provided through the field device.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.
- .5 Coordinate all commissioning and demonstration operations with Departmental Representative.

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 36 01 – Generator Switchboard.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for interlock systems and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry locations and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect interlock systems from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 GENERATOR PROTECTION**

- .1 The microprocessor-based relay shall provide protection, monitoring, control, and automation. Relay self-checking functions shall be included. Specific requirements are as follows:
- .2 Protection and Control
  - .1 Overcurrent: Phase, Ground and negative sequence.
  - .2 Voltage: Overvoltage, under voltage, single phase.
  - .3 Auto synchronizer and Sync check.
  - .4 Frequency: Over, under, rate of change.
  - .5 Volts/Hz.
  - .6 Analog Inputs: 21 current and 3 voltage inputs.
  - .7 Current Transformer Alarm: The relay shall include an element in each zone to detect CT open or short-circuit conditions.
  - .8 Ground Overcurrent: Dedicated current input for current and time based overcurrent and ground fault monitoring/indication.
  - .9 Digital Inputs: As indicated on the drawings.
  - .10 Outputs: As indicated on the drawings.

- .11 Breaker Failure Protection: Internal breaker failure protection with retrip functions for each of the terminals, but be selectable to also accept external breaker failure protection.
- .12 External Faults: Detection of an external fault and enter into a high-security mode but not block the differential protection at any time.
- .3 Communications/Integration
  - .1 Network communications: Ethernet (Dual port) using ION or ModBUS TCP providing full integration into SCADA system for real-time and recorded power/current/voltage values, fault status, fault words and remove operation ( open, close, reset ) of protective device and breaker.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for interlock systems installation in accordance with manufacturer's written instructions.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

#### **3.3 INSTALLATION**

- .1 Install equipment in accordance with the drawings.
- .2 Configure all relay settings as directed by Departmental Representative and Consultant.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 UL61010B-1 Measuring, Testing and Signal Generation Equipment
  - .2 CAN3-C17- latest edition, alternating - Current Electricity Metering
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.
- .3 International Electrical Standards (IEC)
  - .1 IEC62052-11: Electricity metering equipment (AC) – general requirements, tests and test conditions
  - .2 IEC61010-1 (EN61010-1): Safety requirements for electrical equipment for measurement, control, and laboratory use

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Include schematic, wiring, interconnection diagrams.
  - .2 Provide certificate of Revenue Canada Approval for devices requiring compliance and sealing.

**1.3 QUALITY ASSURANCE**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittal.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 DIGITAL POWER METERS**

- .1 Current/Voltage Inputs
  - .1 Have no less than 4 voltage inputs and 4 current inputs
  - .2 Shall be able to accept 600VAC LL / 347VAC LN without using potential transformers.
  - .3 Shall support nominal current ratings of 1A, 2A, 5A, 10A, and/or 20A and an overcurrent rating of 500A for 1s (5A nominal mode) or 200A for 1s (1A nominal mode).
- .2 Power Supply
  - .1 95 to 240VAC ( $\pm 10\%$ ) @ 47 to 440Hz / 120 to 310 VDC
- .3 Measured Values
  - .1 Digital Meter shall provide at minimum the following voltage values:
    - .1 Voltage L-L Per-Phase
    - .2 Voltage L-L 3-Phase Avg
    - .3 Voltage L-N Per-Phase
    - .4 Voltage 3-Phase Avg
    - .5 Voltage % unbalanced
  - .2 Digital Meter shall provide at minimum the following current values:
    - .1 Current Per-Phase
    - .2 Current, Neutral (measured)
    - .3 Current 3-Phase Avg
    - .4 Current % Unbalanced
  - .3 Digital Meter shall provide at minimum the following power values:
    - .1 Real Power (Per-Phase, 3-Phase Total)
    - .2 Reactive Power (Per-Phase, 3-Phase Total)
    - .3 Apparent Power (Per-Phase, 3-Phase Total)
    - .4 Power Factor – True (Per-Phase, 3-Phase Total)
    - .5 Power Factor – Displacement (Per-Phase, 3-Phase Total)
  - .4 Digital Meter shall provide at minimum the following energy values:
    - .1 Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
    - .2 Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
    - .3 Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
    - .4 Reactive Energy by Quadrant

- .5 Digital Meter shall be capable of deriving values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (or equivalent PLC capabilities):
  - .1 Arithmetic functions: division, multiplication, addition, subtraction, power, absolute value, square root, average, max, min, RMS, sum, sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.
  - .2 Trigonometric functions: COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, LOG10
  - .3 Logic functions: =, ==, <=, <>, <, >, AND, OR, NOT, IF
  - .4 Thermocouple linearization functions: Type J, Type K, Type R, Type RTD, Type T
  - .5 Temperature conversion functions: C to F, F to C
- .4 Demand
  - .1 Digital Meter shall be able to provide min/max demand, present demand interval, running average demand, and predicted demand on multiple demand channels.
  - .2 Digital Meter shall be able to perform multiple accepted demand calculation methods including block, rolling block, and thermal demand with user-programmable demand period lengths.
- .5 Accuracy
  - .1 Digital Meter shall meet ANSI C12.20 accuracy class 0.2.
  - .2 Digital Meter shall provide 4-quadrant metering
  - .3 Digital Meter shall be certified and sealed to Revenue Canada standard as applicable for devices to be used for reselling of energy.
- .6 Sampling
  - .1 Digital Meter shall sample at 64 (or more) samples/cycle.
  - .2 Digital Meter shall be able to perform high speed sag/swell detection of voltage disturbances on a cycle-by-cycle basis, providing the duration of the disturbance, the minimum, maximum, and average value of the voltage for each phase during the disturbance. Disturbances less than one cycle in duration can be detected.
- .7 Logging
  - .1 Digital Meter will store all critical internal and revenue data upon sudden power loss and shall have non-volatile memory.
  - .2 Digital Meter shall have a time-stamped event log with the following features:
    - .1 The number of records in the log is programmable.
    - .2 Each event is recorded with the date and time of the event, the cause and effect of the event, and the priority of the event.
    - .3 All events relating to set point activity, relay operation and self-diagnostics is recorded in the event log.
    - .4 Time stamps have a resolution of 1 millisecond.
    - .5 Time stamps can be synchronized to within 100 ms between devices on the same serial communications medium.
    - .6 Minimum event recording response time is ½ cycle (8.3ms 60Hz, 10ms 50Hz) for high speed events and 1 second for other events.



- .7 The priority of set point events is programmable.
- .3 Digital Meter shall be able to log any parameter in the meter including min/max and waveforms.
- .8 Alarming
  - .1 Digital Meter have set point driven alarming capability
  - .2 Digital Meter shall be able to generate an email on an alarm condition.
  - .3 Digital Meter shall have millisecond timestamp resolution on alarm entries.
  - .4 Digital Meter shall support consecutive high-speed alarm conditions which trigger on a cycle-by-cycle basis with no “dead” time between events (i.e. no need for a rearming delay time between events).
  - .5 Digital Meter shall be able to operate relays on alarm conditions.
  - .6 Digital Meter shall be able to initiate datalog captures on alarm conditions.
  - .7 Digital Meter shall be able to control digital output relays in an AND or an OR configuration, using pulse mode or latch mode operation, for control and alarm purposes.
  - .8 Digital Meter shall be able to combine any logical combination of any number of available set point conditions to control any internal or external function or event.
- .9 Communications
  - .1 The Digital Meter shall be capable of the following communications methods simultaneously and independently:
    - .1 Ethernet over copper media.
    - .2 Serial
      - .1 RS-232
      - .2 RS-485
    - .3 Serial
      - .1 RS-485
    - .4 Infra Red
  - .2 The Digital Meter shall support any one of the following communications protocols on any one port at any one time:
    - .1 ION
    - .2 Ethergate
    - .3 Modemgate
    - .4 DNP 3.0
    - .5 Modbus
      - .1 Modbus RTU
      - .2 Modbus TCP
      - .3 Modbus Mastering of serial RS485 slaves
    - .6 SMTP
    - .7 SNTP
    - .8 MV-90 compatibility
    - .9 XML compatibility
    - .10 SNMP

- .11 HTTP (web pages)
- .3 The PMS Instrument has a Modbus TCP gateway for reading Modbus serial devices connected to a serial port on the instrument.
- .4 The PMS Instruments that are equipped with an Ethernet port are internet enabled and supports the following functions:
  - .1 Automatically e-mail alarm notifications or scheduled system status updates. E-mail messages sent by the PMS instruments can be received like any ordinary e-mail message. Data logs can also be sent on an event-driven or scheduled basis.
  - .2 Built in web pages in the PMS instruments enables access to real-time values and basic power quality information using a standard web browser. Basic configuration of the PMS instruments can also be performed through the browser.
  - .3 Integration with custom reporting, spreadsheet, database and other applications with XML compatible data.
    - .1 The following logical nodes shall be supported in addition to LLN0 and LPHD (mandatory):
      - o MHAI - Harmonics
      - o MMTR - Metering
      - o MMXU - Measurement
      - o MSQI - Sequence and imbalance
      - o MSTA - Metering Statistics
      - o GGIO - The ability to view data from and control all I/O points in the meter.
      - o RDRE - Disturbance recorder function
- .10 I/O Options
  - .1 Digital Meter shall be capable of having 4 digital inputs capable of ½ cycle timing resolution, and shall be fitted with 4 inputs.
  - .2 Digital Meter shall have digital outputs that support pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.
  - .3 Digital Meter shall have 4 optically isolated Form a outputs.
- .11 Display
  - .1 Digital Meter shall have two display options: an integral display and a remote mounted display
    - .1 The integral display shall be a backlit LCD display
    - .2 The remotely mounted display shall be a color backlit LCD display, of similar size as to integral display
    - .3 The displays shall be suitable for NEMA 12 enclosures.
  - .2 Digital Meter shall support direct display of all parameters on the front panel.
  - .3 Digital Meter display shall support multiple languages, including English and French.

- .12 Field Programmability
  - .1 Digital Meter is field programmable as follows:
    - .1 Basic parameters: Voltage input scale, voltage mode (Wye, Delta, single phase), current input scale, auxiliary input and output scales, and communications setup parameters are programmable from the front panel.
    - .2 All basic parameters described above, plus additional set point/relay and data log setup parameters may be programmed via the communications port using a portable or remotely located computer terminal.
    - .3 Custom configuration of all operating parameters is possible through a graphical, flexible programming language.
    - .4 The configuration of the device will be done using programmable modules. The modules can be linked together in an arbitrary manner to create arbitrary functionality. Some example module types include min, max, set point, digital input, and digital output.
    - .5 Programming through a computer can be secured by user ID and password.
    - .6 Programming through the front panel is secured by password.
    - .7 Programmability shall be sectioned such that when the meter is sealed, the meter shall still be configurable to an extent that does not affect the accumulation of revenue metering related data.
- .13 Advanced Features
  - .1 The Digital Meter firmware shall be field upgradeable.
  - .2 Onboard meter clock can be paced by a choice of sources including GPS or internal clock.
  - .3 The Digital Meter shall have multi-level security which supports customized access for up to 16 users.
  - .4 The Digital Meter shall have revenue security capabilities including but not limited to the following:
    - .1 Password protected, no hardware lock, or
    - .2 Password protected and hardware locked, or
    - .3 The following data is protected from alteration when locked:
      - .1 kWh and kVARh (import, export, net and total)
      - .2 kVAh (total)
      - .3 kW, kVAR, kVA demand (thermal and sliding window)
      - .4 kWh, kVARh, kVAh pulse outputs
  - .5 The Digital Meter shall have provisions for creating periodic or non-periodic schedules for up to two (2) years. These schedules may be used to perform the following functions:
    - .1 Time of Use (TOU)
    - .2 Demand Control

- .3 Load Scheduling
- .4 Logging
- .5 Periodic Resetting

### Part 3 Execution

#### 3.1 INSTALLATION

- .1 Install Digital Meters in switchgear, motor control centers and control panels/cabinets as noted in drawings. All installations shall be fully integrated to main assemblies at the factory and shall be completely tested for operation prior to shipping to site.
- .2 Use of Digital Meters with remote display units as applicable or required to facilitate compliant installation of meters using 600V voltage inputs. The use of potential transformers to permit mounting of metering on swinging doors is not acceptable when remote display is available.
- .3 Connect Digital Meters to communications means as noted in drawings, typically copper Ethernet. All patch cables shall be STP (shielded twisted pair), CAT 6 with positively engaging locking tabs.
- .4 Where Digital Meters are connected to additional devices using RS 485 twisted shielded media, ensure grounding of shielded cables is done at one end only. Provide end of line resistors as required for reflection/error free communications at the highest transmission speeds the Digital Meters are capable.
- .5 Where Digital Meters are indicated as Revenue Sealed, ensure that all current transformer ratios installed coincide with those set in the sealed meter firmware.
- .6 Connect Digital Meters to 120VAC UPS Source as noted in drawings. Ensure that power supply on Digital Meter is compatible with connected source.
- .7 All potential inputs to Digital Meters shall be fitted with protection fuses. Fuses shall be mounted in flip-open style fuse holder that will also provide isolation means for Digital Meter.
- .8 Provide power supply fusing protecting each meter independently. Fuses shall be mounted in flip-open style fuse holder that will also provide isolation means for Digital Meter. Fuse holders shall be rated for disconnecting meter power supply under load.
- .9 When Digital Meters use current and/or potential transformers with Protection Relays, provide Current Transformer shorting switches to allow removal of Digital Meter without disrupting service to other devices.
- .10 When Digital Meters are Revenue Sealed, provide current transformer shorting switch to allow removal of Digital Meter for re-certification without taking circuit off-line. Provide isolation means for all voltage-sensing inputs.
- .11 Provide protection or additional isolation when the Digital Meter is controlling circuit breakers or other equipment using contact closure. This protection to include (but is not limited to): isolation relays, diodes, optoisolators, fuses, surge arrestors disconnect switches and terminals. Coordinate with all other product suppliers to ensure proper rating for relays with regards to closing/open coil requirements and contact ratings, etc.
- .12 Provide additional graphical screens implemented into existing Power System SCADA monitoring software, including adding additional information to single lines, monitoring and alarming screens.

- .13 Fully integrate all new meters into datalogging system including alarm monitoring, trending and datalogging.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.
- .5 Manufacturer shall coordinate to provide a complete factory demonstration of fully operational equipment prior to disassembly and sending to site.
  - .1 This demonstration to include primary current/voltage injection proving all metering points as well as operational verification of all digital inputs, analog inputs and digital outputs.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 29 23.01 – Digital Metering
- .2 Section 26 29 03 - Control Devices

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.2 No.14-10, Industrial Control Equipment.
  - .2 CAN3-C17- latest edition, Alternating - Current Electricity Metering.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 System riser/block diagram including all hardware, communications links, gateways, converters and computers/PC/PLCs.
  - .2 Software packages, including license certificates/quantities. List all applications to be installed on all computers.
  - .3 Computer/Display Hardware including specifications, monitors, storage devices.
  - .4 Samples of all HMI screens to be developed as well as those that are to be modified.
  - .5 Proposed points list for software level integration to existing and proposed devices included in this contract.
  - .6 Proposed points list for alarming, trending and alerts.
  - .7 Transition procedures for implementing the proposed modifications including procedures for:
    - .1 Transfer, storage and reintegration of existing data.
    - .2 Reconnection/integration of existing metering devices on site to remain.
    - .3 Commissioning and testing of new equipment, programming and logic on a live and operational system on an operating facility.

**1.4 QUALITY ASSURANCE**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

## 1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Submittal Procedures.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

## 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## Part 2 Products

### 2.1 GENERAL SYSTEM DESCRIPTION

- .1 The replacement Power System SCADA ( PSS ) will be a complete replacement of the existing hardware and software of the system currently installed at the South Side Substation. These devices will connect to the existing server(s).
- .2 All new metering, protection and control devices shall be implemented with real-time and recorded values automated input/output operations, trend logs, calculations, alarming, monitoring of ancillary inputs, automation, waveform capture and data display.
- .3 The new PSS devices installed in this contract specifically for use with transfer, generator and load control shall be referred to as the Transfer Control System (TCS), but is a fully integrated part of the PSS.
- .4 All existing graphical interface screens currently in use with the existing System shall be modified to correctly show physically and electrically the new electrical distribution equipment. It is the responsibility of the contractor to ensure that all existing functionality is brought forward and replicated in the new PSS interface screens.
- .5 Provide new graphical interface screens to summarize power system status, generator operation, loadbank system, breaker status, load priorities and position in re-energization sequence.
- .6 Provide new graphical interface screens for each new protective relay, digital meter or motor control device, including a mimic of the front panel display, readout of all alarms, faults and real-time power data from the device. Operators will be able to remotely reset and control device from this screen.
- .7 Provide fully operation touch screen interface at SES Generator Switchboard. This panel will allow for full access and control of devices in the PSS for remote operation of breakers and devices, and specifically the generator, transfer control and loadbank equipment. This device will be a flush mounted, industrial touch screen computer and function as a full node on the PSS SCADA Ethernet network.

- .8 The existing system has extensive custom programming currently in use for alarming, energy monitoring, revenue billing and trending; integration similar to this shall be provided for all equipment on the PSS SCADA system. Refer also to drawings for layout of relevant existing system, including devices that are to remain in operation. It is the responsibility of the contractor to ensure that all existing functionality is maintained or upgraded to be compatibility in the new Generator Switchboard devices.
- .9 Existing PSS System Arrangement
  - .1 The system consists of dual servers, complete with fully redundant RAID storage arrays. One of these servers is located at the PHS control room, the other at the SES control room. These servers will be configured such that in the event of a server failure, complete control will be brought up on the second server. The database for all historical logging and operational logic will be synchronized at both locations.
  - .2 The digital power meters located in the field will not only monitor standard energy, power quality and breaker status functions, but will also have remote and automated control authority for opening and closing circuit breakers to which they are connected.
  - .3 Monitoring of electrically related parameters, including transformer winding temperature and electrical room temperatures will be input into digital meters for trending and alarming.
  - .4 The PSS will provide automated functionality for control of circuit breakers for load control, power factor, priority loading, etc under certain conditions. These automated functions may not be enabled at the conclusion of this project but must be programmed and fully demonstrated in operation.
  - .5 The PSS will be largely Ethernet based, using direct copper Cat 6 STP (shielded twisted pair) cabling to new devices. New and existing optical fiber cabling will be used to tie into existing equipment on the site, as well as linking in between SES and SSSR.
  - .6 The PSS will include direct connection to protection relays, motor protection and control devices, and other systems from which information will be read using Ethernet based protocols. This data will include real-time power measurements, as well as alarm data, and general data that will be used for trending. All devices will integrate tightly using native protocols and programming languages.
  - .7 The PSS and proposed or installed distribution equipment will provide for real-time visualization of actual power consumption at all key locations of the facility. The Transfer Control System (TCS) will be fully aware of the loads in order to provide predictive engagement of an appropriate level of standby power. The system, via interface with the Pumphouse SCADA and control system, will be aware of site priorities to ensure a reserve power capacity for starting/running particular critical loads (pumps, compressors, cranes, etc.) This data will be gleaned through the digital metering devices, PLC equipment, status and recent historical power demands of the site.
  - .8 When the site is to be power by standby power, a priority sequence of energizing the loads shall be followed, along with a time delay between each load step.



- .9 Upon loss of utility power, all 25kV breakers will open by control of the protective devices on site. An automatic 'repowering' sequence can be triggered manually, or automatically once utility power is restored, bringing loads back on in a priority, controlled basis to ensure that stable power is maintained.
- .10 Existing devices on site include, but are not limited to:
  - .1 Powerlogic 7650
  - .2 Powerlogic 7330
  - .3 Powerlogic 8300
  - .4 PML 3710, 3720
  - .5 PML 7700
  - .6 Allen Bradley PowerLogix PLC
  - .7 Schweitzer Engineering Laboratories Protective Relays, various models.
  - .8 Schneider/Square D moulded case circuit breakers with metering and power factor controllers.
  - .9 Schneider Medium voltage distribution and motor control equipment.

## 2.2 PSS – SOFTWARE – EXISTING FUNCTIONAL DESCRIPTION

- .1 Existing PSS software is an implementation of Power logic eSCADA and ION EEM. All TCS devices must be implemented into this system.
- .2 General
  - .1 The Power Management Software shall be a web-enabled monitoring system intended to monitor an entire electrical distribution infrastructure, from incoming utility feeds down to low voltage distribution points as well as interfacing with additional automation and control functions.
  - .2 The system shall be designed to monitor and manage energy consumption throughout an enterprise across a network of facilities to improve energy availability and reliability, manage and measure energy consumption and provide trending/alarm for fault identification and resolution.
  - .3 The software shall be a standard product based on a successful, proven software platform.

Key features shall include:

    - .1 Data acquisition for metering devices, sensors, and other intelligent electronic devices.
    - .2 Power Quality analysis (including harmonics, and voltage and current sinusoids).
    - .3 Graphical displays of information.
    - .4 Reporting tools with standard reports.
    - .5 Automated (and manually activated) revenue metering reports for electrical energy and water.
    - .6 Interactive historical data analysis.
    - .7 Power Factor monitoring and control.
    - .8 Load monitoring and control.

- .9 Third Party Device Integration through Modbus RTU and Modbus TCP protocols.
  - .10 Support real-time data display and control actions for multiple users for applications such as sub-metering, load monitoring / shedding, real-time pricing and generator control.
  - .11 Expansion of system through distributed IO servers.
- .3 Redundancy
- .1 The PSS will have a layer of redundancy as defined in this section. The redundancy will provide a means to run the PSS software from one of two servers. The redundancy software will determine which server is deemed the most fit to host the PSS software at any given time and run the software from that server.
    - .1 Handled Faults
    - .2 The system shall be capable of smoothly handling faults of the following nature: Network, Disk, Fan, Power supply, Temperature, Internal voltage, Memory, Motherboard, BMC, Processor and issues with Host software.
      - .1 Fault notification
      - .3 In the event of a fault listed above the PSS shall be capable of immediately notifying a pre-registered recipient of the problem.
        - .1 System Uptime
      - .4 The PSS shall have an annual uptime of 99.99%.
- .4 Performance
- .1 The PSS shall provide communications, view screen and event performance according to the specifications in this section.
  - .2 Real-Time
    - .1 Communications
      - Response Time**  
The response time of devices in the PSS will be less than or equal to the values below:  
Ethernet Device: 0.5 seconds  
Serial Device: 1 second
      - .2 Screens
        - Update Rate**  
The update rate of any screen in the system shall be less than or equal to the values below:  
Update Rate: 5 seconds
        - Initial Load Time**  
The update rate of any screen in the system shall be less than or equal to the values below:  
Load Time: 5 seconds
        - Alarming
          - Alarm Processing Time**  
The Alarm Processing Time system shall be less than or equal to the values below:  
Load Time: 5 seconds

### **Alarm Notification Time**

The Alarm Notification Time system shall be less than or equal to the values below:

Load Time: 10 seconds

- .3 Effect of Off-Line Devices
  - .1 If any device on a serial loop goes off-line for any reason it shall not have any effect on the communications performance of any of the other devices on the same loop.
- .4 Events
  - .1 Data Logs
    - .1 The Data Log Retrieval Time from any device shall be less than one minute.
- .5 Software Components
  - .1 General
    - .1 Software shall expand on existing Powerlogic SCADA and datalogging software, including all required licensing and drivers required.

## **2.3 PSS SYSTEM – HARDWARE**

- .1 TCS SES HMI
  - .1 19" (478 mm) Active matrix LCD TFT LED backlit touchscreen industrial flat screen industrial PC/display) complete with integral LED indicator and piezo alert.
  - .2 Ethernet interface complete with copper to single mode fiber media convertor
  - .3 Power supply for connection to local 120VAC system and UPS.
  - .4 1280x1024 pixels SXGA; 16 million colours.
  - .5 Processor: Core 2 Duo P8400 2.26 GHz 6MB cache.
  - .6 Video Controller: Intel GMA 4500MHD, 384 MB RAM
  - .7 Memory: 4 GB DDR3 RAM; 512kB SRAM.
  - .8 Fan cooled.
  - .9 Solid State, SSD Flash disk with >60GB storage.
  - .10 Touch panel: Analog Resistive.
  - .11 Ports: USB 2.0 on back and front panel; RS232C serial; DVI-I video; Ethernet.
  - .12 Windows 7 64 bit operating system.
  - .13 Flush Mount with NEMA 4X front panel rating.
  - .14 HMI will be configured to display all TCS and PSS screens and all full access and control to PSS operations Password control will be implemented as required.
- .2 Industrial Ethernet Switch
  - .1 Where Ethernet based communications is inside switchgear, control panels or unitized electrical equipment, network cabling shall shielded twisted pair (STP), including all patch cords and terminations.

- .2 Ethernet switches shall be industrial quality, suitable for mounting inside an enclosure.
- .3 Suitable for temperatures from -40 to 85 degree C.
- .4 Fiber uplink ports where noted.
- .5 Rack and surface mount.

## 2.4 PSS SYSTEM – TCS PROGRAM AND OPERATIONS

- .1 General Description
  - .1 The PSS is a tightly integrated SCADA and automation system that collects information, provides alarming, trending and data analysis while also provide specific automatic and remote control of power system equipment. Much of the information required for use and decision making by the TCS will come from this existing system. The contractor is expected to provide adequate time to completely familiarize themselves with this system prior to initiating their software and hardware design. A Departmental Representative will arrange for suitable access to required information.
  - .2 The TCS will integrate at a software level using ModBUS or similar protocols over Ethernet into new and existing control/protection relays, power system protection relays, generator control systems, air and molded case circuit breakers, power factor controllers, battery chargers, PLC (Programmable Logic Controllers), RID (Remote Input Device) and all existing equipment noted in the drawings.
  - .3 The existing system layout drawings are provided, as a key part of this project is the integration of these existing devices into the new TCS including all existing and new control functions, monitoring, trending and recorded data.
  - .4 Consistency of GUI between the existing system and the new TCS is important to ensure continuity of operations at the facility as the system is viewed or used by both electrical and non-electrical personnel. Existing screens should be thoroughly reviewed. Contractor shall allow for time to liaise with the Departmental Representative to review requirements, controls and layouts for all screens.
  - .5 The existing system has many custom programming elements providing revenue metering, custom alarms, and trending. These must be replicated in the new TCS.
  - .6 Operational and programming considerations are following, but the general operating scheme is presented here:
    - .1 The TCS will act as a standby power system transfer, generator and load controller. The system will provide full authority over the open and closed transition operation of the 25kV Generator breaker, DND feeder breaker, BC Hydro breakers 1 and 2, and 25kV bus tie breaker.
    - .2 The system will accommodate the following scenarios:
      - .1 DND feeder – Generator breaker – Open transition
      - .2 DND feeder – Generator breaker – Closed Transition
      - .3 BCH1, 2, Bus tie – Generator breaker – Open transition
      - .4 BCH1, 2, Bus Tie – Generator breaker – Closed Transition

- .3 Where an open transition transfer scheme is required or noted, it shall be facilitate using electrical interlocks. These interlocks will be selectable by using a conceal mechanical switch, that will also enable close transition switching for that particular transfer pair. Note that mechanical key interlocks are in place to prevent simultaneous closing of the DND and BCH 1,2 breakers.
- .4 Transfer Operations – Utility Failure - Open Transition
  - .1 Upon failure of utility power, the existing protection system will automatically open all 25kV circuit breakers. In this situation the generators will be called to start by the transfer controller. The generators will operate as ‘first to the board’ whereby the first generator to attain 60Hz and rated voltage will be the synch source to which all other generators ( if required ) are to synch to. Once the required number of generators is synronized, the 25kV generator breaker will close. Using a priority and load based sequence ( refer to drawings ), the loads will be energized along with a prescribed time delay to allow for power to stabilize.
  - .2 Upon return of utility power, and selection of open transition, the transfer controller will monitor for 3 minutes of stable utility power. Once this timer has expired, load breakers still closed will now open simultaneously, followed by the 25kV generator breaker and subsequently the 600V generator breakers.. At this point, the BC Hydro feeder breaker(s) will now be closed, and the open load breakers will be closed as prescribed by the priority sequence noted. Upon completion of cool down time delay, the generators will be shut down
- .5 Transfer Operations – Utility Failure - Closed Transition
  - .1 Upon failure of utility power, the existing protection system will automatically open all 25kV circuit breakers. The generators will be called to start by the transfer controller. The generators will operate as ‘first to the board’ whereby the first generator to attain 60Hz and rated voltage will be the synch source to which all other generators ( if required ) are to synch to. Once the required number of generators is synchronized, the 25kV generator breaker will close. Using a priority and load based sequence ( refer to drawings ), the loads will be energized along with a prescribed time delay to allow for power to stabilize.
  - .2 Upon return of utility power the transfer controller will monitor for 3 minutes of stable utility power. Once this timer has expired, load breakers will remain closed and the geneator bus will synchronize with the utility source. Once the synchronizing requirements have been met, the BCH1, 2 breakers will be closed. Load will be shed from the generator(s) to the utility and once below the low power threshold, the 25kV generator breaker will open, and subsequently the 600V generator breakers. Upon completion of cool down time delay, the generators will be shut down.
- .6 The number of generators required to be brought on line at any given time will be based on the following parameters:

- .1 Level of redundancy – a setting on the generator page will allow operators to determine whether an n+1 level of redundancy is required, or a minimal number of generators is acceptable.
- .2 The level of available fuel will be used as a factor for available generators and/or runtime. When an extended runtime is required, the TCS may be configured for minimal loading, no redundancy and therefore maximum runtime on available fuel. The TCS shall provide a constant, real-time predicted available runtime based on the actual available fuel, current ( averaged ) power levels and empirically derived fuel flows.
- .3 When used in a fully automatic mode, the TCS will determine the optimal number of generators to operate based on an extended runtime or n+1 configuration. The system will utilize pre-failure power levels on all controlled loads to determine the required power level, using prioritized loads for shedding as required. The system will know the current and expected requirements for critical loads including the following:
  - .1 **Main dewatering pumps** – if water level in the dock is between high and low levels, it will be assumed that a dewatering operation is underway. Power capacity will be reserved in the system suitable for starting and running one main dewatering pump ( 1000HP ).
  - .2 **Auxiliary dewatering pumps** – if water level in the dock is at an 'empty' state, it will be assumed that a maintenance dewatering operation may be required, such that the auxiliary dewatering pump may be called to operate. The TCS will reserve suitable capacity for starting and running one auxiliary dewatering pump ( 250HP).
  - .3 **Travelling cranes** – the digital metering system, using recent loading data, will determine whether any of the three cranes were recently in use pre-failure. The TCS will reserve suitable capacity for starting and running the correct number of cranes based on recent power usage.
  - .4 **Air Compressors** – Usage and demand on the air compressor system will be considered pre-failure and appropriate power reserves will be made in the generator system. The numbers of compressors required can be manually overridden to allow for extended runtime and manual reduction of air demand. The TCS shall reserve suitable capacity based on recent compressor demand information.
  - .5 **Building loads** – Building and infrastructure loads will be provided for based on recent demand data. Time of day will be a consideration and if building loads are low, and it is after normal operational hours, this load may be considered lower priority, but

will be considered high priority during the normal operating hours regardless of load levels. All lifts stations, pump stations and other critical infrastructure loads will be allowed for at all time.

- .6 **Reserve loading** – The TCS will know when any of the ‘reserved’ loads are operating and actively deduct this from the generator capacity in reserve.
- .7 Automatic shedding of loads shall be initiated by the TCS based on available generator capacity, reserve loading and real-time power demands. Shedding of loads will be done on a priority basis such that lowest priority loads are opened first. The TCS shall monitor the real-time demand and make bring on loads as deemed suitable while preserving the required reserve. All load shedding or closing operation will be completed with a suitable damping factor to allow for loads to stabilize so as to allow any further loading decisions to be made.
- .8 Additional generator(s), if available may be brought on line as determined by preset parameters regarding loading, priorities, runtime and redundancy.
- .9 The TCS will be aware of generators that are ‘off’, faulted or out of fuel and adjust available load capacity accordingly. In the event of a fault or fuel depletion condition, additional or alternate generators may be brought line, if available.
- .10 Load Testing Modes – The TCS will provide a number of manual, automated and semi-automated modes for testing of the generators and transfer systems.
  - .1 **Manual Single Generator Static Test** – The TCS will provide a mode that will allow for the manual load banking ( with the static resistive load bank ) of any of the generators. The TCS will always be monitoring for a utility failure and will revert to a full automatic mode in the event of a utility failure. This mode will, by interfacing with the HMI, start one generators, close the genrator breaker and engage the load bank. Full monitoring and recording of all operational parameters will be provided for review of data as required.
  - .2 **Multiple Generator Static Test** - The TCS will provide a mode that will allow for the manual load banking ( with the static resistive load bank ) of any combination of the generators. The TCS will always be monitoring for a utility failure and will revert to a full automatic mode in the event of a utility failure. This mode will, by interfacing with the HMI, start the appropriate generators, allow the generators to synchronize and close to the generator 600V bus and engage the load bank. Full monitoring and recording of all operational parameters will be provided for review of data as required. This mode can be used ensure correct operation of the 600V generator breakers and synchronizer relays.
  - .3 **Multiple Generator Site Test, Closed Transition** - The TCS will provide a mode that will allow for use of the site as a load and for any combination of the generators. The TCS will always be

monitoring for a utility failure and will revert to a full automatic mode in the event of a utility failure. This mode will, by interfacing with the HMI, start the appropriate generators, allow the generators to synchronize and close to the generator 600V bus and synchronize with the utility at the 25kV generator breaker. A closed transition transfer will occur at this time, that will gradually transfer loads to the generator. Once a low load condition is met, the utility circuit breakers will be opened. Note that the transfer of load to generator will be inhibited if the current site loading exceeds the capability of the connected generators. Full monitoring and recording of all operational parameters will be provided for review of data as required. A controlled return to normal state will be initiated upon completion of this test. This mode can be used ensure correct operation of the 600V generator breakers, 25kV generator breaker and synchronizer relays as well as utilizing site loading to suitably load the generator system.

- .4 If the static resistive load bank is in use at the time of a utility failure, the TCS shall immediately shed this load and put the TCS system back into automatic mode.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Existing System
  - .1 Review and thoroughly understand all existing programmed logic and installed hardware of the existing digital metering system, including inputs/outputs that are to be read by the TCS system or that shall be read using software protocols.
  - .2 New TCS shall be fully operational and commissioned prior to implementing. All transitions or phased cutovers to existing equipment must be approved by the Owner in advance and must be presented as part of the shop drawing submittals. Approaches or methodologies that compromise the safety of operation of the facility, as determined by the Owner, will be rejected.
  - .3 All existing functionality will remain in place after the installation of the new TCS. Any modifications to existing equipment, cabling or infrastructure to support the revised system architecture, communications or software requirements is the responsibility of the contractor.
  - .4 Upon successful demonstration of the new TCS, all equipment made obsolete and noted for removal in these drawings shall be removed. All digital metering equipment shall be carefully removed and handed over to the Owner in the current operational state that is was in, prior to removal.
  - .5 All existing workstations shall be retained, and new client viewing software, complete with all required licenses, shall be installed for correct operation with the new TCS.
- .2 New PSS
  - .1 The new PSS shall be fully tested and commissioned, to that extent possible, prior to arriving on site. This testing will include at a minimum all new switchgear, low voltage distribution and motor controls. The



equipment and networking will be mocked up and all functions demonstrated to the satisfaction of the Departmental Representative. A minimum of 96 hours notice must be provided as to the initiation of this testing.

- .2 Install, test and fully commission all communications cabling to appropriate EIA/TIA Category 6 STP standards prior to connecting to equipment. All communications equipment shall be fully tested and deemed acceptable by manufacturer's representative prior to connecting to PSS.
- .3 All Digital Meters, protection relays, generator/transfer controls, circuit breakers and other devices communicating via Ethernet or serial communications shall be configured to use a protocol or language native to both the field devices and the PSS software. Intermediate protocol or language convertors will not be accepted.
- .4 All PSS communications equipment shall be grouped together and mounted in the Communications closet co-located at each substation. Equipment specific to the TCS and interconnecting within the Generator Switchboard or to generators can reside in the Generator Switchboard. This equipment shall be arranged to be as compact as possible while not reducing access for maintenance, inspections or additions. Connect to a dedicated UPS circuit.
- .5 All existing PSS server equipment is located in the control room co-located at each substation.
- .6 PSS/TCS vendor/integrator/contractor shall provide all required time as need to fully commission, program, and test and demonstrate the complete TCS system to the satisfaction of the Departmental Representative. This work phase shall be undertaken early enough such that unexpected delays do not hinder or delay to completion of the project to the schedule provided. Deployment of additional forces by the aforementioned parties to complete this project in a timely fashion is expected.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

### **3.4 DEMONSTRATION AND TRAINING**

- .1 The vendor of the PSS/TCS software and integrator shall provide a complete and thorough demonstration of all functionality of the PSS/TCS, including full array of operational modes, simulated alarms, trending, viewing of data, fault finding,

- waveform capture, sequence of operations, remote equipment operation and navigation around the TCS software.
- .2 The demonstration will be conducted three times, with approximately six attendees in each session. Documentation and operational guides shall be provided to all attendees.
  - .3 Four training sessions shall be provide for four attendees per group. This training would be performed on site, on the actual equipment being operated on, or in meeting room facilities at the site. These sessions, with a duration of approximately 30 hours, upon completion would provide training to give confidence in the operators with regards to the following tasks:
    - .1 Viewing of data.
    - .2 Viewing and acknowledging alarms.
    - .3 Output data/waveforms/alarms to hardcopy or pdf format for export.
    - .4 Navigation around all standard and custom GUI screens.
    - .5 Viewing data in protection devices, including fault information and waveform captures.
    - .6 Basic data manipulation related to trend data (max, min, plotting graphs, etc.).
    - .7 Use of manual and automatic revenue report generation.
    - .8 Discussion of basic troubleshooting for normal issues or problems.
    - .9 Overview of actual installed hardware, servers and software systems, including specification communications topologies and unique operational arrangements.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for liquid cooled electric diesel generating unit.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 78 00 - Closeout Submittals.

**1.3 REFERENCES**

- .1 Canadian Standards Association, (CSA International)
  - .1 CAN3-Z299.3-85(R1997) (R2002), Quality Assurance Program - Category 3.
  - .2 CAN/CSA-B139-15 (2015 version) Installation Code for Oil Burning Equipment;
- .2 International Organization for Standardization (ISO)
  - .1 ISO 3046-1-2002, Reciprocating internal combustion engines - Performance - Part I: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use.
  - .2 ISO 3046-4-1997, Reciprocating internal combustion engines - Performance - Part 4: Speed governing.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA MG 1-1998, Motors and Generators.
- .4 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - March 1998.
- .5 National Research Council - Canada
  - .1 2015 National Fire Code of Canada (NFC);
- .6 Canadian Council of Ministers of the Environment ( CCME )
  - .1 2003 CCME Environmental Code of Practice for Above Ground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME);
- .7 Environment and Climate Change Canada
  - .1 2008 Federal Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (STR)

**1.4 SYSTEM DESCRIPTION**

- .1 Provide automatic, unattended, standby power supply system consisting of:
  - .1 Liquid cooled low voltage diesel electric generating units with remote operated generator breakers and consolidated generator and transfer controls.

- .2 Self contained, sub-base double wall fuel tank.
- .3 Accessories and equipment specified in this specification.
- .2 Provide design, fabrication, testing, transportation, demonstration and equipment warranty.
- .3 Proprietary or onboard synchronizing/load control systems will not be accepted.
- .4 Overall Description
  - .1 Standby power system will consist of three generators with a future fourth generator. The fourth generator will be fully provisioned in this contract aside from the actual generator and associated cabling; all generator controls, protection, indicators and operators required for operation will be installed in the generator control panel/transfer controller.
  - .2 The generator/diesel controller shall be located at the generator assembly. A motor operated, remotely controlled synchronizing circuit breaker shall be mounted at each generator assembly that shall be controlled via the transfer controller, protective relay and SCADA system.
  - .3 The generator protection relay shall be located at the generator control board located in the SES. All required sensing wiring, control cabling and power cabling shall be run to the generator as required.
  - .4 The generator enclosure shall contain LED service lighting controlled by a local switch along with a self contained battery powered emergency light set to operated on the failure of the lighting circuit.
  - .5 A local panelboard will be installed in each generator enclosure to provide power for: block heater, battery charger, lighting, convenience receptacle and accessory devices as required.

## 1.5 DESIGN REQUIREMENTS

- .1 Design equipment to meet following requirements:
  - .1 Total load: 750 kW, 0.8pf.
  - .2 Voltage: 347/600 V.
  - .3 Frequency: 60 Hz.
  - .4 Phase/Wire: 3 phase, 4 wire.
  - .5 Power factor: 0.8.
  - .6 Load harmonic content: 20% THD.
  - .7 Maximum rotational speed: 1800 rpm.
  - .8 Duty rating: full load continuous plus 10% overload for 1h in every 12h period.
  - .9 Performance: automatic.
  - .10 Elevation above sea level: 40 m.
  - .11 Ambient temperature: 40 °C.
  - .12 Relative humidity: 60 %.
- .2 Design unit capable of starting, settling to specified steady state bands, within 10 seconds for any temperature between -15°C to 40 °C.

- .3 Use engine manufacturer's standard, published continuous (prime) horsepower rating in assessing engine capacity and derate this rating for specified conditions and engine driven accessories in accordance with ISO 3046-1.
- .4 Description of generating set operation:
  - .1 Automatic starting, stopping, synchronizing and load control shall be handled by the generator control switchboard and transfer controller.
  - .2 Adjustable time delay relay to allow engine to run unloaded to cool down and subsequently to shut down, ready for next cycle.
  - .3 Equip engine with key switch with following positions: auto-off-crank-start, key removable in auto position only.
  - .4 Automatic shut down on:
    - .1 Overcranking.
    - .2 Overspeed.
    - .3 High Engine Temperature.
    - .4 Low lubricating oil pressure.
    - .5 Over and under frequency.
    - .6 Emergency breaker failure.
    - .7 Remote shutdown signal from generator controller, circuit breaker or transfer controller.

## 1.6 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Dimensions and data in metric units and symbols followed by in bracket imperial units and symbols wherever applicable.
- .2 Include following:
  - .1 Engine: make, model, rating and performance curves.
  - .2 Starter motor, make model.
  - .3 Generator: make, model and rating complete with generator saturation curves, heat damage curves, reactive capability and special data.
  - .4 Voltage regulator: make, model, type.
  - .5 Governor: type, model.
  - .6 Battery: make, type, voltage, capacity.
  - .7 Charger: make, model, input and output rating.
  - .8 Submit general outline drawing of complete assembly showing engine, radiator and generator mounting, exhaust, recirculating and intake air louvre arrangement, exhaust gas silencer and pipe arrangement, locations of fuel and lubricating oil filters, fuel supply and return line connections, lubricating oil drain valve, [radiator and coolant drain valves], air cleaner, engine instrument panel, starting motor, power and control junction boxes, engine and generator mounting feet. Indicate on drawings:
    - .1 Horizontal and vertical dimensions.
    - .2 Minimum door opening required for moving unit.
    - .3 Head room required for removal of piston and connecting rod.

- .4 Weight of engine, generator, baseplate, and radiator and exhaust silencer.
  - .9 Baseplate construction details and materials.
  - .10 Transfer and bypass system: make, model, type.
  - .11 Outline and layout of panels.
  - .12 Schematic and wiring diagrams of engine, generator, control panel, and power panels complete with interconnecting wiring diagrams.
  - .13 Single line diagram showing all breakers, switches, metering and protective relays.
  - .14 Field wiring diagrams.
  - .15 Complete bill of materials, including manufacturer's name, catalogue numbers and capacity.
- .3 Lubricating oil system: where oil pump not provided, submit certification to ensuring oil pump is not required and will not detract from service life of engine.

#### 1.7 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for diesel generating units for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Asbuilt drawings of the fuel tanks shall be signed and sealed by a Professional Engineer prior to filling the tanks on site.
- .3 Provide following in English for incorporation into instruction manuals:
  - .1 Complete set of reviewed shop drawings.
  - .2 Factory test data of engine, generator, exciter, control logic, metering and other pertinent test data.
  - .3 Maintenance and operation bulletins for:
    - .1 Engine and Accessories.
    - .2 Generator.
    - .3 Voltage Regulator and Accessories.
    - .4 Exciter.
    - .5 Permanent magnet generator.
    - .6 Battery charger.
    - .7 Speed Governor.
    - .8 Starting Motor.
    - .9 Batteries.
    - .10 Ventilating Equipment.
    - .11 Timers, Relays, Meters.
    - .12 Power Circuit Breakers.
    - .13 Controller, Contactors.
    - .14 Other Accessories.
- .4 Submit original brochures; photocopies are not acceptable. Include technically relevant data.
- .5 Complete sequence of system operation.

- .6 Complete bill of materials including nameplate data of equipment and accessories.

**1.8 QUALITY ASSURANCE**

- .1 Do work in accordance with CAN3-Z299.3.

**1.9 DELIVERY, STORAGE AND HANDLING**

- .1 Prepare, crate and protect equipment against shipping and storage damage.
- .2 Provide minimum 12.5 mm plywood outer covering single vapour barrier inside.
- .3 Provide minimum 20 mm plywood outer covering with one side finished and double vapour barrier and sufficient desiccant for one year's [remote] storage.
- .4 Mount unit and panel on shipping skids with plank floor.
- .5 Each package to have shipping weight, address, dimensions and Department D number and brief description of contents stencilled on at least two sides.
  - .1 Staple on outside packing list contained in waterproof envelope.
  - .2 Place copy of packing list inside.

**1.10 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Dispose of unused paint material at official hazardous material collections site approved by Departmental Representative.
- .6 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or other location where it will pose health or environmental hazard.
- .7 Dispose of unused lubricating oil and fuel material at official hazardous material collections site approved by Departmental Representative.
- .8 Dispose of unused batteries material at official hazardous material collections site approved by the Departmental Representative.
- .9 Fold up metal banding, flatten and place in designated area for recycling.

**1.11 MAINTENANCE - EXTRA MATERIALS**

- .1 For panels provide following:
  - .1 One spare control circuit breaker per rating.
  - .2 Twelve spare indicating light bulbs per rating.
  - .3 One spare control relay and socket per rating and contact arrangement.
  - .4 One spare contactor operating coil.

- .2 Provide generator unit with standard set of engine manufacturer's spare parts for normal operation of 1,000 operating hours. Spares to include:
  - .1 Twelve fuel filter elements for each type of fuel filter/water separator.
  - .2 Twelve lubricating oil filter elements.
  - .3 Six air cleaner elements.
- .3 Provide conclusive evidence that Canadian distributor has been established and will stock in Canada spare parts likely to be required during normal life of engine.

### 1.12 MAINTENANCE - TOOLS

- .1 Supply suitable engine barring device and battery manufacturer's standard set of tools for battery service.
  - .1 Battery service tools to include hydrometer, one plastic bottle for topping up purposes and one insulated battery terminal wrench.

## Part 2 Products

### 2.1 ASSEMBLY

- .1 Provide following items plus such other items as necessary to make unit complete:
  - .1 Diesel Engine.
  - .2 Diesel Engine Accessories.
  - .3 Baseplate and Drip Pan.
  - .4 Vibration isolators.
  - .5 Governor.
  - .6 Engine Exhaust System.
  - .7 Engine Cooling System.
  - .8 Engine Ventilating System.
  - .9 Starting Motors.
  - .10 Batteries and Rack.
  - .11 Battery Charger.
  - .12 Generator and Exciter.
  - .13 Voltage Regulator and Accessories.
  - .14 Spares and Accessories.

### 2.2 MOUNTING

- .1 Connect engine flywheel housing rigidly to generator stator housing with SAE adapter.
  - .1 Mount unit on common, heavy duty fabricated steel baseplate.
  - .2 Obtain approval for design and materials of baseplate from engine manufacturer and Departmental Representative.
- .2 Baseplate: rigid material to maintain alignment of engine-generator shafts and frames under shipping, installation and service conditions.
- .3 Install machine engine-generator feet and baseplate sole plates parallel and true.
  - .1 Shims: steel type, installed under generator feet.



- .4 Support baseplate on spring type isolating fixtures from welded side brackets located to support bottom of baseplate 25 mm above supporting floor.
  - .1 Isolators: cast iron housings, complete with levelling bolts, adjustable oil proof snubbers and minimum 6 mm sound pads.
  - .2 Isolation efficiency 95% minimum.
- .5 Determine quantity and location of isolators. Locate each isolator to carry equal proportion of weight and that pressure exerted on floor by each isolator does not exceed 345 kPa.
- .6 Ship isolators loose for installation at project site.

### **2.3 DIESEL ENGINE**

- .1 Full diesel, heavy duty, cold start, liquid cooled, vertical in-line or vee, and current manufacture of a type and size that has been service as a prime mover for electric power generation for not less than two years.
  - .1 Turbo supercharged engine acceptable providing brake mean effective pressure (BMEP) at rated output does not exceed 1800 kPa (225 psi).
  - .2 Mechanically driven superchargers not acceptable.
  - .3 Tier 4 EPA Emissions performance certification.
- .2 Engine: minimum of four (4) cylinders.
- .3 Engine with auxiliary starting aids (e.g., glow plug assist start) not acceptable.
- .4 Equip engine air intakes with dry type heavy duty air cleaners located close to inlet manifold.
  - .1 Cleaner element: directly replaceable with elements of Canadian manufacture.
- .5 Provide engine wiring in liquid-tight conduit and fittings with insulated bushings.
  - .1 Use stranded, minimum No.14 AWG, TEW 105°C and coloured coded wires.
  - .2 Terminate wiring with coded, insulated terminals flanged fork type. Terminal blocks heavy duty, screw type.
  - .3 Wire markers of slip on oil proof type.
  - .4 Junction boxes on unit of liquid-tight type.
  - .5 Maximum of two wires per terminal block.
- .6 Provide high quality lubricating oil pressure gauge, lubricating oil temperature gauge, tachometer, coolant temperature gauge, exhaust pyrometer and other standard gauges and instruments.
  - .1 Calibrate and scale gauges and instrument in both metric and imperial units and symbols.
  - .2 Mount oil temperature sensors on engine full flow pressure line.
  - .3 Hoses or tubing for gauges: high pressure reinforced type.
- .7 Mount unit accessories, including gauges, instruments, and protective sensors, to isolate or dampen vibrations.
- .8 Dynamically balance complete engine-flywheel generator arrangement after assembly.

- .1 Torsional or other vibration tolerance within 10% above or below rated speed of unit, when operating unloaded or connected to any load within its rating.
- .2 Cyclic irregularity: 1/250 maximum.
- .9 Provide engine flywheel with graduated marking around its periphery to facilitate fuel injection and valve timing.
- .10 Provide removable wet type cylinder liners.
  - .1 Furnish cylinder head with removable valve seat insert and guides.
- .11 Provide personnel safety guards for exposed moving parts and exhaust manifolds.
  - .1 Provide platform for servicing upper part of engine where applicable.
- .12 Engine control panel complete with:
  - .1 Lubricating oil pressure gauge.
  - .2 Lubricating oil temperature gauge.
  - .3 Coolant temperature gauge.
  - .4 Low coolant level gauge.
  - .5 Engine switch auto-off-crank-start selector switch and crank pushbutton.
  - .6 D.C. main power supply circuit breaker.
  - .7 Terminal blocks for connection to D.C. power supply, engine monitoring and shutdown device.
  - .8 Provide low oil pressure, high coolant temperature, and low coolant level and overspeed protection to shut down engine on manual operation.

## **2.4 COOLING AND VENTILATING SYSTEM**

- .1 Provide complete cooling and ventilating system for unit as indicated.
- .2 Thermostatically control system and maintain coolant, ethylene glycol, within engine manufacturer's tolerance, with unit operating at rated load under specified conditions. Cooling system engine mounted radiator type.
  - .1 Design and supply complete ventilating system as indicated where engine mounted radiator is required. Radiator cooling fan to be pusher type, minimum two belt drive with belt adjuster. Fan, pulley and belt with removable protective cage.
- .3 Provide drain valves for draining coolant from engine block and radiator.
  - .1 Drain coolant conveniently into large container through flexible extensions.
  - .2 Dripping valves or leaking connections will not be permitted.

## **2.5 LUBRICATION SYSTEM**

- .1 Provide full pressure lubricating system complete with duplex filters and oil cooler.
- .2 Oil pump: engine driven gear type complete with strainer.
- .3 Equip filters with automatic by-pass valve and full flow filter elements conveniently located for servicing and directly replaceable with elements of Canadian manufacture.

- .1 Cooler to have sufficient capacity to maintain oil temperature within engine manufacturer's tolerances with unit operating at rated load under conditions specified.
- .4 Equip engine oil sump with oil drain pipe, gate valve and pipe cap.
  - .1 Permit complete drainage in a convenient manner.
- .5 Ensure unit is able to start and assume full rated load within the specified time period when, operational requirements are such that unit may lay idle for periods up to one month.
  - .1 Provide electrical motor driven, integrally mounted, gear type oil priming pump with interval timer and breaker type combination starter.
  - .2 Lubrication oil pressure switch to stop priming pump when engine is running.
- .6 Metallic oil hoses: steel reinforced rubber type with crimped or swaged end fittings.

## 2.6 FUEL SYSTEM

- .1 Provide complete fuel system including fuel lift pump and duplex filters.
  - .1 Filter elements to be directly replaceable with elements of Canadian manufacture.
- .2 Bring fuel supply and return lines to extreme forward part of baseplate with drop ear elbows. Connect other end of each elbow with 1 m of flexible neoprene hose.
- .3 Non-metallic fuel hoses: steel reinforced rubber type with crimped or swaged end fittings.

## 2.7 EXHAUST SYSTEM

- .1 Provide complete exhaust system including heavy duty critical type silencer with condensate drain, plug and flanged couplings; stainless steel, corrugated expansion joints, length to suit, to absorb both vertical and horizontal expansion; flanges, bolts, gaskets, adjustable hangers and pipe and pipe-thimble to permit projection of pipe 1.0 m beyond wall.
  - .1 Exhaust tail pipe end at 90 degree angle and terminate in bird screen. Insulate all interior exhaust piping, turbo and silencer.
  - .2 Exhaust system discharge shall be oriented to the south of the site.
- .2 Arrange exhaust system to suit openings.
  - .1 Where schedule of dimensions does not indicate location of opening, arrange exhaust run best suited to engine.
- .3 Provide exhaust pyrometers located on common exhaust manifold or two pyrometers on separate manifolds.
  - .1 Pyrometer range to include temperature at 110% load.

## 2.8 JACKET COOLANT HEATER

- .1 Provide engine jacket coolant heater(s) complete with 20°C to 60°C adjustable immersion type thermostat. Size heater(s) to maintain coolant at 40°C in an ambient temperature of 0°C.
- .2 Obtain circulation of heated coolant on thermosiphon principle.

- .1 However, if this does not provide sufficient circulation to avoid hot spots in system, provide electrical motor driven circulating pump to operate automatically when heater is energized.
- .2 Motor: 120V single phase splash-proof type complete with breaker type combination starter.
- .3 Starter mounted in control panel.

## 2.9 SPEED GOVERNOR

- .1 Provide full electronic governor with speed changer and dry type actuator.
  - .1 Governing system: in accordance with ISO 3046-4.
  - .2 Isochronous control for single units with synchronizing control for parallel units as controlled by synchronizing relays and generator speed controllers.
- .2 Governor with following features:
  - .1 Ten turn locking type manual speed adjustment.
  - .2 Speed regulation, steady state, no-load to full load and vice versa: +/-0.25%.
  - .3 Transient peak, no-load to full-load and vice versa +/-10%.
  - .4 Recovery time to steady state condition on application of full load from no load not to exceed 3 seconds.
  - .5 Frequency: externally adjustable from zero to 5% while engine is running.
  - .6 Class A accuracy.

## 2.10 STARTING SYSTEM

- .1 Provide complete starting system including cranking starting motor, batteries, heavy-duty battery cables and battery charger.
- .2 Provide positive engaging type cranking motor. Cranking motor and flywheel ring gear arrangements which may permit tooth to tooth abutment are not acceptable.
- .3 Provide lead acid battery with sufficient capacity in ambient room temperature of 0°C to crank unit at engine manufacturer's recommended cranking starting speed for period of 3 minutes.
  - .1 Voltage measured at starting motor terminals at end of 3 minutes cranking, with cranking current flowing, not less than 1.75 V per cell.
  - .2 Size battery to suit engine and battery manufacturer's published data.
  - .3 Batteries: dry charged, specific gravity of electrolyte 1.220 when fully charged at 27°C.
  - .4 Battery termination: bolt-on or study type.
  - .5 Protect terminals and exposed electrical connections from accidental short circuit by falling conductive objects on battery.
- .4 Provide battery charger with 120 volt AC input and output equal to 1.20 of ampere-hour capacity of battery based on 8h rate.
  - .1 Output voltage ripple: 3% or less.
  - .2 Provide AC input circuit breaker and 24h terminating equalizer timer with approximately 4 m of connecting cord and permanent connectors for connecting to battery terminals.

- .3 Provide 5 spare fuses inside charger panel.
- .4 Charger: CSA approved.
- .5 Provide necessary heavy duty, maintenance-free battery cables and connectors.
  - .1 Select cable wire size on the basis of allowing not more than 5% voltage drop at time of peak load.
  - .2 Cable length sufficient to allow battery location on either side of engine.
- .6 Fit turbocharged engines with one spring actuated, two stage accumulator per turbocharger to automatically provide pre-start and post run lubrication to turbocharger(s).

## 2.11 GENERATOR

- .1 Provide generator, drip proof, single bearing and close coupled to engine with SAE housing: to NEMA MG 1.
  - .1 Generator: full amortisseur winding, direct connected brushless exciter with easily removable bolt-on diodes with surge protection.
- .2 Maximum deviation of open circuit terminal voltage waveform not to exceed 5%.
- .3 Provide permanent magnet generator (PMG) for generator short circuit sustaining capability not less than 3 times rated current for a minimum of 10 seconds.
- .4 Generator winding insulation: Class F; winding temperature rise not to exceed 80°C as measured by resistance in ambient temperature of 40°C.
- .5 Identify generator windings with metal tags.
  - .1 Bring windings to insulated terminals in metal junction box mounted on side or top of generator.
  - .2 Size junction box to permit mounting of engine and generator low voltage controls and wiring terminals blocks.
  - .3 Provide barrier in junction box to separate low and high voltage wiring.
- .6 Provide voltage regulation system complete with auto/manual control module.
  - .1 Voltage regulator: capable of withstanding continuous vibration, 15 shock and temperature up to 50°C while maintaining accuracy to plus/minus 1%.
- .7 Steady-state voltage regulation not to exceed 1%.
  - .1 Transient voltage regulation, when full load is applied or removed, not to exceed 10% when measured by oscilloscope or high speed strip chart recorder with recovery time to steady-state less than 3 seconds.
- .8 Design equipment to minimize radio frequency interference (RFI) under operating conditions.
  - .1 Balanced telephone influence factor (TIF) to: NEMA MG 1.

## 2.12 PANEL - GENERAL

- .1 Panel: indoor, dead front, metal-enclosed steel construction complete with lifting eye bolts.
  - .1 Doors: formed edges, reinforced by stiffeners and complete with lockable handles.
- .2 Design and construct panel to withstand strains, jars, vibrations and other conditions incident to shipping, storage, installation and service.

- .3 Panel CSA certified. Mount a nameplate bearing CSA monogram in a prominent position on panel.
- .4 Identify instruments and controls with lamacoid or metal engraved nameplates fastened by rivets or screws for permanent identification.
  - .1 Identify door mounted items with nameplates.
  - .2 Attach nameplates to removable items such as relays and wireway covers.
- .5 Provide panel with bolted rear covers.
- .6 Factory wire panel completely. Use stranded, minimum No.14AWG, TEW 105°C and coloured for control wiring. Use No.10AWG for CT secondary connections:
  - .1 Blue - DC control.
  - .2 Red - AC control.
  - .3 Black - PT secondary connections.
  - .4 Orange - CT secondary connections.
  - .5 Green - non-current carrying ground.
  - .6 White - current carrying ground.
  - .7 Yellow - interlocks.
  - .8 Brown - generator excitation system.
- .7 Code wiring at each wire end with permanent, non-aging slip on markers. Support and run wiring neatly. Protect wiring from mechanical damage by grommets and shields.
- .8 Code terminal blocks, clamp type, serrated for positive grip and of tough, non-brittle, unbreakable nylon, size 3,453/0 or equivalent.
  - .1 For current transformer secondary circuits, provide terminals blocks of dual connector type.
  - .2 Provide test block for current transformer secondary connections.
- .9 Provide door detent mechanism to maintain hinged door at open position.
- .10 Supply loose 2 sets of wiring markers for each external wiring connection. Place markers in plastic bag and secured inside panel.
- .11 Use wiring duct for interconnection within panel.
- .12 Direct inter-panel connection not permitted, use terminal blocks.

### **2.13 CIRCUIT BREAKERS**

- .1 Generator shall come factory equipped with integrated circuit breakers mounted to generator assembly, size and quantity as noted in drawings.
- .2 Circuit breakers shall be moulded case, with interrupting capacity as required per generator performance.
- .3 Circuit breaker shall be motor operated and suitable for use a generator-synchronizing breaker.
- .4 See 26 28 21 – Moulded Case Circuit Breakers.

### **2.14 CONTROL PANEL**

- .1 Provide control panel for controlling engine generator unit.
- .2 Provide hinged front door and internal sub-panel.

- .3 Panel dimensions and layout.
- .4 Mount terminal blocks on common mounting strips for interconnection wiring between the following:
  - .1 Sub-panel and panel door.
  - .2 Sub-panel and external wiring from diesel generator unit circuits.
  - .3 Sub-panel and external indicating circuits.
  - .4 Sub-panel and secondary circuits of power sub-cubicle.
  - .5 Sub-panel and external wiring from transfer control panel.
- .5 Terminal blocks: CSA approved, clamp type, serrated for positive grip and of tough, non-brittle unbreakable nylon material; maximum two wires per terminal block.
  - .1 Use factory made terminal block jumpers wherever necessary.
- .6 Provide circuit breakers for equipment protection: use fuses where breakers are not applicable.
- .7 Provide top and bottom entry for power and control cables. Provide removable bottom plate.

## **2.15 SUBBASE**

- .1 The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
- .2 The generator set shall be equipped with factory installed vibration isolators mounted between the set and fabricated steel base to prevent distortion of alignment between generator and engine when installed.

## **2.16 GENERATOR SUBBASE TANK**

- .1 Provide an in-skid sub-base diesel fuel tank, in size suitable for 72 hours operation of the engine at 50% loading for the generator set. The fuel tank shall be a standard product of the manufacturer of the engine-generator set. The tank shall be ULC listed, made of aluminized steel, with welded construction, and pressure tested to 5 psi.
- .2 The tank is to be dual wall complete with interstitial alarm connected to generator control panel and SCADA system.
- .3 The fuel tank shall be provided with a fuel level sensing at 1/8, 1/4, and 1/3 levels. An analog level sensors shall be provided with a scaled 0-10V or 4-20mA output to be connected into the generator controller for integration into the SCADA system.
- .4 Refer to Section 1.7 for earthquake restraint.
- .5 All tank sensors shall be installed such that there is a service loop in the wiring to allow for removal of the sensor from the tank with wiring intact confirming correct operation of the sensor.
- .6 Contractor is to provide all fuel required for testing, commissioning and demonstration purposes and is to leave the tanks in a 100% full state at substantial completion.
- .7 Tanks shall be constructed to one of the acceptable standards listed in the National Fire Code of Canada and CSA B139-15, Installation Code for Oil

Burning Equipment. The ones which are suitable and are listed in both the NFC and CSA B139 are limited to the following:

- .1 CAN/ULC-S601, "Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids,"
- .2 CAN/ULC-S653, "Aboveground Steel Contained Tank Assemblies for Flammable and Combustible Liquids,"
- .3 CAN/ULC-S655, "Aboveground Protected Tank Assemblies for Flammable and Combustible Liquids,"
- .8 Tank fill pipe openings shall be located outside of the equipment enclosures and shall be equipped with tight fill connections, with weathertight covers, designed to prevent tampering.
- .9 Tank fill connections shall be located in spill containment devices that conform to ULC/ORD C149.19, CAN/ULC-S663 or ULC/ORD C58.19.
- .10 Visual tank level gauges shall be provided at the tank fill points.
- .11 Tanks shall be provided with audible/visual overflow protection devices conforming to CAN/ULC-S661, set to operate at 90% of tank capacity, located at the fill points.
- .12 Tank fill pipes shall be provided with positive shut off overflow protection devices conforming to CAN/ULC-S661, set to operate at 95% of tank capacity.
- .13 Tank normal and emergency vent pipes shall terminate outdoors and at heights specified in NFC.
- .14 Each tank shall be provided with two spare 50mm (2") plugged top openings for possible future transfer system - location to be approved prior to tank manufacture
- .15 Each tank shall be provided with suction and return pipe connections to facilitate "fuel polishing" - location and arrangement to be approved prior to tank manufacture.
- .16 The tank installations must be supervised and signed off by an I.T.A. Certified Petroleum Equipment Installer.
- .17 Provide as-built drawings (stamped by a P. Eng) before the tank can be filled.
- .18 Supply and install the Environment Canada Identification Label once it has been provided by the Departmental Representative.

## **2.17 SPILL RESPONSE KIT**

- .1 Supply a mobile spill response kit with a sorbent capacity of 350 litres.
- .2 Spill response kit shall be contained in a weatherproof, UV resistant enclosure and permanently mounted in a readily accessible location at the fuel transfer area for EACH GENERATOR.

## **2.18 GENERATOR ENCLOSURE**

- .1 The sound attenuated generator housing shall be a minimum 12 gauge, marine-grade (copper free, 5000 series) Aluminum, rigid, free-standing, vandal-resistant



cabinet, fabricated to EEMAC 3 standards with sufficient bracing to form a structure capable of withstanding wind, snow and ice loading. The roof shall have a minimum 25 mm overhang and provide rain gutters over all doors and openings. All hinges shall be internally mounted and concealed, with grease fittings as required. External hinges will not be accepted. Note that stainless steel enclosures will be considered.

- .2 All enclosure sheet metal shall be primed for corrosion protection and finish painted with a powder coat finish. The finish paint and color shall be polyester RAL color code RAL 7004 or approved equal. **Note that RAL Code is subject to final approval by Departmental Representative during final shop drawing review.**
- .3 Access to all regularly serviced items within the enclosure shall be provided by at least two hinged lockable doors on each side. All handles shall be recessed or flush when in the locked state.
- .4 The enclosure must be vandal resistant. Externally accessible fasteners shall preferably be blind head (e.g. stove bolts) although Allen head will be permissible. Air inlet and outlet openings shall be designed such that objects of any size directed at the enclosure from vertically downward to horizontally flat cannot enter and shall be sized such that inlet air velocity is below the level at which water penetration will occur. No other enclosure openings will be allowed.

## 2.19 GENERATOR NOISE

- .1 The engine exhaust system shall incorporate a seamless, stainless steel flex-connector and critical silencing type muffler, all mounted within the genset enclosure. Discharge shall be into the air outlet hood, downstream of the radiator. Sound attenuated air inlet and discharge hoods with opening bird screens shall be rectangular in shape and match the profile of the enclosure.
- .2 Genset overall full load operating noise level shall be less than **68 dbA** when measured at a distance of **7** meters from any side of the enclosure and 1 meter above ground. This shall be demonstrated and will be verified on site. Manufacturer will be required to ensure that noise levels meet the requirements as stated herein at the time of installation/commissioning.
- .3 Ducting and sound attenuation components shall be designed and supplied by an approved manufacturer specializing in this type of work.

## 2.20 SIGNS

- .1 Provide at front top of each panel and on each generator junction box, lamacoid or metal engraved identification nameplate.
  - .1 Provide nameplates with letter and number identification designation to be given at time of acceptance tests.
- .2 Provide and attach to unit in prominent location, bilingual warning sign.

- .3 Where metric tools are required to service engine-generator unit, provide bilingual warning sign.
- .4 Provide signage in accordance with NFC 2015 4.3.1.7 "A storage tank and its filling and emptying connections shall be identified in conformance with CFA 1990, "Using the Canadian Fuels Colour-Symbol System to Mark Equipment and Vehicles for Product Identification."
- .5 Supply and install signage outlining the site specific fill procedure sign to be posted at each tank fill port. Details to be provided by the Departmental Representative.
- .6 Supply and install signage outlining the site specific emergency response procedures. Details to be provided by the Departmental Representative.
- .7 Supply and install a weather proof cabinet for storage of the site specific emergency response plan documentation.
- .8 Final details for all signage to be approved during shop drawing submittal and review.

## **2.21 FINISHES**

- .1 Clean, finish and paint equipment with smooth and durable finish.
  - .1 Use grey gloss paint; inside of panel white gloss in accordance with The Master Painters Institute (MPI) schedule of paint colours.
- .2 Provide one half pint can of grey gloss paint for touch up.

## **2.22 WORKMANSHIP**

- .1 Manufacture and construct equipment free from blemishes, defects, burrs and sharp edges; accuracy of dimensions and marking of parts and assemblies; thoroughness of welding, brazing, painting and wiring, alignment of parts and tightness of assembly screws and bolts.

## **2.23 QUALITY CONTROL**

- .1 General: before acceptance, assemble and set up the unit, complete with specified equipment, for tests on site.
  - .1 Ensure tests are witnessed by Departmental Representative on mutually agreed date.
  - .2 Provide suitable test area with adjustable loading facilities.
  - .3 Ensure that engine has run in sufficiently prior to load test, test forms completed, system debugged and recorders connected.
- .2 Product examination: complete mechanical and electrical examination to determine compliance with specification and drawings with respect to materials, workmanship, dimensions and marking.
- .3 Non-operational tests and checks: perform following test and checks before starting the unit:
  - .1 Shaft alignment, end float, angular and parallel.
  - .2 Cold resistance of generator windings.
  - .3 Belt tensioning.

- .4 Equipment grounds.
- .5 Electrical wiring.
- .6 All grease lubricating points.
- .7 Personnel safety guards.
- .8 Air cleaner.
- .9 Coolant.
- .10 Lubricating oil type and level.
- .11 Type of fuel.
- .12 Vibration isolator adjustment.
- .13 Temperature and pressure sensors.
- .14 Engine exhaust system.
- .15 Tools.
- .16 Spares.
- .4 Operation test and check: on completion of non-operational tests and checks, start unit cold. Provide multi-channel recorder and record following:
  - .1 Time for unit to start and reach settled voltage and frequency.
  - .2 Time from initiation of start to full load application, with voltage and frequency settled.
  - .3 Voltage and frequency transient and steady state limits for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa. Measure machine vibration levels under the same load conditions.
  - .4 Record battery voltage drop during cranking.
- .5 Protection and control demonstration: on completion of operation test and check, demonstrate following:
  - .1 Overheat protection.
  - .2 Low oil pressure protection.
  - .3 Cranking cut out.
  - .4 Overcrank protection (3 tries).
  - .5 Overspeed protection.
  - .6 Under and over frequency.
  - .7 Under and over voltage.
  - .8 Electrical fault protection:
    - .1 Failure to close breaker.
    - .2 Failure to build up voltage.
    - .3 Generator short circuit and overcurrent.
  - .9 All control functions.
- .6 Load tests: load test the unit for 4h at full rated load in ambient temperature in excess of 20° C. Take following data at start of load test and every [one hour] interval thereafter:
  - .1 Frequency.
  - .2 Voltage.
  - .3 Current.

- .4 Kilowatts.
- .5 Generator winding temperature.
- .6 Generator frame temperature.
- .7 Engine coolant temperature.
- .8 Oil temperature and pressure.
- .9 Manifold pressure.
- .10 Ambient room temperature.
- .11 Generator cooling air outlet temperature.
- .12 Exciter field current and voltage.
- .13 Vibration displacement.
- .14 Ambient air temperature inside panel with all doors closed.
- .7 Miscellaneous: provide accurate means for determining fuel and lubricating oil consumption.
  - .1 Provide strip chart recorders for monitoring frequency, voltage and load.
  - .2 Provide recorder with ability to select speeds to allow accurate measurement of voltage, frequency and time during tests.
  - .3 Calibrate recorder by the recorder manufacturer (or designated representative) within three months of factory testing.
- .8 Interpretation of ambient room temperature: consider ambient room temperature as that temperature, which is lowest temperature registered out of a group of three thermometers when placed in engine room as follows:
  - .1 One thermometer located on each side of engine block, approximately two-thirds of length of block back from front (radiator) end of block, 900 mm out from block and at height equal to height of block
  - .2 Locate third thermometer over end of exciter on unit centre line, approximately 150 mm above top of exciter.
  - .3 Take thermometer showing lowest temperature to give true ambient air temperature.
  - .4 Adjust temperature to maintain this thermometer at 40°C during heat test.
- .9 Voltage and frequency regulation tests: on completion of load tests take hot resistance reading of generator windings.
  - .1 Subject the unit to hot voltage and frequency regulation tests for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa.
- .10 Panel performance and functions: check sequence of operation under service conditions.
  - .1 Make provision for supplying and connecting required levels of voltage for primary circuits.
  - .2 Test overcurrent relays by impressing current in secondary circuits.
- .11 Hi-pot tests: perform over potential tests on primary and secondary wiring in accordance with NEMA, NETA.
- .12 Additional tests: perform tests, consistent with contract, which Departmental Representative may require to satisfy adequacy and satisfactory operation of the unit.

- .1 Complete forms with requisite information pertaining to make, model and serial numbers prior to test.
- .13 Record test data on appendix forms, recording charts and manufacturers' test forms and be complete with diagrams and description of test results, deficiencies and corrective action.
  - .1 Ensure test data sheets signed by supplier and Departmental Representative.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## Part 1 GENERAL

### 1.1 SECTION INCLUDES

- .1 Materials and installation for towable liquid cooled electric diesel generating unit.

### 1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 78 00 - Closeout Submittals.

### 1.3 REFERENCES

- .1 Canadian Standards Association, (CSA International)
  - .1 CAN3-Z299.3-85(R1997) (R2002), Quality Assurance Program - Category 3.
  - .2 CAN/CSA-B139-15 (2015 version) Installation Code for Oil Burning Equipment;
- .2 International Organization for Standardization (ISO)
  - .1 ISO 3046-1-2002, Reciprocating internal combustion engines - Performance - Part I: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use.
  - .2 ISO 3046-4-1997, Reciprocating internal combustion engines - Performance - Part 4: Speed governing.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA MG 1-1998, Motors and Generators.
- .4 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - March 1998.
- .5 National Research Council - Canada
  - .1 2015 National Fire Code of Canada (NFC);
- .6 Canadian Council of Ministers of the Environment ( CCME )
  - .1 2003 CCME Environmental Code of Practice for Above Ground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME);
- .7 Environment and Climate Change Canada
  - .1 2008 Federal Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (STR)

### 1.4 SCOPE

- .1 Provide, and acceptance test a complete and operable towable standby electric generating system (Genset), including all devices and equipment specified herein or required for the service. Equipment shall be new, factory tested, and

delivered ready for installation.

- .2 Provide Genset complete with standby generator, circuit breaker, instrumentation, power cable and connector, battery charger, voltage regulator, and towable outdoor enclosure.
- .3 Provide Genset with mufflers and connection to exterior of exhaust system.
- .4 Provide towable power system with a sub-base fuel tank under the unit.
- .5 Provide generator or trailer with environmental containment for oil, fuel, and coolant and battery electrolyte.
- .6 Provide equipment of new and current production by a national firm who manufacture's the generator and control panel and who assembles the standby generator set as a matched unit having a service and parts organization within British Columbia.
- .7 Single supplier: the supplier shall be the manufacturer's authorized distributor, who shall provide initial start-up (commissioning) services, conduct field acceptance testing, and warranty service. The supplier shall have 24-hour service availability and factory-trained service technicians authorized to do warranty service on all warrantable products. Manufacturer shall be equipped and prepared to deliver warrantee service within 24 hours of a trouble call, with no added expense to the Departmental Representative, during the warranty period.
- .8 Towable power Genset shall come complete from factory mounted with all required towing equipment to ensure compliance with all local and federal transportation regulations.
- .9 Generator fuel tank shall be specifically approved for use as a portable fuel tank.

## **1.5 OPERATION**

- .1 The unit shall be equipped for local starting, and shall come complete with sound attenuating enclosure.

## **1.6 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data covering diesel engine, generator, voltage regulator, battery and charger, three phase connectors, control system and, fuel system and enclosure.
- .2 Provide as a minimum for all equipment specified, three copies each of the following:
  - .1 Specification and data sheets.
  - .2 Manufacturer's certification of prototype testing.
  - .3 Manufacturer's published warranty documents.

- .4 Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.
- .5 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
- .6 Manufacturer's installation instructions.
- .7 Operating and maintenance manuals.

## 1.7 WARRANTY

- .1 Provide a warranty for all products against defects in materials and workmanship, for a one (1) year period from the date of delivery.

## Part 2 PRODUCTS

### 2.1 GENERATION PLANT

- .1 Provide Genset consisting of a fully automatic diesel engine driven electrical generation plant completely equipped with the following:
  - .1 Fuel system and sub-base fuel tank
  - .2 Exhaust system
  - .3 Cool system
  - .4 Battery starting system, including battery charger
  - .5 All automatic controls
  - .6 Radio suppression to commercial standards
  - .7 Block heater
  - .8 Surge suppression
  - .9 Weatherproof enclosure
  - .10 Engine control panel
  - .11 Alternator
  - .12 Battery
- .2 Supply and install all components necessary for the satisfactory operation of the standby power system.
- .3 Provide Genset with manual start upon normal power failure. Upon restoration of normal power supply, the unit shall be manually transferred back to normal power supply and shutdown after expiration of pre-set, cool-down time delays.
- .4 Ratings:
 

.1	Minimum generator set ratings:	75 kW, 94 kVA at 0.8 PF,
	Standby rating, 130 deg C	
.2	System voltage of:	347/600 VAC 3 Phase, 4 Wire, 60 Hz.
.3	Site Conditions:	Altitude 20 metres,
	Temperatures up to 30°C.	
- .5 Provide complete unit, CSA approved.

### 2.2 DIESEL ENGINE - GENERATOR SET

- .1 Provide diesel engine-generator set with a 4-cycle, 1800 rpm, diesel engine generator set with low reactance brushless alternator, 3-phase RMS sensing automatic voltage regulator, set-mounted control panel, and high ambient cooling system 50°C.
- .2 Provide unit with net brake horsepower sized in accordance with the formula



- given in CSA Bulletin, and substantiated by manufacturers published data.
- .3 Design engine to operate on #2 diesel fuel. Diesel engine requiring premium fuels will not be considered.
  - .4 Tier 4 EPA Emissions performance certification.
  - .5 Prototype Tests and Evaluation: Test complete and functional unit. Component level type tests will not substitute for this requirement.
  - .6 Performance
    - .1 Voltage regulation of  $\pm 1.5$  percent for any constant load between no load and rated load.
    - .2 Maximum transient voltage dip less than 25% below rated voltage on application of the single largest surge load step at a 0.8 power factor.
    - .3 Maximum transient voltage rise less than 12% above rated voltage on removal of full load at 0.8 power factor.
    - .4 Transient recovery time is 1 second.
    - .5 Stability plus or minus 0.25%.
    - .6 Provide isochronous frequency regulation from steady state no load to steady state rated load.
    - .7 Provide diesel engine-generator set capable of single step load pick up of 100% nameplate kW and power factor, with the engine-generator set at operating temperature.
    - .8 The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
    - .9 Provide Genset capable of delivering 10% overload for one hour in every twelve hours of continuous operation, without exceeding maximum permissible temperature rise.
    - .10 Provide Genset capable of providing stable voltage and pick up of loads within 10 seconds.
    - .11 Provide Genset equipped with surge suppression and the excitation system shall include an instantaneous overcurrent shutdown capability after 10 seconds.
  - .7 AC Generator
    - .1 Provide AC generator with: synchronous, four pole, revolving field, drip-proof construction, single pre-lubricated sealed bearing, and air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s).
    - .2 Provide all insulation system components to meet NEMA MG1 temperature limits for Class H, 125°F insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 80°C at 40°C ambient.
    - .3 Provide permanent magnet generator (PMG) with excitation power for immunity from voltage distortion caused by non-linear loads. The PMG shall sustain excitation power for optimum motor starting and to sustain short circuit current at approximately 300% of rated current for not less than 10 seconds.
    - .4 Provide automatic voltage regulator with temperature compensated, solid-state design. Provide voltage regulator equipped with three-phase RMS sensing. The regulator to control buildup of AC generator voltage

- providing a linear rise and limit overshoot.
- .5 Provide voltage control in accordance with applicable CSA Bulletins.
- .8 Engine-Generator Set Control
- .1 Provide pushbutton cranking, manual starting control.
- .2 Provide control with shut down and lock out upon: overspeed, low lubricating oil pressure or high engine temperature. A panel mounted switch shall reset the engine monitor and test all the lamps. Lamp indications on the control panel shall include:
- |                                     |                           |
|-------------------------------------|---------------------------|
| Overspeed shutdown -                | red                       |
| Low oil pressure shutdown -         | red                       |
| High engine temperature shutdown -  | red                       |
| High engine temperature pre-alarm - | yellow                    |
| Low engine oil pressure pre-alarm - | yellow                    |
| Low coolant temperature -           | yellow                    |
| Low fuel -                          | yellow                    |
| Run -                               | green                     |
| Auxiliary (2 each) -                | red (customer identified) |
- .1 Engine Oil Pressure Gauge, Coolant Temperature Gauge, DC Voltmeter, and Running Time Meter (hours).
- .2 Voltage adjusting rheostat, locking type, to adjust voltage  $\pm 5\%$  from rated value.
- .3 Analog AC Ammeter, dual range, 80 mm, 2% accuracy.
- .1 Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 rpm for 1800 rpm diesel engine set 80 Battery charging ammeter.
- .2 Voltage/Phasing selector switch.
- .4 Provide engine generator set control of solid state design. Relays will be acceptable only for high current circuits. Circuitry shall be of plug-in design for quick replacement. Provide controller equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine.
- .9 Engine
- .1 Provide the engine with a diesel, 4 cycle, radiator and fan cooled. Tier 4 EPA Emissions performance.
- .2 Provide an electronic governor with automatic frequency regulation adjustable from isochronous to 5% droop.
- .3 The engine shall be cooled by a mounted closed loop radiator system rated for full load operation in 120oF (50oC) ambient as measured at the generator air inlet. The equipment supplier shall fill the cooling system with 50/50 ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.
- .10 Engine Accessory Equipment: Provide engine-generator set with the engine accessories as follows:
- .1 An electric starter(s) capable of three complete cranking cycles without overheating.
- .2 Positive displacement, mechanical, full pressure, lubrication oil pump.

- Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
- .3 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Replaceable dry element air cleaner with restriction indicator. Flexible supply and return fuel lines.
  - .4 Engine Electrics:
    - .1 Provide engine complete with a DC electric starting motor, one heavy duty 12 volt lead-acid battery (minimum 200 ampere-hour capacity), battery mounting rack, fully enclosing plastic box and interconnecting cables of generous length.
    - .2 A 2 Amp, 12 VDC automatic battery charger for 120 VAC supply and capable of maintaining a preset float voltage when permanently connected to the battery. Provide engine with a belt-driven battery charging alternator.
- .11 Base
- .1 Provide engine-generator set mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
  - .2 Provide the generator set equipped with factory installed vibration isolators mounted between the set and fabricated steel base to prevent distortion of alignment between generator and engine when installed.
- .12 Generator Set Auxiliary Equipment and Accessories
- .1 Engine mounted, thermostatically controlled, water jacket heater. Provide heater sized as recommended by the equipment supplier.
  - .2 Starting and Control Batteries:
    - .1 Starting batteries, lead acid type, 12 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.
    - .2 Provide battery capable of providing at least five engine start cycles without recharging.
    - .3 Provide battery and charger conforming to the latest CSA Bulletins. Mount within the generator enclosure on a metal rack clear of the ground with earthquake restraint.
    - .4 Supply battery dry charged with electrolyte added shortly prior to test.
  - .3 Silence Provide the exhaust flex-connector and all exposed exhaust components, including muffler, with fully insulated by means of a thermofibre blanket-type heat resistant wrapping, 25 mm thick, with SS mesh inner liner and silicone/aluminized outside cover secured by stainless steel lacing hooks and wire.
    - .1 Sound pressure level measured at 7 meters, with generator at full load shall be less than 67dBA.
  - .4 Engine Ventilating System:
    - .1 The engine shall be radiator cooled and equipped with a pusher fan. The cooling system shall be filled with a solution of 50 percent ethylene glycol. Provided shall be a translucent overflow coolant recovery reservoir.
    - .2 Provide a 115 VAC engine jacket heater, sufficient to maintain coolant at 40°C. Provide complete with thermostat and

- electrical disconnect on engine start, if required to prevent element damage.
- .3 Motorized (spring open/power close) air inlet and (gravity close) exhaust shutters shall be sealed to minimize air leakage and shall automatically open whenever the engine is started. Preapproved, similarly performing automatic inlet shutters will be accepted.
  - .5 Circuit Breaker and Electrical Connections:
    - .1 .Shall be mounted on the generator and shall be a non-automatic trip free thermal magnetic moulded case circuit breaker in CSA type 3 (weatherproof) enclosure complete with neutral bar isolated from ground.
    - .2 Provide circuit breaker 3P rated 200A, 100% for 120/208V, 3 phase, and 4 wire operation.
    - .3 Locate circuit breaker so that the feeder conduits rise straight out of the floor into the bottom of the breaker enclosure.
    - .4 Provide cable connection lugs capable of accepting #3/0 copper extra flexible conductors for all phase and neutral conductors.
    - .5 Provide for full size ground conductor via a threaded stud complete with locking washers/hardware.
    - .6 Provide a separately protected 15A, 120VAC, duplex receptacle mounted on the exterior of the enclosure with a weatherproof box and cover.
    - .7 Provide a separately protected reverse-pinned 20A receptacle for extel power connection to battery charger and block heater.
    - .8 Provide permanently connected 15 meters of four conductor, #3/0 copper DLO portable power cabling, connected to a 'Cam-Lock' style single conductor power cable connectors, 400 amps and coordinated with temporary power connection boxes provided in this contract. Provide reversed neutral and ground pinning.
      - .8 .Provide permanently mounted cable storage box.
  - .6 Towable Generator Fitments and Features:
    - .1 Front and rear leveling jacks.
    - .2 2 5/16" ball hitch.
    - .3 Running lights with 6-wire harness and connector, rear facing, enclosure mounted exterior flood lights (DC).
    - .4 Spare tire, jack and lug wrench.
    - .5 Fuel-water separator.

### 2.3 GENERATOR SUBBASE TANK

- .1 Provide an in-skid sub-base diesel fuel tank, in size suitable for 24 hours operation of the engine at 100% loading for the generator set. The fuel tank shall be a standard product of the manufacturer of the engine-generator set. The tank shall be ULC listed, made of aluminized steel, with welded construction, and pressure tested to 5 psi.
- .2 The tank is to be dual wall complete with interstitial alarm.
- .3 The fuel tank shall be provided with a fuel level sensing at 1/8, 1/4, and 1/3 levels.

- .4 All tank sensors shall be installed such that there is a service loop in the wiring to allow for removal of the sensor from the tank with wiring intact confirming correct operation of the sensor.
- .5 Contractor is to provide all fuel required for testing, commissioning and demonstration purposes and is to leave the tanks in a 100% full state at substantial completion.
- .6 Tanks shall be constructed to one of the acceptable standards listed in the National Fire Code of Canada and CSA B139-15, Installation Code for Oil Burning Equipment. The ones which are suitable and are listed in both the NFC and CSA B139 are limited to the following:
  - .1 CAN/ULC-S601, "Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids,"
  - .2 CAN/ULC-S653, "Aboveground Steel Contained Tank Assemblies for Flammable and Combustible Liquids,"
  - .3 CAN/ULC-S655, "Aboveground Protected Tank Assemblies for Flammable and Combustible Liquids,"
- .7 Tank fill pipe openings shall be located outside of the equipment enclosures and shall be equipped with tight fill connections, with weathertight covers, designed to prevent tampering.
- .8 Tank fill connections shall be located in spill containment devices that conform to ULC/ORD C149.19, CAN/ULC-S663 or ULC/ORD C58.19.
- .9 Visual tank level gauges shall be provided at the tank fill points.
- .10 Tanks shall be provided with audible/visual overfill protection devices conforming to CAN/ULC-S661, set to operate at 90% of tank capacity, located at the fill points.
- .11 Tank fill pipes shall be provided with positive shut off overfill protection devices conforming to CAN/ULC-S661, set to operate at 95% of tank capacity.
- .12 Tank normal and emergency vent pipes shall terminate outdoors and at heights specified in NFC.
- .13 Each tank shall be provided with suction and return pipe connections to facilitate "fuel polishing" - location and arrangement to be approved prior to tank manufacture.
- .14 The tank installations must be supervised and signed off by an I.T.A. Certified Petroleum Equipment Installer.
- .15 Provide as-built drawings (stamped by a P. Eng) before the tank can be filled.
- .16 Supply and install the Environment Canada Identification Label once it has been provided by the Departmental Representative.

## 2.4 SPILL RESPONSE KIT

- .1 Supply a mobile spill response kit with a sorbent capacity of 350 litres.

- .2 Spill response kit shall be contained in a weatherproof, UV resistant enclosure and permanently mounted in a readily accessible location at the fuel transfer area.

## 2.5 GENERATOR CONTROL PANEL

- .1 Provide generator control panel with the following features:
  - .1 AC voltmeter
  - .2 AC ammeter
  - .3 Combination Amp/Volt phase selector switch with OFF position
  - .4 Frequency meter
  - .5 Running time meter
  - .6 Engine oil pressure gauge
  - .7 Engine coolant temperature gauge
  - .8 Battery voltmeter
  - .9 Engine protection shut-down and individual indicators for low oil pressure, high coolant temperature, overcrank and overspeed (2000 rpm)
  - .10 Individual alarm only indicators for low coolant temperature, low battery voltage, low fuel level and fuel leak
  - .11 Panel illumination light and switch

## 2.6 METERS

- .1 Provide an AC Voltmeter, an Ammeter, and a Frequency meter; 2.5 inches, analogue, 2% accuracy. Provide a phase selector switch to read L-L voltage and current of both power sources.

## 2.7 BATTERY CHARGER

- .1 Provide a float charge battery charger rated 10 amps. DC output voltage shall be as required for the starting batteries. An ammeter shall display charging current. A voltmeter shall display battery voltage. The battery charger shall have fused AC input and fused DC output. Include fault indications and Form C contact for AC Fail, High Battery Voltage, and Low Battery Voltage.

## 2.8 GENSET ENCLOSURE

- .1 The sound attenuated generator housing shall be a minimum 12 gauge, marine-grade (copper free, 5000 series) Aluminum, rigid, free-standing, vandal-resistant cabinet, fabricated to EEMAC 3 standards with sufficient bracing to form a structure capable of withstanding wind, snow and ice loading. The roof shall have a minimum 25 mm overhang and provide rain gutters over all doors and openings. All hinges shall be internally mounted and concealed, with grease fittings as required. External hinges will not be accepted. Note that stainless steel enclosures will be considered.
- .2 All enclosure sheet metal shall be primed for corrosion protection and finish painted with a powder coat finish. The finish paint and color shall be polyester RAL color code RAL 7004 or approved equal. **Note that RAL Code is subject to final approval by Departmental Representative during final shop drawing review.**

- .3 Access to all regularly serviced items within the enclosure shall be provided by at least two hinged lockable doors on each side. All handles shall be recessed or flush when in the locked state.
- .4 The enclosure must be vandal resistant. Externally accessible fasteners shall preferably be blind head (e.g. stove bolts) although Allen head will be permissible. Air inlet and outlet openings shall be designed such that objects of any size directed at the enclosure from vertically downward to horizontally flat cannot enter and shall be sized such that inlet air velocity is below the level at which water penetration will occur. No other enclosure openings will be allowed.

## 2.9 GENSET NOISE

- .1 Provide engine exhaust system with a seamless, stainless steel flex-connector and critical silencing type muffler, all mounted within the Genset enclosure. Ensure discharge into the air outlet hood, downstream of the radiator. Provide attenuated air inlet and discharge hoods with opening bird screens rectangular in shape and match the profile of the enclosure.
- .2 Provide a Genset with overall full load operating noise level less than 67 dbA when measured at a distance of 7 meters from any side of the unit and 1 meter above ground. This shall be demonstrated during site testing.
- .3 Provide ducting and sound attenuation components designed and supplied by an approved manufacturer specializing in this type of work.

## 2.10 SIGNS

- .1 Provide at front top of each panel and on each generator junction box, lamacoid or metal engraved identification nameplate.
  - .1 Provide nameplates with letter and number identification designation to be given at time of acceptance tests.
- .2 Provide and attach to unit in prominent location, bilingual warning sign.
- .3 Where metric tools are required to service engine-generator unit, provide bilingual warning sign.
- .4 Provide signage in accordance with NFC 2015 4.3.1.7 "A storage tank and its filling and emptying connections shall be identified in conformance with CFA 1990, "Using the Canadian Fuels Colour-Symbol System to Mark Equipment and Vehicles for Product Identification."
- .5 Supply and install signage outlining the site specific fill procedure sign to be posted at each tank fill port. Details to be provided by the Departmental Representative.
- .6 Supply and install signage outlining the site specific emergency response procedures. Details to be provided by the Departmental Representative.
- .7 Supply and install a weather proof cabinet for storage of the site specific emergency response plan documentation.

- .8 Final details for all signage to be approved during shop drawing submittal and review.

### **Part 3 EXECUTION**

#### **3.1 INSTALLATION**

- .1 Not Applicable.

#### **3.2 TESTS**

- .1 Factory Tests:
  - .1 Set factory tests on the equipment to be shipped, at rated load and rated PF. Generator sets that have not been factory tested at rated PF will not be acceptable. Perform the following tests: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and safety shutdowns.
  - .2 Provide a detailed test specification from the manufacturer with the submittal documents.
- .2 On-Site Acceptance Test:
  - .1 Conduct testing of the complete assembly for compliance with the specification following delivery. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by manufacturer.
  - .2 The Departmental Representative shall be notified in advance and shall have the option to witness the tests.
  - .3 Perform on site tests in accordance with CSA Standards C282-1977:
    - .1 A load test 1 hour duration at full load.
    - .2 A battery charger test.
    - .3 A one step rated load pickup test.
    - .4 Perform all tests for the single phase and three phase settings.
  - .4 Provide a resistive load bank and make temporary connections for full load test.
  - .5 Provide certified copies of all test procedures and results to the Departmental Representative.
  - .6 At the project's completion, provide a full fuel tank for the Genset.

#### **3.3 WIRING AND CONNECTIONS**

- .1 Provide all cabling and complete all connections as specified in these documents.

#### **3.4 OPERATOR TRAINING**

- .1 Demonstrate the operation and maintenance to the Departmental Representative. Run through all failure modes and control options. Conduct demonstration with qualified manufacturer's representative.

#### **3.5 COMMISSIONING**



- .1 Provide a certificate from a qualified manufacturer's representation that the complete unit is installed to their standards and recommendations.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 Materials and installation procedures for generator switchboard up to and including 600 Volts.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 30 - Health and Safety Requirements.
- .3 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 00 - Commissioning.
- .6 Section 26 05 00 - Common Work Results - Electrical.
- .7 Section 26 05 28 - Grounding - Secondary.
- .8 Section 26 29 23.01 – Digital Metering
- .9 Section 26 29 23.02 – Power System SCADA
- .10 Section 26 36 33 – Automatic Transfer Switches
- .11 Section 26 29 03 – Control Devices

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-C22.2 No.31-M89(R2000), Switchgear Assemblies.
  - .2 CSA C22.2 No.178- latest edition, Automatic Transfer Switches.
- .2 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .3 Electrical Equipment Manufacturers Advisory Council (EEMAC).
  - .1 EEMAC 2Y-1-[58], Light Grey Colour for Interior Panels.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .5 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

**1.4 SYSTEM DESCRIPTION**

- .1 Switchboard to consist of:
  - .1 Synchronizing panel for four generators.
  - .2 Generator control panels, protection relays and controls for four generators.
  - .3 Generator master control panel complete with HMI, 25kV generator breaker synchronizing controls.
  - .4 Digital metering and SCADA interface devices.
- .2 Automatic transfer controllers shall be built and certified to CSA No 178.1.

**1.5 SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings with single line diagram of entire Switchboard assembly.
- .3 Provide operation and maintenance data for generator switchboard for incorporation into manual specified in Section 01 78 00 - Closeout Submittals. Include operating information required for start-up, synchronizing and shut down of generating units.

**1.6 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

**1.7 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.

**Part 2 Products****2.1 METERS**

- .1 Frequency meter, synchroscope.

**2.2 INSTRUMENT TRANSFORMERS**

- .1 Current and potential transformers.

**2.3 MASTER SYNCHRONIZING PANEL**

- .1 HMI touch screen industrial panel mount PC providing complete software control and access to SCADA functions.
- .2 Synchroscope for generator bus to 25kV utility bus.
- .3 Selection for synchronizing controls: open/close transition
- .4 Transfer controller and PLC.

**2.4 GENERATOR PANELS**

- .1 Each of the four generator panels shall have the following devices:
  - .1 Synchroscope
  - .2 Synchronizing relay
  - .3 Governor or generator speed controller
  - .4 Digital Meter

- .5 Breaker open/close controls with indicating lights.
- .6 Panel mounting digital generator protection relay.
- .7 Panel mounted digital generator control relay complete with hour meter, digital volts, amps, and power and frequency indication.
- .8 Remote off/manual/auto/test keyswitch.
- .9 Emergency stop pushbutton.
- .10 Voltage regulator
- .11 Power/load share/shedding controller.

## **2.5 VOLTAGE REGULATOR**

- .1 Solid state, to control alternator output within plus or minus 1%, for steady state load conditions with maximum 5% frequency variation. Capable of plus or minus 10% adjustment of alternator output voltage.

## **2.6 HMI PANEL MOUNT PC INTERFACE**

- .1 Section 26 29 23.02 – Power System SCADA

## **2.7 DIGITAL METERING**

- .1 Section 26 29 23.01 – Digital Metering

## **2.8 CONTROL DEVICES**

- .1 Section 26 29 03 – Control Devices

## **2.9 PROGRAMMABLE LOGIC CONTROLLER**

- .1 Section 26 36 33 – Automatic Transfer Switches

## **2.10 FABRICATION**

- .1 Switchboard assembly to CAN/CSA-C22.2 No.31, free standing, floor mounted, dead front metal enclosed type with:
  - .1 Hinged locked doors on front for all control panels and hinged, removable access covers on rear.
  - .2 Mounted over top of existing pulpit complete with steel covers.
- .2 Install meters and equipment in each panel.
- .3 Install wiring to meters, instrument transformers, relays, terminal strips and circuit breaker controls.
- .4 Connect main synchronizing devices to utility switchboard potential transformers.

## **2.11 SOURCE QUALITY CONTROL**

- .1 Perform following tests for each assembly:
  - .1 High potential insulation level test on switchboard assembly.
  - .2 Operating check of meters.
  - .3 Instruments and relays under service tests by impressing properly phased current and voltage.
  - .4 Operation of breaker control, sequence and interlocking circuits.

**2.12 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Metal enclosures shop finished by cleaning, priming inside and out with rust resistant primer and finished with at least two coats of enamel.
  - .1 Interior surfaces: white.
  - .2 Exterior surfaces: grey enamel, minimum thickness 0.05 mm for both primer and top coat, EEMAC light grey colour to EEMAC 2Y-1.
  - .3 Supply two tins of spray touch-up enamel as recommended by manufacturer.

**2.13 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Nameplates for switchboard panels: size 6.
- .3 Nameplates for instruments and controls: size 4.

**Part 3 Execution****3.1 INSTALLATION**

- .1 For generator unit No. 1 to 3:
  - .1 Connect all remote control wiring between generator switchboard to generator, generator sensors, instrument transformers, controls, regulators, controllers, circuit breakers and devices.
  - .2 Connect all devices to SCADA via Ethernet or appropriate software interface for full integration into SCADA system for remote operation and monitoring.
  - .3 Connect engine monitoring circuits to instrumentation.
- .2 For generator unit No. 4:
  - .1 Provide terminal blocks for connection of remote control wiring between generator switchboard to generator, generator sensors, instrument transformers, controls, regulators, controllers, circuit breakers and devices.
  - .2 Connect all devices to SCADA via Ethernet or appropriate software interface for full integration into SCADA system for remote operation and monitoring.
  - .3 Generator 4 Panel shall be fully outfitted for future generator, including all devices identical to Generators 1 to 3.
- .3 Grounding: to Section 26 05 28- Grounding - Secondary.
- .4 For Master Control Panel
  - .1 Connect and integrated HMI panel mount PC.
  - .2 Connect all synchronizing devices to 25kV potential transformer utility sources, remote breakers operators, to transfer controller and PLC.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Start generator unit No. 1 and adjust voltage to nominal value.
- .3 Close circuit breaker on generator panel No. 1 to energize switchboard bus.
- .4 Close feeder panel circuit breakers to load bus.
- .5 Check meters for correct readings.
- .6 Start generator unit No. 2 and synchronize with No. 1 unit.
- .7 Check generator panel No. 2 meters.
- .8 Repeat for each additional generator unit until sets are synchronized with bus.

**3.3 COMMISSIONING**

- .1 Perform commissioning in accordance with Section 01 91 00 - Commissioning.
- .2 Commission generator switchboard with power generating unit[s] as complete system.
  - .1 Allow two days minimum for testing and instruction to operating and maintenance staff.
- .3 Manufacturer's representative to remain on site until defects that may occur during installation, are corrected.
  - .1 Include costs in this contract.
- .4 Complete two (2) copies of field testing data sheets. Data sheets shall be signed by supplier's field technician and by Departmental Representative.
- .5 Provide one (1) copy immediately to Departmental Representative. Make additional copies as required and include one (1) copy in each Operating and Maintenance Manual.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 This section specifies materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit when normal power is re-established.
- .2 The Contractor shall furnish and install the low voltage automatic transfer switch having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.
- .3 This system will incorporate a transfer controller/PLC to remotely operator four generator synchronizing breakers, two BC Hydro utility breakers, an interim utility breaker and a tie breaker.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C282 – Emergency Electrical power Supply for Buildings
  - .2 CSA C22.2 No.178- latest edition, Automatic Transfer Switches.
  - .3 CSA C22.2 No. 5.1 Moulded Case Circuit Breakers

**1.3 SCOPE OF WORK**

- .1 Automatic transfer switch and controls shall be contained in the Generator Switchboard assembly.
- .2 Provide and install an open and closed transition transfer controller with the circuit breakers and topology indicated in the drawings.
  - .1 The system will consist of four generators with integral remote operated synchronizing breakers to tie on to the Generator Bus. A step up transformer will connect this Generator Bus to the 25kV utility bus via the 25kV Generator breaker, controlled using a synchronizing relay for closed transition and electrical interlocked with the utility breaker for open transition.
  - .2 At the initial implementation of this system will be for an open transition, electrically interlocked switching scheme between the 25kV Generator breaker and the 25kV 'DND' breaker. With removal of these electrical interlocks, closed transition switching will also be operational.
  - .3 The final implementation of this system will be for closed transition switching between the 25kV Generator breaker and two 25kV BC Hydro utility breakers, along with control of a 25kV tie breaker.
  - .4 Upon power failure, 25kV protection system will drop all circuit breakers. Upon transfer to generator power, transfer controller must work with the Power System SCADA to re-energize these loads in a priority basis, as load exists on the generators, based on recent load history, operational priorities and fuel availability. Refer also to 26 29 23.01 Power System SCADA for additional programming requirements.

## 1.4 SYSTEM DESCRIPTION

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator units on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
  - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
  - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.
- .2 Automatic load transfer equipment shall be built and certified to CSA No178.1.

## 1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Include:
  - .1 Make, model and type.
  - .2 Load classification.
  - .3 Single line diagram showing controls and relays.
  - .4 Description of equipment operation including:
    - .1 Automatic starting and transfer to standby unit and back to normal power.
    - .2 Test control.
    - .3 Manual control.
    - .4 Automatic shutdown.

## 1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

## Part 2 Products

### 2.1 MATERIALS

- .1 Section 26 36 01 – Generator Switchboard



## 2.2 CONTROLS

- .1 Selector switch - four position "Test", "Auto", "Manual", "Engine start".
  - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
  - .2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
  - .3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
  - .4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120V secondary to isolate control circuits from:
  - .1 Normal power supply.
  - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
  - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2V minimum undervoltage protection.
  - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60s.
  - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60s delay.
  - .4 Time delay on retransfer from standby to normal power, adjustable 0 to 60s.
  - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, and 20s intervals to 10 min.
  - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5s intervals to 180s.
  - .7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
- .4 Solid state electronic in-phase monitor.

## 2.3 ACCESSORIES

- .1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .3 Potential transformers - dry type for indoor use:
  - .1 Ratio: 600 to 120.
  - .2 Rating: 600V, 60Hz.
  - .3 Accuracy rating: 5%.

## **2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Control panel:
  - .1 For selector switch and manual switch: size 4 nameplates.
  - .2 For meters, indicating lights, minor controls: size 2 nameplates.

## **2.5 OPERATIONS**

- .1 The automatic transfer switches are to be continuous rated as per drawings and are to be compatible with new emergency generator system.
- .2 The automatic transfer switches shall include standard components and provide control to:
  - .1 Select through a switch “with load” or “without load” to test as follows:
    - .1 “Without load” the generator set runs unloaded.
    - .2 “With load” the automatic transfer switch transfers load to the generator set as if normal source interruption occurred.
  - .2 Monitor each ungrounded line with a calibrated dial adjustable voltage solid state sensors and sense a decrease of voltage below a set point or loss of voltage on any phase of the normal power supply. Voltage sensors shall be temperature compensated.
  - .3 Signal the engine generator set to start in the event of power interruption. A solid state time delay shall delay this signal three seconds to avoid nuisance start-ups on momentary voltage dips or power outages. The maximum 15 second reaction time permitted under CSA standard C282 shall include the three second start delay.
  - .4 Retransfer the load to the line after normal power restoration. A time delay shall delay this retransfer to avoid short term normal power restoration (variable one to five minutes, set at one minute).
  - .5 Provide an automatic retransfer of the load from generating set to normal source if the generating set output interrupts after normal source restores voltage.
  - .6 Signal the engine generator to stop after load retransfer to normal source. A solid state time delay on stop shall permit the engine to run unloaded to cool down before shutdown.
  - .7 Provide a device to electrically disconnect the control sections from the transfer switch for maintenance service during normal operation.
  - .8 Interlocks:
    - .1 Positive electrical interlocks shall prevent possible source to source interconnections as noted.

## **2.6 SOURCE QUALITY CONTROL**

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.
- .2 Notify Consultant 10 days in advance of date of factory test.

- .3 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in modes of operation [Test, Auto, Manual, and Engine Start] and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.
    - .4 In-phase monitor operation.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Locate, install and connect transfer equipment.
- .2 Check relays, solid state monitors and adjust as required.
- .3 Install and connect remote alarms.

#### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with this specification and as follows:
  - .1 Energize transfer equipment from normal power supply.
  - .2 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
  - .3 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
  - .4 Repeat, at 1h intervals, 3 times, complete test with selector switch in each position, for each test.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Moulded--Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings
    - .1 Indicate on drawings:
      - .1 Make, model and type.
      - .2 Load classification.
      - .3 Single line diagram showing controls and relays.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 SYSTEM DESCRIPTION**

- .1 Manual transfer equipment to:
  - .1 Allow for manual transfer of loads from normal to standby using hand operated or manually controlled device.
  - .2 Mechanical ( key ) and electrical interlocks shall prevent inappropriate operation of transfer switch.
  - .3 Auxiliary contacts in transfer switch shall provide feedback to SCADA on all positions of the switch, indicating power flow through the switch.

**2.2 MATERIALS**

- .1 Contactors: to NEMA ICS2.

**2.3 CIRCUIT BREAKER TYPE TRANSFER EQUIPMENT**

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2 No.5.
- .2 Rated: 600 V, 60Hz, 400 (or as noted) A, 3 wire, solid neutral.
  - .1 Fault withstand rating: 22kA symmetrical for 3 cycles.
  - .2 One normal-single 3 pole moulded-case circuit breaker mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked, wall mounted in a CSA enclosure.
  - .3 One standby -single 3 pole moulded-case circuit breaker with trip, motor operated, and interlocked.
  - .4 Circuit breakers:
    - .1 Trip free in closed position.
    - .2 Interrupting rating: 22kA symmetrical.
  - .5 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.
  - .6 Auxiliary contacts: transfer switch in 'normal'; transfer switch in 'standby'
  - .7 Solid neutral bar, fully rated.

**2.4 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

**2.5 SOURCE QUALITY CONTROL**

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Departmental Representative
- .2 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
    - .1 Operation of all remote monitoring contacts.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for transfer switches installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Locate, install and connect transfer equipment as indicated.
- .2 Check solid state monitors and adjust as required to ensure correct operation.
- .3 Install and connect remote alarms.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Verify transfer of load from 'normal' to 'standby' sources.
- .4 Verify operation of remote contacts.
- .5 Verify correct operation and security of mechanical interlocking devices.

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Make, model and type.
    - .2 Enclosure ratings and approvals
    - .3 Load classification.
    - .4 Single line diagram showing controls and connections.
    - .5 Description of equipment operation including:
      - .1 Interlocks
      - .2 Cable connectors and type
      - .3 Enclosure locking
      - .4 Mounting template.

**1.4 QUALITY ASSURANCE**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

**1.5 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

**1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products****2.1 GENERAL**

- .1 Entire assembly, including all internal wiring, receptacles, disconnects, breakers and enclosure shall bear a single mark of certification or inspection to CSA or equivalent certification, as accepted by the BC Safety Authority. Product must be assembled in an approved facility. Local special inspection will not be accepted.

**2.2 ENCLOSURE**

- .1 Enclosure shall be constructed from fully welded Marine Grade aluminium ( 5000 series alloy ), suitable for continuous exterior installation in marine environment,
- .2 Doors will be arranged with hydraulic hold-opens holding doors at 180 degrees to closed position.
- .3 Enclosure doors will have continuous gasketing made from neoprene rubber or similar providing a durable weather seal.
- .4 Mounting tabs shall be provided such that all mounting hardware will not penetrate and/or compromise the weather resistant integrity of the enclosure.

**2.3 RECEPTACLES**

- .1 Receptacles shall be sized and rated as noted in drawings and as noted herein. Terminations and connections shall be suitable for terminating using wire sizes as noted in drawings.
  - .1 600V Temporary Power Connection
    - .1 400 total amps, 3 phase 4 wire with ground ( parallel cabling, 8 connections and ground total )
    - .2 'Cam Lock' style single conductor DLO connectors, reverse pinning for ground and neutral positions. Connection arrangement suitable for feeding power into connection box from portable generator.
    - .3 NEMA 3R enclosure.

**2.4 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.



**Part 3 Execution****3.1 INSTALLATION**

- .1 Securely mount Temporary Power Connection Box as noted in drawings. Coordinate precise final location on site with Departmental Representative.
- .2 Terminate all cabling and conduits into enclosure using weather proof connections suitable for location and wiring method.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for primary lightning arresters.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

**1.3 REFERENCES**

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/IEEE C62.11-2005 IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1kV).
  - .2 ANSI/IEEE C62.1-1989, Standard for Surge Arresters on AC Power Circuits

**Part 2 Products**

**2.1 MATERIALS**

- .1 Arrester component parts: to ANSI/IEEE-C62.1 and ANSI/IEEE-C62.11.
- .2 Arrester characteristics:
  - .1 Distribution arrester.
  - .2 System highest voltage line to ground: 7.5 / 15 kV.
  - .3 MCOV (maximum continuous operating voltage): 7.5/15kV.
  - .4 Indoor type.
  - .5 Housing: polymer.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Mount arresters at padmount transformer on line conductors.
- .2 Connect line terminals to phase conductors.
- .3 From arrester ground terminal run No 6 AWG copper ground wire down pole to ground rod.
- .4 From arrester ground terminal run shortest possible 6 AWG conductor to secondary neutral of transformer.
- .5 Mount arresters adjacent to primary bus of pad mounted transformer and connect line terminals to phase conductors. Connect ground terminals to ground bus.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies materials and installation for emergency lighting systems.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.141-M1985 (R1999), Unit Equipment for Emergency Lighting.

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

**Part 2 Products****2.1 EQUIPMENT**

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120, AC.
- .3 Output voltage: 24 V dc.
- .4 Operating time: **120** min.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit [remote], 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED, 3 W.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.
- .13 Auxiliary equipment:
  - .1 Test switch.
  - .2 Battery disconnect device.
  - .3 AC input and DC output terminal blocks inside cabinet.
  - .4 Bracket.
  - .5 Hardwire connection for AC.
  - .6 RFI suppressors.

**2.2 WIRING OF REMOTE HEADS**

- .1 Conduit: in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: in accordance with Section 26 05 21 – Wires and Cables 0-1000 V, sized as indicated in accordance with manufacturer's recommendations.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install unit equipment.
- .2 Connect to AC power source.
- .3 Direct heads.

**END OF SECTION**

**Part 1 General****1.1 SECTION INCLUDES**

- .1 This section specifies the materials and installation for communication cables for electrical equipment.

**1.2 SCOPE**

- .1 Supply and installation of a data/communication cabling system as related to the digital metering, SCADA, protection and transfer/generator control equipment, complete with complete with provision of cables, connectors, and patch panels as indicated on the drawings and as required for a complete and fully functioning system.
- .2 All materials and installation shall meet the requirements of these specifications.
- .3 The complete data/communications system installation is to be in accordance with EIA/TIA-568 Standards.
- .4 All cables made redundant by new installation are to be removed. All existing abandoned cables are also to be removed back to the source.

**1.3 REFERENCES**

- .1 Canadian Standards Association, (CSA International)
  - .1 CSA-T529-latest edition, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).
  - .2 CSA-C22.2 No. 214-latest edition, Communications Cables (Bi-national Standard, with UL 444).
  - .3 CAN/CSA-C22.2 No. 182.4-latest edition, Plugs, Receptacles, and Connectors for Communication Systems.
- .2 Telecommunications Industry Association (TIA)
  - .1 TIA/EIA-568-latest edition, Commercial Building Telecommunications Cabling Standards Set.

**1.4 SYSTEM DESCRIPTION**

- .1 Structured system of telecommunications cables (copper) installed within buildings for distributing voice and data, using shielded twisted pair (STP) cabling and connectors.
- .2 Installed in physical star configuration with separate horizontal and backbone sub-systems. Horizontal cables link work areas to telecommunications closet located on same floor. Telecommunications rooms linked to central equipment room by backbone cables.

**Part 2 Products****2.1 CABLES AND CONNECTORS**

- .1 All cables will be certified/approved by CSA Standard PCC FT4 flammability test and UL CMR.
- .2 STP cables will meet or exceed the requirements in the proposed National Electrical Manufacturers Association (NEMA) Standard for Low-Loss Extended

Frequency Premises Telecommunication Cable. The cable will meet the performance requirements of Category cable of the Underwriters Laboratories

- .3 Each jack shall be identified with a Brother P-Touch lettering tape label. The unique identification used must be preapproved by the Consultant.

## **2.2 CABLE AND CONNECTORS**

- .1 Each STP cable shall meet the requirements of will consist of four unshielded twisted pairs of 24 AWG (0.5mm) 100-ohm nominal characteristic impedance, solid round annealed copper conductors insulated with flame retardant polymer.
- .2 All cables will be certified/approved by CSA Standard PCC FT4 flammability test and UL CMR.
- .3 STP cables will meet or exceed the requirements in the proposed National Electrical Manufacturers Association (NEMA) Standard for Low-Loss Extended Frequency Premises Telecommunication Cable. The cable will meet the performance requirements of Category cable of the Underwriters Laboratories Inc. specifications and cable surface markings shall indicate this classification.

## **2.3 COMMUNICATION OUTLETS AND TERMINAL CONNECTIONS**

- .1 Data/communications outlets are to consist of 100 x 100 box c/w single gang plaster ring and flush mounted into walls unless indicated otherwise. Outlets to be complete with quantity of modular RJ45 jacks as indicated on plans.
- .2 Cable runs will have 300mm length of cable left coiled up inside outlet box for termination of RJ45 jacks.
- .3 All cables shall have all pares connected using the EIA.TIA standard pin configuration 568A. Telephone jacks are to mount in the top position of outlets, and data jacks in the lower position.

## **2.4 COVERPLATES**

- .1 Coverplates are to be brushed stainless steel in accordance with Section 26 27 26 complete with provision for data/communication jacks as indicated on plans.
- .2 Cover plates to have 2, 4 or 6 cutouts for jacks.
- .3 Provide blank filler plugs for all unused ports.
- .4 The wall plates shall be clearly and permanently marked with icon identification for both service types as well as with clear identification of cable/termination numbers.

## **2.5 PATCH PANELS AND PATCH CORDS**

- .1 Provide modular RJ45, patch panels for data/communications system as indicated on plans for termination of data/communications cabling; hinged wall brackets.
- .2 Provide cable management rings for wall mounted patch panels.
- .3 Label patch panel ports, indicating room locations of all outlets.
- .4 Cross-connect ports shall be labelled to correspond to work station address and riser cable number.
- .5 Provide cable support bars for wall mounted patch panels.
- .6 Based on the functionality, the patch panels will be clearly labeled

**2.6 GROUND BAR**

- .1 Label bus bar connections.
- .2 All patch panels, racks, and cable trays must be bonded to ground with #6 Cu. green insulated ground wire.

**2.7 LABELLING**

- .1 Labels on wall plates and patch panels to be Brother P-Type or equivalent, black lettering on white tape. Labelling identification numbering to be as directed by Owner's representative.
- .2 All raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .3 All empty raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .4 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at patch panels and at data/comm. outlets. Label of wiring to be the same identifier as the label at the termination point.

**2.8 PERFORMANCE REQUIREMENTS**

- .1 The complete end-to-end installation, including jacks, cables, patch panels, and patch cords shall meet the industry standard performance parameters for enhanced Category 6 as recommended by CAN/CSA-T529, latest revision. Test parameters shall include: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELNEXT, Power Sum NEXT, ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew.

**Part 3 Execution****3.1 INSTALLATION OF HORIZONTAL DISTRIBUTION CABLES**

- .1 Communications raceway shall be minimum 27mm (1") EMT conduit.
- .2 Wires and cable shall be as short as practical except that sufficient slack shall be provided to:
- .3 Prevent undue stress on cable forms, wires, and connections.
- .4 Enable network components to be removed and replaced during servicing without disconnecting other parts.
- .5 Facilitate movement of equipment for maintenance purposes.
- .6 Wires and cables shall be placed and protected to avoid contact with rough surfaces or sharp edges. Where wires or cables run through holes in metal, they shall be protected by suitable grommets or bushings.
- .7 The horizontal wiring shall be continuous with no splice points. Bridged taps are not permitted and there will be no cross-connects between the outlet and the patch panel.
- .8 The maximum cable length for each run is 90 metres and will allow for 3 extra metres at the utilization end and 7 extra metres for the patch cord/cross-connect end.

- .9 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at cross-connects and at telecommunications outlets. Labelling will include room number or patch panel as per labelling requirements reference.
- .10 Horizontal conduit fill must comply with the Canadian Electrical Code requirements.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 All data/communications cables shall be tested using testing equipment approved for Category 6 installations.
- .3 Testing shall be conducted by authorized representative of cable and hardware manufacturer.
- .4 Tests shall be performed from termination block to outlet jack on horizontal cables.
- .5 Testing set-up shall be for a channel test, maximum length of 95m.
- .6 Testing shall include verification of labelling integrity.
- .7 Test results shall be documented and shall include the following information in addition to the cable parameters:
  - .1 Cable ID
  - .2 Transmit and Receive locations
  - .3 Test Equipment used to complete the test
  - .4 Contractor's name
  - .5 Technician's name and signature
  - .6 Date test was performed
  - .7 Relevant additional comments
- .8 The complete end-to-end installation, including jacks, cables and patch panels shall meet or exceed industry standard performance requirements for Category 6. Cable test parameters are to include: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew. Permanent Link Test is required.
- .9 Provide verification of the pin outs to CSA T529, ISDN (T568A) configuration.
- .10 Test results must include the Telecommunication Room number from which the cables terminate and indicate the following information:
  - .1 Telecommunication Room
  - .2 Room number of outlet box location
  - .3 Communication jack number.

**END OF SECTION**





## **APPENDIX A**

### **CHECKLIST OF HEALTH & SAFETY PLAN REQUIREMENTS**

### **CHECKLIST OF SUBMITTALS**



## CHECKLIST OF HEALTH & SAFETY PLAN REQUIREMENTS

Prepare and comply with a site-specific project Health and Safety Plan (see sample below) based on hazard assessment, including, but not limited to, the following:

- Reference to Contractor's health & safety policy.
- Indication Health & Safety has been fully considered in the bid.
- General safety rules for the project.
- Commitment to comply with all applicable regulations and applicable policies and procedures of PWGSC and Esquimalt Graving Dock.
- Confirmation that PWGSC will be informed of any sub-contractors before they enter the site and that PWGSC has the right to remove any sub it deems unsatisfactory.
- Commitment to completion of a Job Hazard Analysis and ensuring workers are made aware of the hazards and comply with specific requirements.
- Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations.
- Commitment to the documentation of job-specific safe work procedures and ensuring workers are trained in those procedures before starting work.
- Define regular communication channels to ensure information is transferred between the Construction team and the Departmental Representative/ operations and record keeping procedures.
- Commitment to provision of plans by Qualified Persons when required by regulation (e.g. fall arrest program, etc.), ensuring workers are trained in the plan, have approved equipment and follow the agreed plan.
- Commitment to ensuring no worker (including sub-trades) enters the job site without proper training. Ensuring Workers are made aware of their right to refuse work they consider too hazardous. Acknowledgement that the PWGSC orientation is not to be considered complete training.
- Commitment to using only "Qualified Persons" on the project and provision of proof of qualification as required.
- Definition of roles & responsibilities for project safety/organization for project specifically the Construction Superintendent, OH&S Representative and Worker Safety Representative. Identify any alternates and the qualifications of all individuals.
- A commitment to holding Occupational Health and Safety Meetings at a frequency agreed with the Departmental Representative and provision of minutes within 2 days of the meeting.
- Define Inspection Policy & Procedures. A commitment to holding formal site inspections at a frequency agreed with the Departmental Representative and provision of a report within 2 days of the inspection. The Worker Safety Representative will participate whenever possible.
- A commitment to conform to all environmental requirements and safe work procedures for hazardous materials. This includes provision of MSD Sheets and training of workers in correct use, handling, disposal and personal protective measures to be used.
- Definition of how First Aid will be provided and how medical emergencies will be treated.



- ❑ Incident reporting and investigation policy and procedures. Commitment to reporting all incidents, accidents, near-miss and WORKSAFEBC inspections/orders to the Departmental Representative immediately followed by copies of relevant reports etc. within 2 days.
- ❑ Occupational Health and Safety Committee/Representative procedures.
- ❑ Occupational Health & Safety communications and record keeping procedures.
- ❑ List hazardous materials to be brought on site as required by work.
- ❑ Indicate engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
- ❑ Identify personal protective equipment (PPE) to be used by workers.
- ❑ Identify personnel and alternates responsible for site safety and health.
- ❑ Identify personnel training requirements and training plan, including site orientation for new workers.

## XYZ CONSTRUCTION

### CONTRACTOR'S HEALTH & SAFETY PLAN – sample only

XYZ Construction (XYZ) considers safety to be an integral part of doing the work and takes pride in its safety program and record. See XYZ safety policy and program documentation attached.

XYZ's Safety Plan to ensure compliance with WORKSAFEBBC Regulations and Environmental practices as required under this contract includes the following elements.

#### **Safety & Health Considered in Bid:**

XYZ confirms all known hazards and safety requirements have been considered in the bid and that it will follow all applicable policies and procedures of PWGSC as the owner's representative and comply with all applicable regulations.

#### **Sub-Contracting:**

XYZ confirms it will not enter into any sub-contracting agreements without the approval of the PWGSC Departmental Representative. XYZ confirms PWGSC will retain the right to remove any sub-XYZ from the work site if the Departmental Representative deems it necessary and has so informed its sub-contractors.

Sub contractors will be identified to the Departmental Representative prior to entering the work site.

#### **Job Hazard Analysis**

XYZ will work with sub-trades and other resources to complete the Job Hazard Analysis to the extent possible. XYZ will then assist in finalizing the Job Hazard Analysis documentation with the Departmental Representative, Safety specialists and IOS Operations Representatives *prior* to starting work. The Departmental Representative will review the Job Hazard Analysis provided by the XYZ prior to worker orientation proceeding. XYZ will ensure worker compliance with requirements included in the Job Hazard Analysis, job/site specific procedures and all regulations.

XYZ will comply with the PWGSC Lockout Policy, Confined Space Entry Policy and other applicable site rules/ policies.

#### **Safe Work Procedures:**

XYZ will work with safety professionals, engineers and others as required to document safe working procedures for all hazardous work and ensure workers are trained in these procedures prior to starting work. Where required, Personal Protective Equipment will be provided and a list is attached.

#### **Provision of Plans by Qualified Persons:**

Where regulations require plans provided by Qualified Persons (e.g. Fall Protection Plan, Crane lifting plans, Confined Space Entry procedures) XYZ will identify the requirement, provide the plan and commit to ensuring workers are trained in the plan, have suitable approved equipment and follow the agreed plan. ABC Engineering will provide the required documentation for the 3 identified needs.

## XYZ CONSTRUCTION

### CONTRACTOR'S HEALTH & SAFETY PLAN – sample only

#### **Worker Training:**

XYZ will ensure no worker (including sub-trades) enters the job site without proper training in applicable WORKSAFEBBC Regulations and project specific procedures as defined in the Job Hazard Analysis, Emergency Response /Rescue Plans, or detailed work procedure. XYZ will ensure all workers understand the hazards of the work and those inherent in working at IOS and that they have the right to refuse work they consider to be too hazardous. XYZ will provide documentation confirming training to the Departmental Representative prior to the workers starting work. It is understood that the Orientation to be conducted by PWGSC cannot be considered complete training in everything the worker must know and Supervisors are ultimately responsible for workers being fully trained. No worker will enter the site without a complete orientation.

#### **Qualified Persons:**

XYZ will ensure that only “Qualified Persons” are used on the project and provide proof of qualification prior to the Pre-startup Orientation and Tour for workers as requested by the Departmental Representative. The list of designated qualified persons for this project is attached.

#### **Construction Superintendent:**

XYZ will ensure that the Construction Superintendent is qualified to supervise the work and will be capable of carrying out the following roles & responsibilities. John Smith, an employee with 34 years experience in building/construction type of work will supervise during the most critical activities and otherwise Dustin Brown, a senior employee with 10 years experience will act as alternate Construction Superintendent. Resumes are attached. The Construction Superintendent and Alternate meet the requirements outlined below:

1. To document a Project Safety Plan (this document) for both his people and any sub-trades involved on the project. This will be prepared in conjunction with the sub-contractor management as necessary and provides the framework for safety and health related activity on the project.
2. To train and/or ensure training has been done for any worker under his/her supervision including sub-trades.
3. To monitor the daily activities of his workers, including sub-trades, for compliance with safe work practices and immediately correct any violations.
4. To ensure no worker operates IOS equipment of any kind.
5. To re-train and coach workers as required for the purpose of correcting improper practices. To ensure the same is done for workers of sub-trades.
6. To report any injury, near miss or hazardous condition observed or brought to his attention to the PWGSC Departmental Representative immediately.
7. To report any WORKSAFEBBC Orders or Inspections received by XYZ to the PWGSC Departmental Representative immediately.
8. To conduct safety meetings as outlined in the section below.

XYZ will ensure sufficient supervision to monitor the activities of the workers and ensure compliance with safe work practices. For this project, the Construction Superintendent or his alternate Construction Superintendent will be on site at all times when work is proceeding.

## XYZ CONSTRUCTION

### CONTRACTOR'S HEALTH & SAFETY PLAN – sample only

#### **Designated O H & S Person:**

XYZ will employ and assign to the work, a competent and authorized representative as the Health and Safety Officer. Jack Brown, the Health and Safety Officer meets the following requirements (resume attached):

1. Have a minimum of 2 years of site-related working experience specific to activities associated with the work.
2. Have basic working knowledge of specified occupational safety and health regulations and site-specific safe work procedures.
3. To finalize the Job Hazard Analysis and safe work practices with the Departmental Representative, Safety Representative(s) and Operations Representative(s).
4. Be responsible for completing Health and Safety Worker Training and Site Orientation sessions, and ensuring that personnel who do not successfully complete the required training are not permitted to enter the site to perform work.
5. Be responsible for implementing and enforcing daily, and monitoring, the site-specific Health and Safety Plan.
6. Be on site during execution of work.
7. To be responsible for carrying out accident/incident investigations and provide a copy of the report to the PWGSC Departmental Representative. The Departmental Representative and/or his representative will assist in doing this.
8. Conduct regular drills, in co-ordination with Departmental Representative, to test adequacy of emergency response procedures and worker knowledge of their roles and responsibilities.
9. To conduct site inspections daily, as agreed with the PWGSC Departmental Representative and provide documentation of inspections to the Departmental Representative on a weekly basis.
10. To participate in safety meetings as outlined in the section below.

#### **Worker Safety Representative:**

The Worker Safety Representative on this project will be Sam White. Sam has been XYZ's worker safety rep for 5 years and is very familiar with applicable WORKSAFEBC regulations and safe work practices. Workers will be encouraged to contact their safety rep regarding safety and health issues that may arise. The Worker Safety Rep will participate in safety meetings and inspections and the resolution of health & safety issues.

#### **Safety Meetings:**

It is agreed that safety meetings with workers will consist of weekly meetings to be held every Monday morning with minutes to be provided to the Departmental Representative by the following Wednesday. The Construction Superintendent will document the actions of the meetings, who attended and provide a copy to the PWGSC Departmental Representative or his designate.

Typical topics for meetings will include but are not limited to:

- Review of hazards and safe work procedures and use of protective equipment.
- Changes in work practices, schedule or adjacent work areas which could affect worker safety,

## XYZ CONSTRUCTION

### CONTRACTOR'S HEALTH & SAFETY PLAN – sample only

- A review of critical procedures (e.g. Fall arrest plan, Fire and Emergency procedures,)
- Discussion of any injury, near miss or accident and steps to prevent recurrence.
- Worker health & safety concerns.

If changing conditions require communication to the workers prior to the next safety meeting, a “tail-gate” meeting will be held to train the workers prior to commencing work.

#### **Inspections:**

The Construction Superintendent/ OH&S resource will carry out daily inspections to identify new hazards, observe adherence to safe work practices and record findings and actions in his log. Written Inspection Reports will be provided to the PWOSG Departmental Representative weekly. Whenever possible, the weekly inspection will be conducted together with the Workers Safety Representative. This inspection will make use of the Job Hazard Analysis as a checklist of items to inspect.

#### **Hazardous Materials & Environmental:**

XYZ confirms it will conform to all environmental requirements as defined in the contract and comply with Environmental Services best practices and directives. Material Safety Data Sheets will be provided prior to finalizing the Job Hazard Analysis for all potentially hazardous materials to be used. Workers will be fully trained by XYZ in the hazards of these materials and the proper use, storage, handling, Personal Protective Equipment (PPE) usage, disposal of these materials, appropriate emergency response and any other relevant information from the MSD Sheets. XYZ will ensure workers have received WHMIS training as required by regulations. A list of hazardous materials and PPE to be used on this job is attached.

#### **First Aid/ Medical Assistance:**

XYZ will provide a written risk assessment and detailed procedures for dealing with various types of possible injuries to comply with WORKSAFEBC First Aid amendments effective 31 Mar/04 and ensure required First Aid coverage is in place prior to the first day of work. A Level 1 First Aid Kit will be kept at the XYZ field office trailer near the work area. All First Aid Attendants will have their Original certificates on site for inspection by WORKSAFEBC if required. Three employees, Bob Horvath, Brian West, and George Taylor have level 1 First Aid training.

In the case of non-serious injury not requiring a stretcher or ambulance, the injured worker will be taken to:

Admirals Walk Health Centre, 105-1505 Admirals Rd. (PH. 380-9070) using a company truck.

In the case of more serious injury, 911 will be called and ambulance service will be provided. Two XYZ workers will have 4-channel radios and can raise the alarm. The Construction Superintendent has a cell phone and will call 911.

#### **Emergency Response Plan**

XYZ will work with sub-trades, fire departments and others to document the response procedures in

## XYZ CONSTRUCTION

### CONTRACTOR'S HEALTH & SAFETY PLAN – sample only

the event of an emergency or serious injury if work is of a nature that requires these details. Documentation will be posted and all workers trained. Plans will be compatible with IOS emergency response for fire, bomb threat, earthquake and confined space rescue.

**SAMPLE  
ONLY**







## CHECKLIST OF SUBMITTALS

Spec Note: This list is intended to highlight documentation, etc. that PWGSC expects to be provided by the successful bidder. Delete items not applicable to this project.

### General:

- Finalized Job Hazard Analysis (see Spec 01 35 33). Mandatory. See Appendix B for Preliminary Job Hazard Analysis (JHA) provided by PWGSC that identifies those hazards known to PWGSC.
- Documentation of Contractor's Health & Safety Policy and Program to extent required by WORKSAFEBC. Mandatory
- Names of all Sub-Contractors and their Superintendents and phone numbers.
- Names of Worker's Safety Representative or Joint Safety Committee Representatives (where required by regulation).
- Documented methods and procedures to be used to carry out the work. This is not required for certain routine work (e.g. lawn maintenance, garbage collection). Engineer will indicate if not required.
- Confirm WORKSAFEBC clearance on WORKSAFEBC website
- Contingency & Emergency Response Plan. General site emergency response will be defined by Esquimalt Graving Dock (EGD) for earthquake, tsunami, fire, hazardous material spills.
- Plans for PWGSC Site Orientation and introductory Site Visit for the Contractor's Workers. If workers join the project later, they must be given the same orientation and training.
- Regular Safety Meeting Schedule including when minutes will be delivered. For projects of short duration (5 days or less) additional safety meetings not required. Carry out tailgate meeting if changing conditions require communication to workers.
- Regular Site Inspection Schedule including when reports will be delivered. For projects of short duration (5 days or less) additional formal inspections not required. Construction Superintendent will carry out observations while supervising and correct work practices, site conditions etc. and note in log.

### Environmental:

- Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements. These are provided to Environmental Services at EGD and must be accepted before use on the project.
- WHMIS plans and training documentation, where required. Workers must receive WHMIS training before working with hazardous materials.



**Qualifications/Certificates/Procedures:**

- Contractor's Superintendent qualifications and those of any alternate. Mandatory.
- Provide qualifications of Contractor's dedicated OH & S Qualified Person (and any alternate) to provide OH & S coordination (mandatory). The Contractor's Superintendent may fulfill this role, if qualified.
- Rigging and Lifting plans by Qualified Person (when required).
- Fall protection methods and procedures developed by a Qualified Person (when required).
- Scaffolding plans by a Qualified Person (when required).
- Fire Safety Plan. Hot Work Permits, when required, are obtained through the Engineer.
- Participate in Lockout Plan including details of all steps and points to be locked out and numbers of locks required. The EGD Guarantor will review the plan before issuing a Record of Isolation. PWGSC will be responsible for determining lockout points, completing isolation and reviewing with the Contractor. Contractor's workers will apply personal locks as required.
- Insulated aerial device certification (last 12 months).
- First Aid provision and copies of certificates for all F.A. Attendants. Plans for treatment of injuries including transport to clinic/hospital.
- First Aid assessment and written procedures for providing first aid to comply with WORKSAFEBC first aid amendments effective 31 Mar/04.
- Exposure control plans for Heat, Cold, Vibration, Noise, Radiation (where required by regulation).
- In addition to names of Qualified Persons referenced in preceding submittals, provide names of persons qualified as:
  - Electricians
  - Operate other equipment where required by regulation.

**Records:**

- Equipment inspection & maintenance logbooks required on site (copies not required).
- Records of workers instruction in use, care, fit etc. of Personal Protective Equipment (PPE) including fit tests. Produce for Engineer to review, copies not required.
- Supervisors & Worker training plan and documentation. Documentation must be received before any work begins (mandatory).

**Site/Project Specific Health & Safety Plan:**

Prepare and comply with a site-specific project Health and Safety Plan. See Appendix A accompanying Health And Safety Specification 013533 for detailed checklist.



Public Works and  
Government Services  
Canada

Travaux publics et  
Services gouvernementaux  
Canada

PROJECT # R.057890.003

PWGSC

ESQUIMALT GRAVING DOCK (EGD)

SSES – STANDBY POWER GENERATION SYSTEM

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APPENDIX B

**APPENDIX B**  
**PRELIMINARY JOB HAZARD ANALYSIS CHECKLIST**

**DRAFT**

**Inspection Date: 3 May 2012**

**Inspection/Job Hazard Analysis Conducted By: Ken Nielson**

**Note:**

1. This form is also intended for use as a checklist when making daily inspections of the worksite. Therefore some questions will not apply to the initial inspection/ job hazard analysis.
2. This form is intended as a guide only and does not necessarily cover every situation regulated by WORKSAFEBBC or other jurisdictions. It is imperative that the Contractor be familiar with safety requirements and add anything that is relevant but not listed below. New items should be noted to the attention of the Project Manager for inclusion in future revisions. Contractors must finalize the JHA to reflect the methods/equipment etc. they will use to do the work.
3. Project Managers must review all items as part of creating preliminary JHA. Do not simply reuse this form from a previous project. Delete or add to "Hazard/Action Required" items as appropriate for your project and enter checkmarks or NA (not applicable) or TBD (to be determined with Contractor) under "Existing" column as appropriate.
4. **CODES:**
  - "\*" indicates covered in Basic Site Orientation for Contractors presentation by PWGSC.
  - "S" indicates item covered in startup meeting with Contractor and up to Contractor to carry out appropriate action. Not covered in EGD orientation session.
  - "O" indicates item covered in EGD project specific orientation session. This does not relieve the contractor of responsibility for training workers with regards to this item.
5. Column "WORKSAFEBBC Ref." May also contain Canadian Occupational Safety & Health (COSH) regulation references.

This project involves installing a wire in two load banks, one for each stand by generator. One is located at the main north side electrical building and one at the south side electrical building. Work involves installation of concrete pads for the load banks, installing the load banks and associated ductwork on the roof of the buildings to exhaust heat.

Risks include but are not limited to:

- Electrocutation if proper isolation procedures are not followed.
- Falling over 25 ft when installing ventilation ducts if proper fall arrest/restraint procedures are not followed.
- Exposure to noise and dust when cutting and removing concrete. Use PPE.
- Exposure to lead if existing paint is disturbed by the work. Controls and worker protection will be required when drilling anchors for conduit. Details of potential locations to be provided.
- Be aware of low level (2%) asbestos contained in caulking around doors in the S. Side Substation. There should be no need to disturb this caulking.

	Cond No.	Condition	Existing √	CODE	WORKS AFEBC Ref. #	Hazard/ Action Required
<b>GENERAL</b>	1.1	<p>Notice of Project (NOP) given to WORKSAFEBC? Check regulations for conditions requiring notice:</p> <ul style="list-style-type: none"> <li>- Over \$100,000.</li> <li>- All or part of works are required to be designed by P.Eng.</li> <li>- Asbestos removal</li> <li>- Disturb Lead coatings</li> <li>- Significant Risk of Occupational Disease</li> <li>- New construction, major alteration, structural repair or demolition of : <ul style="list-style-type: none"> <li>- Bldg over 2 stories (or 20ft.)</li> <li>- Bridge</li> <li>- Earth/water retaining structure over 10'</li> <li>- Silo/chimney over 20'</li> </ul> </li> <li>- Work in compressed air environment</li> <li>- Work in a caisson</li> <li>- Work in a tunnel (see 22.2)</li> <li>- Work on underground working (22.6)</li> <li>- Trenches 4' deep and 100' long or other type of excavation over 4' a worker must enter.</li> <li>- Diving Operations check 24.9</li> <li>- Aircraft involved? check 29.8</li> </ul>	√	S	20.2 24.9 22.6 29.8	<p>Contractor to provide NOP to WORKSAFEBC and provide copy to Project Manager before pre-startup safety orientation meeting.</p> <p>Note that WORKSAFEBC NOP Form 52E49 is used for general construction work and when asbestos or lead is involved. Use WORKSAFEBC Form 52E48 for NOP when diving, underground workings or aircraft are involved. NOP should go to WORKSAFEBC 4-5 days before starting work if possible and MUST be submitted no less than 24 hrs before commencing work.</p> <p>The white copy is for the site and the canary and pink copies go to the WORKSAFEBC.</p> <p>Photocopies should be posted on the safety notice board, placed on the project file, contract file and sent to the Regional Safety Coordinator.</p> <p>Note also the requirement to provide written notice to WORKSAFEBC before commencing (under Part 19) if workers, equipment, machinery or materials could come in contact with energized high voltage conductors or other exposed electrical equipment.</p> <p>Note application to underground workings in WORKSAFEBC section 22.2</p>
	1.2	<p>Multiple Contractor Coordination.</p> <ul style="list-style-type: none"> <li>- 2 or more employers?</li> <li>- Overlapping work areas</li> <li>- Appoint qualified safety coordinator</li> <li>- Post construction procedures and JHA</li> </ul>	√	S	Review WORK SAFEBC 20.3	Contractor to appoint Worker Safety Representative and Construction Superintendent. Coordination with EGD personnel and others on site will be through Project Manager. Post Final JHA and procedures.
	1.3	Building and other permits obtained?	√	S		Building permit required for new construction.
	1.4	Notice of Project Posted?	√	S		Contractor will post on safety notice board.
	1.5	<p>Post emergency response plan and site plan? Workers trained in emergency response? Conduct risk assessment for: Work at high-angles Special needs individuals Others as required by 4.13 or identified in other sections below</p>	√	*	4.13-4.18 20.3	<p>Site plan and emergency response to be posted on safety notice board. Contractor to ensure all workers trained in emergency response for fire, earthquake, medical, bomb threats and hazardous materials accidents before starting work.</p> <p>Note the special rescue requirements for high-angle work and the need for written agreements to provide service.</p>

1.6	Regular Safety Meeting Minutes Posted?	√	*	3.2	Weekly safety meeting to be held. Contractor to provide minutes to Project Manager for posting.
1.7	WORKSAFEBC Orders, Inspections or “Notice to Workers” Posted? Notification of compliance posted?	√	S	Div. 10 183	Contractor to provide any WORKSAFEBC inspections and/or orders to Project Manager and post any inspections and compliance reports.
1.8	Regular Inspections carried out with Safety Rep and Posted? Conduct special inspection if required due to malfunction or accident.	√	S	3.5 3.7 3.8	Provide inspection reports to P.M. and post.
1.9	Contractor’s workers safety representative identified for each employer? Alternatively, a Joint Committee set up if required by WORKSAFEBC Div. 4?	√	S	20.3 Div4 125-140	Worker Safety representative if 9 or more workers.
1.10	Insufficient lighting?	√	S	4.65	Contractor to ensure lighting levels are sufficient for work to be performed. Provide portable lighting where necessary.
1.11	Workers informed of the hazards of the job and that they have the right to refuse work they consider too hazardous without discriminatory action?	√	*	Review 3.12	To be covered in orientation session and reinforced by Contractor.
1.12	Workers with physical or mental impairment that could affect work must inform their supervisor.	√	*	4.19	To be covered in orientation session and reinforced by Contractor. Do not work at heights if subject to dizziness or if worker has a fear of heights.
1.13	Workers informed no alcohol, drugs or other substance so as to endanger self or others?	√	*	4.20	To be covered in orientation session and reinforced by Contractor. Inform First Aid attendant of any medications being taken as they may be important in case of accident.
1.14	Firearms of any kind are prohibited on site.	√	*		To be covered in orientation session and reinforced by Contractor.
1.15	Duties of Employers, Workers, Supervisors and Owners	√	*	Div.3 115-119	Review duties/responsibilities of parties involved. To be covered in orientation session.
1.16	General Duty: In the absence of a specific requirement, all work must be carried out without undo risk of injury or disease to anyone.	√	*	2.2	To be covered in orientation session and reinforced by Contractor.
1.17	Do not remove or render inoperative any safeguard and ensure safeguards are in place before operating equipment.	√	*	4.11 4.12	To be covered in orientation session and reinforced by Contractor.
1.17a	All workers must be given adequate instruction in the fire prevention and emergency evacuation procedures applicable to their workplace.	√	O	4.16	To be covered in orientation session and reinforced by Contractor.
1.18	Do not operate any EGD equipment. Only those trained and authorized by the contractor are to operate contractor’s equipment.	√	*	4.10	

1.19	Ensure equipment inspection & maintenance record (s) are readily available to equipment operators or inspectors.	√	*	4.9	To be covered in orientation session and reinforced by Contractor.
1.20	Workers must not engage in improper activity that could constitute a hazard to themselves or others including horseplay threats or physical force. Improper activity must be investigated.	√	*	4.24-4.31	To be covered in orientation session and reinforced by Contractor. Violence or harassment will not be tolerated. Contractor carry out risk assessment of injury from violence if there is potential for violence. Inform workers and prepare plans to minimize risk as required by 4.30
1.21	Workers to restrict activity to designated areas of the site.	√	*		Restrictions to be discussed at pre-start-up safety orientation meeting.
1.22	Workers informed of location of copy of WORKSAFEBC Regulations and Worker's Compensation Act.	√	*		Cover at orientation meeting. Contractor to ensure current copy of Regulations and the Act is available on site.
1.23	Written work procedures developed? Provided to P.M. and workers?	√	S & O		Contractor to document work procedures and sequence of activities and provide to Project Manager and workers before starting work.
1.24	Do not work on site outside of agreed working hours.	√	*		EGD must ensure an employee is on site anytime contractors are on site. Therefore notice is required.
1.25	If work damages a utility it must be reported.	√	O	4.18	Immediately inform the Utility and then the Project Manager
1.26	Wildlife, rodents may be encountered on the site.	√	O		Be aware of potential for encounters with wildlife on the site. Rodents may leave droppings in crawl spaces that could present a hazard if dust is breathed. Also, raccoons may be aggressive if cornered and deer may protect their young.



FIRST AID & INVESTIGATIONS	2.1	Has the Contractor carried out an assessment and identified the numbers of workers who may require first aid at any time; the types of injuries that might occur; barriers to first aid being provided to an injured worker; and time required to transport an injured worker to medical attention?	√	*	3.16 & 3.17	Contractor to provide <u>written</u> first aid assessment and written procedures for providing first aid to comply with first aid amendments effective 1 Feb/08.
	2.2	Workers instructed to report ALL injuries or near misses, hazardous conditions?	√	*	3.10	To be covered at the pre-startup safety orientation meeting.
	2.3	Workers know where first aid is located and how to call for first aid? Communication between first aid attendant and ambulance service defined?	√	*	3.17 & 3.18	Contractor MUST have own F.A. Before starting work. Identify location & adequacy of Contractor's F.A. equipment. Cover procedures in orientation.
	2.4	First Aid qualified person(s) on contractor's crew? ORIGINAL Certificate(s) must be with person(s) on site. Provide photocopy to Project Manager.	√	S	Part 3	Required. Provide certificate(s) to Project Manager before orientation session.
	2.5	F.A. equipment on site where required? Must comply with "High" Hazard class 20 min or less travel to hospital.	√	S	3.16	Provide location and type.
	2.6	Provide immediate investigation & notice to WORKSAFEBC for: - serious injury/death - major structural failure of bldg., bridge, tower, crane, hoist, excavation, temp. construction support system. - major release of a hazardous substance. - incident required to be reported.	√	S	Div. 10 172	To be covered in project startup meeting with Contractor. Do not disturb the accident site except to attend injured persons, prevent further injuries or protect property. Assist investigators every way possible.
	2.7	Provide emergency transport to hospital as required by WORKSAFEBC and written procedures for transport.	√	S	3.17	Contractor to define procedures for provision of first aid, calling ambulance service etc. as required by regulation. Post them and ensure workers are informed.
	2.8	Is the first aid attendant available to render prompt service?	√	S	3.18	Do not assign activities that will interfere with the attendant's ability to receive and respond to call for first aid. Ensure coverage during lunch and other breaks. Provide backup first aid immediately for planned absences. About ½ shift absence is permissible for unplanned absence until replacement attendant is in place.
	2.9	Has the general contractor included all subs in determining the numbers or workers and first aid requirements	√	S	3.20	General Contractor's first aid assessment and procedures to include sub-contractors.

	2.91	Has the contractor assigned a person to manage first aid service?	√	S	3.17	Assign someone to ensure attendants, supplies, facilities and equipment are always available.
	2.92	Does the Contractor have New or Young Workers as defined by WorkSafeBC regulations?	√	S	3.22-3.25	Ensure New or Young workers receive special orientation and training as required by regulations and documentation is provided to the Project Manager. Ensure follow up observation and provide reinforcement training if required or requested by the worker.
	2.91	Has the contractor assigned a person to manage first aid service?	√	S	3.17	Assign someone to ensure attendants, supplies, facilities and equipment are always available.
CHEMICAL/ BIOLOGICAL - WHMIS	3.1a	Hazardous Substances Used? Provide details.	√	O	PART 5	No hazardous substances expected to be used by the contractor. Contractor to provide Material Safety Data (MSD) Sheets for all hazardous substances to be used including welding materials and gases. Sheets must be provided by the contractor at first meeting with the engineer in order to complete the Job Hazard Analysis and define safe work practices. Ensure effective written procedures are prepared and implemented to prevent exposure by any route that could cause an adverse health effect, and to address emergency and cleanup procedures in the event of a spill or release of the substance. Ensure the supervisor and the workers are trained in and follow the established procedures.
	3.1b	Environmental Assessment completed? Check identified hazards and measures to be taken.	NA	S		Formal Environmental Assessment not required.
	3.1c	EGD Environmental Best Management Practices applicable?	√	O		Contractor to follow Best Management Practices provided by Environmental Services.
	3.2	Implementation Plan Checklist completed?	TBD	S	5.7	Contractor to follow Implementation plan checklist for hazardous substances. See WORKSAFEBC section 5.7
	3.3	Material Safety Data Sheets Available?	TBD	O	5.16	Contractor to provide MSD Sheets and make available at worksite to all workers.
	3.5	Emergency Response Defined?	TBD	O		Contractor to define emergency response as appropriate for hazardous substances.
	3.6	Training Checklist Completed?	TBD	S	5.7	Contractor to follow education & training checklist for hazardous substances provided by WORKSAFEBC. See 5.7
	3.7	Flammable/Combustible Substances?	TBD	O	5.27-5.35	
	3.8	Substances under pressure?	TBD		5.36-5.47	
	3.9	Controlling Worker Exposure	TBD	O	5.48-5.59	
	3.10	Ventilation controls?	TBD	O	5.60-5.71	
	3.11	Internal Combustion Engines operated in poorly ventilated areas?	TBD		5.72-5.75	
3.12	Hazardous Wastes & Emissions	TBD	O	5.76-5.81		

3.13	Personal Hygiene	√	O	5.82-5.84	Wash hands before eating or smoking or at breaks as required by regulation.
3.14	Emergency Washing Facilities, eyewash required?	TBD	O	5.85-5.96	Contractor to provide emergency washing facilities where required due to hazardous substances.
3.15	Emergency Procedures defined? Review First Aid, Fire, Spill Control.	TBD	O	5.97-5.102	Contractor to review emergency procedures with workers.
3.16	First Aid and Fire depts. aware of substance and quantities used and locations stored?	TBD	S	4.17	Contractor provide notice if required by regulations.
3.17	Supervisor & Workers trained? General WHMIS instruction as well as substance specific training?	TBD	S		Contractor to ensure Workers and Supervisors have WHMIS training and training in dealing with specific substances.
3.18	Substance specific requirements?	TBD	S	PART 6	Review Part 6 and ensure compliance as per MSD sheets. See also sections 25, 28 and 29 below.
3.19	Evaluate worker understanding of substance specific requirements and emergency/spill procedures during inspections.	TBD	S		Inspection item.
3.20	Ensure containers for hazardous substances are maintained to ensure secure containment. Keep covered when not in use.	TBD	S	5.20-5.22	Inspection item.
3.21	Keep only enough for one shift, store balance of quantity in designated separate area. Ensure workplace/supplier labels are on EVERY container.	TBD	S	5.23	To reduce the risk of a major spill, fire etc. minimize quantities on site. Ensure workers can easily tell what is in every container. Inspection item.
3.22	Store incompatible substances so that they can not mix in event of leakage, breakage etc.	TBD	S	5.24	Serious consequences can result from mixing certain substances. Ensure they cannot mix. Inspection item.
3.23	Store hazardous substances so they can't fall, be damaged or exposed to extreme temperatures.	TBD	S	5.25	Inspection item.
3.24	Ensure the designated storage area meets design requirements.	TBD	S	5.26	Inspection item.
3.25	Protective and spill equipment available?	TBD	O		Contractor to ensure all personal protective equipment and spill response equipment is readily available and workers are trained in spill response plan.
3.26	Follow proper procedures in disposing of hazardous substances.	TBD	S		Follow MSD Sheet instructions.
3.27	Other	TBD			
	Note: Refer to WHMIS Implementation Plan checklist when doing inspections for hazardous substances	TBD	S		Create inspection checklist where required.

<b>WORKING ALONE</b>	4.1	Working alone process defined for workers assigned to work alone? Note new guidelines Nov./08 for determining if working alone regs apply. Amongst other things a "person check" system alone is unlikely to meet the "readily available" test.	No working alone	*	4.21-4.23	There will generally be no working alone. Document special procedures and agree with Project Manager if working alone is necessary. Note regulation changes 1 Feb/08
	4.2	Working alone process followed?	√		4.21-4.23	Inspection item.
	4.3	Restricted Access area?	√	O		Contractor to ensure workers follow procedures for restricted access.
<b>LOCK-OUT &amp; ELECTRICAL</b>	6.1	Has the EGD Lockout policy been reviewed and relevant sections complied with?	√	S		Policy to be reviewed by Contractor with workers as part of training.
	6.2	Each worker has own lock, no combination locks? Means of identifying lock owner?	√	O	PART 10	Every worker must have own lock and tag identifying worker and company.
	6.3	Lockout procedures documented for project?	√	O	PART 10	To be documented and agreed with J. Lezetc and permit issued before initiating lockout.
	6.4	Workers and Supervisors trained in lockout? Only certified electricians to do electrical work.	√	O	PART 10	Contractor to ensure all Workers and Supervisors are trained in the lockout procedure. Contractor to provide proof of certification to Project Manager before start of work.
	6.5	All isolation points identified?	√	S	PART 10	To be done in conjunction with J. Lezetc and documented in lockout procedure.
	6.6	Electrical ground hazard?	√	S		To be done in conjunction with J. Lezetc and documented in lockout procedure.
	6.7	Pneumatic Devices hazard?	√	S		Document if this type of hazard exists and controls required.
	6.8	Potential Energy hazards? All parts secured against inadvertent movement?	√	S		Document if this type of hazard exists and controls required.
	6.9	Kinetic Energy hazards? All parts secured against inadvertent movement?	√	S		Document if this type of hazard exists and controls required.
	6.14	If over 750V follow H.V. guidelines in lockout policy.	NA	O		No H.V. work required.
	6.15	No working NEAR energized H.V. equipment or conductors.	Not permitted	S	Lockout Policy	Not permitted.
	6.17	Control the use of metal ladders, wire reinforced ladders, metal scaffolds or work platforms.	√	S	19.10	Planned use of ladders, scaffolds etc. to be determined with Contractor and electrical risks assessed.
	6.18	No Qualified workers within 1 m. of uninsulated, energized parts.	Not permitted	S	Lockout Policy	Not permitted. Keep unqualified personnel at least 3 m. from energized parts.
	6.19	If using an insulated aerial device has it been tested as required by WORKSAFEBC Reg. 19.9	√	S	19.9	Check plans to use aerial device & insure compliance.
6.20	Is all portable electrical equipment either double insulated and so marked or effectively grounded? Workers trained to inspect?	√	S	19.14	Contractor to check any portable equipment and ensure workers trained in inspecting electrical equipment for safe operation.	

	6.21	Is all portable electrical equipment used outdoors or in wet/damp conditions protected by Class A Type ground fault circuit interrupters?	√	S	19.15	Contractor to check any portable equipment and ensure workers trained in inspecting electrical equipment for safe operation.
	6.22	Ensure good access to electrical equipment and that no flammable materials are stored or placed close to electrical equipment.	√	O	19.7	Practice good housekeeping. Keep areas clear in front of electrical panels, fire alarms & extinguishers. No flammables inside work areas unless agree by Project Manager.
	6.23	Other, specify:				
	6.24	Are lockout points easily identifiable (e.g. By number) to prevent lockout errors and identify the equipment it serves?	√	S	19.13	All lockout points are labelled.
	6.25	Note that lockout of a panel door preventing access to other live breakers is unacceptable.	√	S		Generally there should be no other users of panels while the project work is underway. Confirm.
	6.26	Note lockout of Control Circuits is not sufficient for total isolation.	√	S		Reminder item
	6.27	Be SURE to understand what will happen if an energy source is activated.	√	S		Reminder item
	6.28	Consider severity of injury, frequency of doing the job and probability of injury in assessing tasks.	√	S		Reminder item
	6.29	Before the conclusion of the job and after energizing, have conspicuous signs been placed near the equipment stating "Danger – Energized Equipment"?	√	O	19.11 19.17	Place signs when finished.
	6.30	Ensure electrical instrumentation is functioning properly and has not been the subject of recall by the manufacturer.	√			Note that some Fluke Model 179 Multimeters have exhibited faulty readings and need to be replaced.
FALL PROTECTION	7.0	Fall Protection required? Yes work over 7.5 ft above unguarded surfaces.	√	S	11.2	1. Work over 7.5 ft. (CLC requirement) or shorter distance if risk of injury greater than fall to flat surface. 2 .Use guardrails or similar restraint if practicable. 3 .Use other fall restraint if 2 not practicable. 4 .If 3 not practicable use fall arrest system. 5. If 4 not practicable ensure work procedures acceptable to WORKSAFEBEC are used. Note changes to WORKSAFEBEC regulations 1 Jan/05
	7.1	Fall Protection System defined in writing?	√	S& O	11.3	Contractor to define fall protection plan for any work over 7.5 ft. (CLC requirement) above ground on unguarded surfaces from which fall greater than 7.5m.(25ft) can occur or 11.2(5) applies.
	7.2	Workers & Supervisors Trained?	√	S& O	11.2(6)	Contractor to ensure all workers & supervisors trained in fall protection procedures before work starting and provide documentation to Project Manager.

	7.3	Workers trained & Fall Protection Procedures followed?	√		11.2(6)	Inspection item.
	7.4	Inspection of fall arresting equipment before each use by a qualified person being done?	√	S	11.9-	Qualified Person to perform inspection before use on each shift. Keep free from foreign substances & conditions that can contribute to deterioration & keep in good working order.
	7.5	Fall Protection System used?	√	S	11.2(7)	Ensure workers use system
	7.6	Safety Belts used for fall restraint only? Otherwise use body harness.	√	S	11.4	Follow written fall protection plan.
	7.7	Ensure equipment meets standards	√	S	11.5	Ensure components are suitable and compatible, sufficient to support the forces and meet and are used in accordance with standards.
	7.8	Ensure anchors meet standards	√	S	11.6	Check anchors meet WORKSAFEBC requirements. Changed 17 May/06
	7.9	Temporary horizontal lifeline system used?	TBD	s	11.7	Acceptable if 1) manufactured for commercial use and installed and used per written instructions and drawings (available on site) 2) designed, installed & used per written instruction and drawings (available on site) certified by P.Eng. 3) other acceptable to WORKSAFEBC Changed 17 May/06
	7.10	Need to remove from service?	√	s	11.10	If fall protection system has arrested fall of a worker remove from service until inspected and recertified safe by manufacturer or P.Eng.
FIRE RELATED	8.1	Workers aware they generally do not fight fires? First priority is to raise the alarm and get selves and others to safety.	√	*		Workers to fight fires only if small (2'x2') and they have been trained in fire extinguisher use and they are confident they can extinguish the fire. To be reinforced at orientation meeting and reinforced by Contractor.
	8.2	Fire Extinguishers Available and accessible?	√	O		Contractor to ensure proper type and number of extinguishers available. Check monthly inspection and tags.
	8.3	Electrostatic Discharge	√	O		Contractor to determine risk of ignition due to discharge and take preventive measures.
	8.4	Ignition Sources eliminated or controlled if flammable gas or liquid used or stored?	√	O	5.27	No smoking on this project except in designated areas defined by Project Manager. Define any other ignition sources and controls required.
	8.5	Flammable gas concentrations	√	S&O		Ensure adequate ventilation to comply with WORKSAFEBC regulations. Monitor flammable gas concentrations and use forced ventilation if required.
	8.6	Combustible materials	√	O		Keep area clear of combustibles. Practice good housekeeping. Store oily rags in approved metal containers with tight fitting lids and empty daily. Burning of waste is prohibited.

	8.7	No smoking in buildings, on cranes, in caissons or tunnels. Define other restrictions. Rules being followed?	√	O	4.81	Contractor to enforce no smoking except in areas designated by the Project Manager.
	8.11	Do not use flammable liquids as a manual cleaning solvent.	√	S	5.32	Flammable fumes can collect on clothes and result in the worker being engulfed in flames should ignition occur. Also, these substances are often hazardous to health and can be absorbed through the skin. Contractor to reinforce with workers and monitor for compliance.
	8.12	Hot Work Permits issued and posted?	√	*		Obtain permit from Project Manager before starting any cutting, welding, brazing, soldering, grinding, heat-treating or other hot work like roof tarring, thawing pipe, hot riveting or using powder-driven fasteners.
	8.13	Fire Alarms explained?	√	*		To be covered at pre-startup meeting and worker orientation session.
LADDERS/SCAFFOLDS & TEMP WORK PLATFORMS	9.0	Is work off ladders/scaffolds etc planned? Note new guidelines Nov/08 re suitable ladders, work platforms, and scaffoldings, and to specify that the top plate of interior or exterior walls, the top plate/top whalers used in concrete formwork, or other elevated surfaces narrower than 50 cm (20 in) are not considered suitable work platforms or acceptable as elevated walkways.	√	S		Work off ladders/scaffolds foreseen.
	9.1a	Workers trained and authorized to use temporary work platform?	√	S	COSH 3.5	Ensure all workers trained before authorizing use.
	9.1b	Weather conditions likely to be hazardous to use of temporary structure?	√	S	COSH 3.3	No work in rain, snow, hail or electrical/wind storm likely to be hazardous to worker safety
	9.2	Has Qualified Person inspected temporary structure before use each shift?	√	S	COSH 3.6	If defect found, do not use until remedied.
	9.3	Could temporary structure be contacted by person or vehicle?	√	S	COSH 3.7	Install hi-viz barricade around base or post a person.
	9.4	Ladder type and condition? Meet specifications per WORKSAFEBEC?	√	S	PART 13	Contractor to ensure all ladders are in good condition and meet WORKSAFEBEC requirements for the application. Ensure portable ladders are marked with grade of material and use for which ladder constructed.
	9.5	Ladder Inclination, Footing and Support and use according to WORKSAFEBEC regulations	√	S	PART 13 COSH 3.11	Check for minimum ¼ maximum 1/3 inclination, solid footing and support. Projects at least 1m(3ft.) above upper landing to which it supplies access. Check extension overlap. Tie off if possible for stability during use.

9.6	Contractor to ensure work off ladders meets regulations. If work cannot be done safely from a ladder provide work platform.	√	O	13.6	Follow safe ladder work practices
9.7	Heavy/bulky objects or others that may make ascent or descent unsafe not to be carried up ladders	√	O	13.6	Use an assist to raise & lower tools.
9.8	Scaffold or other work platforms to be designed and approved by a P.Eng.?	√	S	Check WORKS AFEBC PART 13 13.11	Contractor to provide P.Eng. certified scaffolding plan where required by regulation 13.11. Follow instructions including fall protection during erection/ dismantling and use of the system. Signed copy to be available on site.
9.9	Employer must ensure scaffold is in a safe condition regardless of who erected it. Ensure scaffold manufacturer's technical data & instructions for erection available on site.	√	O	13.13, 13.15 COSH 3.10	Ensure manufacturer's documentation is on site or follow P.Eng. instructions. Contractor ensure compatibility if different manufacturers of components used. Ensure qualified Person supervises erection, use and dismantling and scaffold capable of holding 4 times load likely to be imposed. (COSH)
9.10	Guardrails and toe boards installed at every open edge of platform?	√	S	4.55-4.60 COSH 3.8	Ensure guardrails and toeboards installed.
9.11	Tools/equipment/materials arranged to prevent being accidentally knocked off platform?	√	S	COSH 3.4	Ensure safe arrangement on platform
9.12	Check Scaffold Stability, Bracing, Access and all connections secure.	√	S	13.17 13.18	Ensure scaffold is stable, plumb and level and WORKSAFEBC requirements are met. If height 3 times min. base dimension or other circumstance requiring stability- bldg ties/guys required. Inspection item.
9.13	Plank type & condition inspection. Planks secured?	√	S	13.14 13.16	Contractor Inspect planks regularly and secure to scaffold frame. Dimensions and guardrails meet requirements?
9.14	Scaffold grounded if near high voltage or hazardous level of voltage likely to be induced in scaffold?	√	S	13.19	Ensure grounding. Inspection item
9.15	Safe access provided to work platform?	√	S	13.7 COSH 3.9	Provide safe access. Temporary stairs have uniform steps, slope not exceeding 1.2 in 1; hand-rail between 90 and 110cm above stair level. Ensure temporary ramps securely fastened; safe footing, braced if necessary; slope 1 in 3 except in stairwells check COSH Inspection item
9.16	Work platform strength sufficient for load and secured against separation form supporting equipment, structure or surface?	√	S	13.8	Ensure scaffold can support 4 times load likely to be imposed on it (COSH 3.10)



9.17	Work platform subjected to sudden drop, contact with electrical conductors or showing signs of mechanical damage/wear?	√	S	13.12	Remove from service until certified safe by manufacturer or P.Eng.
9.18	Ensure movable work platforms are clearly marked with rated capacity	√	S	13.20	Also check for marking on components (e.g. rigging capacity, counterweight, etc.) as required by regulations
9.19	For elevating work platforms ensure operation manual, maintenance instructions, replacement parts information are reasonably available to workers.	√	S	13.21	If information is not available, equipment must not be used until obtained or written instructions provided by P.Eng.
9.20	Employer must keep records regarding inspection, maintenance, repair or modification for each elevating work platform, swing stage, and permanent powered platform	√	S	13.22	If inspection and maintenance records other than pre-shift inspections not available, do not use until certified safe by manufacturer or P.Eng.
9.21	Vehicle-mounted and self-propelled boom-supported elevating work platforms tested?	√	S	13.23	Inspect and certified by manufacturer or P.Eng. every 12 months. In 10 <sup>th</sup> year after manufacture & every 5 years thereafter include structural inspection to verify integrity and stability. Dielectric test insulated units at least annually- certified by testing agency.
9.22	If a movable work platform is not designed to be moved while a worker is on it, ensure it is secured before being accessed by the worker. Move platforms designed to be moved while occupied only as specified by the manufacturer.	√	S	13.24	Exceptions: If the height of the work platform of a rolling scaffold is: (a) not more than 1 1/2 times the least base dimension of the scaffold, the scaffold may be moved by the effort of the person occupying the platform or a person on the floor or other supporting surface, (b) more than 1 1/2 times the least base dimension of the scaffold, the scaffold must be moved only by the effort of a person on the floor. (c) more than 2 times the least base dimension of the scaffold, the scaffold must not be moved while the person is occupying the platform.
9.23	Elevating work platform meets requirements for warning devices and controls?			13.25 13.26	Ensure intermittent horn or flashing light and warning system for deviation from level are provided as required by regulation. Ensure controls including STOP are clearly marked. Clearly mark overriding lowering control to be used in emergency.
9.24	Guardrails installed? Ensure temporary guardrails meet specs.	√	S	4.58	Contractor to ensure guardrails are installed and meet regulations. Inspection item.
9.25	Forklift mounted work platform not to be used except as defined by WorkSafeBC regulation.	√	S	13.30	Check revised regulations 1 Feb/08. Inform Project Manager before using a forklift mounted platform.

	9.26	Work platforms suspended from a crane or hoist must be certified and loaded weight including rigging not over 50% of crane/hoist rated capacity at the working radius or configuration.	√	S	13.27-	Boom must be powered or fixed. No platform suspended from articulating boom crane unless approved by manufacturer. Secondary hoisting line must not be used when workers are on platform suspended from a crane.
	9.28	Hoisting and lowering work platforms done according to safe practices?			13.29	Operate as slowly as practicable. Lower under power if device powered. May not be controlled only by brakes. Ensure lower travel limit device is used where required. Carry out a trial lift before platform is occupied.
	9.29	Portable powered platform capable of raising/lowering by 2 or more separately controlled hoists?			13.31	Ensure controls located so one person can operate all hoists simultaneously.
	9.30	Ensure fall protection meeting WORKSAFEBBC requirements is in place for suspended or elevating work platforms	√	S	13.33	Include in fall protection plan. Each person on a work platform attached to a crane boom must use a personal fall arrest system secured to an anchor on the boom or on the platform that is designated by the manufacturer, or a professional engineer.
	9.31	WORKSAFEBBC approval obtained for high risk situations?	√	S	13.32	A swing stage, boatswain's chair and portable powered platform must not be used without prior permission of the Board if (a) one work platform will be used above or below any portion of another work platform, (b) a deck or planking will be used to span a gap between two independent work platforms, (c) the work platform will exceed 10 m (32 ft) in length, or (d) the suspension height will exceed 91 m (300 ft).
PROTECTIVE EQUIPMENT	10.1	Hard Hats Worn at all times. Chinstraps available for high wind/ bending over?	√	*	8.11-8.13	Contractor to monitor and enforce hardhat and chinstrap usage.
	10.2	High Visibility Clothes, correct type for the job.	√	O	8.24-8.25	Wear high viz vests when required. Traffic Control Persons will have special requirements.
	10.4	Safety Footwear	√	*	8.22-8.33	Approved steel-toed footwear in good repair, required at all times meeting WORKSAFEBBC requirements for the work to be performed.
	10.5	Approved Safety Eyewear/ Face Shields. Note new guidelines re acceptable standards Nov/08	√	O	8.14-8.18	Eye protection required when energizing and de-energizing breakers. Also when doing any other work where flying objects may be encountered. Also may be required when using hazardous substances (TBD).
	10.6	Wear Hearing Protection when required by WORKSAFEBBC regulations.	√	O	7.1-7.9	Hearing protection required when in high noise situations exceeding WORKSAFEBBC noise exposure limits. Implement and provide evidence of noise control and hearing conservation program where required by regulation. Post warning signs in high noise areas.

	10.7	Respiratory Protection & Fit	√	O	8.32-8.37	Wear approved respiratory protection considering the respirator protection factor and maximum use concentration, MSD Sheets, exposure to oxygen deficient atmosphere when selecting respirators for workers that may be exposed to dusts or hazardous fumes/mists above exposure limits.
	10.71	Respirator fit tests conducted?	√	O	8.38-8.41 8.44	Ensure proper fit tests per regulations and keep records. Workers must perform a positive or negative pressure user seal check in accordance with <i>CSA Standard before each use</i> .
	10.72	Worker's ability to use a respirator in doubt for medical reasons?	√	O	8.42	Ensure worker examined by a physician, and advice obtained re the ability of the worker to wear a respirator.
	10.8	Gloves, Aprons, leg protection	√	O	8.19-8.21	Wear protective clothing when performing work that could result in cuts, slivers, abrasions, etc. Check added requirements from MSD Sheets.
	10.12	Vibration Reduction	√	O	7.10-7.16; 5.54	Provide written exposure control plan where required by regulation and inform worker of hazards. Employer ensure equipment is labelled to identify hazard. Ensure hands and arms not exposed to cold if also exposed to vibration.
	10.14	Personal clothing, rings, hair etc. OK	√	O	8.10	Ensure workers do not have loose clothing, long hair or rings which could become entangled if operating rotating power tools.
	10.15	Apply Sunscreen, to protect against sunburn on exposed skin.	√	O		Wear sunscreen when working outdoors.
	10.16	Safety belts, harnesses, lanyards & shock absorbers	√	O		Follow fall protection plan and use prescribed equipment.
	10.17	Employees must wear suitable personal clothing for the work they are doing to reduce risk of injury.	√	S		Contractor to ensure workers wear suitable clothing.
		Note: Check all protective equipment for proper fit and condition.	√	S		Contractor responsible for ensuring proper fit and care of all protective equipment and documentation thereof.
HEAT STRESS	11.1	Heat Stress Control Required? Followed?	√	S	7.27	To be determined by Contractor's Superintendent based on section 7 WORKSAFEBC regulations (Jan/05), weather conditions, and worker proximity to heat sources and clothing worn.
	11.2	Check for heat stress if temp warrants.	√	S	7.28- 7.30	Contractor to monitor environmental conditions and take action accordingly if ACGIH standard requires. If required, conduct assessment and develop exposure control plan. Provide engineering controls if practicable, otherwise reduce exposure or provide admin controls or PPE.
	11.3	Potable drinking water nearby?	√	O	7.31	Contractor to supply adequate drinking water for Workers

	11.4	Workers & Supervisors trained to recognize?	√	O	7.32	Contractor to ensure Workers and Supervisor recognize symptoms and know proper response. Contractor's F.A. attendant to be instructed to monitor workers for signs. Remove workers exhibiting stress from exposure and provide First Aid or physician treatment.
COLD STRESS	12.1	Cold Stress Control Required? Followed?	√	S	7.33	Cold stress not likely to be a factor during summer months. Contractor to be aware of conditions under which cold stress could be a concern based on ACGIH standard (Jan /05)
	12.2	Check Table 7-4 for conditions	√	S	7.34- 7.37	Contractor to monitor for cold stress risk conditions and take appropriate action. if ACGIH standard requires. If required, conduct assessment and develop exposure control plan. Provide engineering controls if practicable, otherwise reduce exposure or provide admin controls or PPE.
	12.3	Workers & Supervisors trained to recognize?	√	O	7.38	Ensure workers trained. First Aid attendant may be asked to monitor for cold stress. Remove workers exhibiting stress from exposure and provide First Aid or physician treatment
CRANES, HOISTS & RIGGING	13.1	Note WorkSafeBC definitions for "critical lift" "duty cycle work", "load bearing component", "sign truck" and "tandem lift"	√	S		Changes effective 1 Feb./08 to add clarity.
	13.1a	Only EGD Operators operate EGD Cranes/hoists or other equipment.	√	*		No plans to use any EGD equipment. Contractor to reinforce that only EGD workers are to operate EGD equipment.
	13.1b	Contractor supplied crane meets specifications and has required labelling etc per WORKSAFEBC regulation?	√	S	14.2-14.8	Ensure crane is marked with: a) Manufacturer, model, sr# b) rated capacity or load chart. c) boom angle, boom extension and load measure (where applicable) d) any modifications to the crane or components
	13.1c	Crane Hoist documentation available?	√	S	14.12	Ensure manufacturer's crane/hoist manual, including instructions for assembly/disassembly, maintenance, and safe operation are readily available on site.
	13.1d	Inspection and maintenance carried out and documented including any modifications? Operator to carry out start of shift inspection and document.	√	S	14.13 to 14.16 14.35	(1) Each crane and hoist must be inspected and maintained at a frequency and to the extent required to ensure that every component is capable of carrying out its original design function with an adequate margin of safety. (2) A crane or hoist must not be used until any condition that could endanger workers is remedied. (3) Any repair to load bearing components of a crane or hoist must be certified by a professional engineer or the original equipment manufacturer.
	13.1e	Crane properly equipped?	√	S	14.17 to 14.33	Ensure crane/hoist meets all WORKSAFEBC requirements for stops, audible warnings, guards, controls, operator protection, etc. as per WORKSAFEBC regulations

13.2	Weight lifted determined and communicated to operator and all others involved in lift?	√	O	14.36 14.38	Contractor to ensure that load weights are accurately determined and communicated to the crane operator and others involved. Crane operators must not lift if there is any doubt about the safety of the lift.
13.3	Ensure crane operators meet the trade qualification specified by WORKSAFEBEC	√	S	14.34	Provide proof of qualification to Project Manager before starting work.
13.4	Ensure workers stay clear of swinging loads and equipment when swinging creates a hazard	√	O	14.40 14.41	Position equipment to ensure 2 ft. clearance or more between crane parts etc. and obstructions in any area accessible to workers.
13.5	Multiple Crane lift? Follow WORKSAFEBEC regs	NA	S	14.42	No multiple crane lifts planned.
13.6	Travel with load? Follow WORKSAFEBEC regs.	√	S	14.43	Follow safe practices.
13.7	Prevent passing over workers with load	√	O	14.44	Contractor to ensure loads do not pass over workers.
13.8	Load left suspended and unattended?	√	O	14.45	Do not leave loads suspended & unattended.
13.9	Hook position over load to prevent side loading?	√	O	14.46	Ensure straight lifts are used. If lifts on an angle are necessary observe working load limit (WLL) reduction.
13.10	Designated signalman? Use std signals? Use radio if possible.	√	O	14.47 to 14.49	Ensure trained workers use standard signals when communicating with crane operator. Use dedicated 2-way radio communication on UHF at power assigned and coordinated by the WORKSAFEBEC whenever possible.
13.11	High voltage in vicinity? Risk of induced charge? Review and follow WORKSAFEBEC requirements.	√	O	14.51- 14.52	No lifts planned near high voltage.
13.12	Up-travel limit tested for bridge, gantry & OH traveling cranes? (crane operator daily check)	√	O	14.55	If crane/hoist is not EGD operated equipment, Contractor to ensure operator has tested limits.
13.13 a	Ensure mobile cranes are on surface capable of supporting the load	√	S	14.69	Contractor to check before lift.
13.13 b	Mobile cranes or boom trucks inspected at least annually?	√	S	14.71	Ensure mobile cranes or boom trucks are inspected at least annually. Provide proof to Project Manager.
13.14	Rigging/slinging work done by or under direct supervision of qualified workers familiar with the rigging to be used.	√	S	15.2	Contractor to use trained riggers following accepted good practices when performing lifts and provide a list of trained individuals to the Project Manager.
13.15	Ensure rigging is identified with the manufacturer and Working Load Limit (WLL) as well as any other information required by WORKSAFEBEC and meets the WORKSAFEBEC requirements for the work to be performed.	√	O	15.5 15.42 15.46 15.55 15.59	Do not use rigging without proper permanent identification. DO NOT EXCEED the designated WLL; also applies to below-the-hook lifting devices.
13.16	Use only rigging permanently marked with an adequate working load limit considering the angle of lift, termination efficiencies, numbers of legs used, conditions for the lift, temperature restrictions and good rigging practices.	√	S	15.9	Follow good rigging practices. Ensure design factors comply with changes Jan/05.

	13.17	Ensure any attachments (rings, shackles, couplings etc) are designed for use with the rigging to which they are fastened.	√	S		Contractor to ensure compatibility in design.
	13.18	Slings & attachments must conform with specifications and be visually inspected before use on each shift.	√	S	15.30 15.31	Remove defective equipment from service immediately.
	13.19	Do not subject the rigging to dynamic loading.	√	S		Apply the load slowly & smoothly.
	13.20	Do not use rope/slings with evidence of wear or distortion, broken strands, kinking, bird-caging, corrosion, heat or arc damage that meets the rejection criteria specified by WORKSAFEBC.	√	S	15.25- 15.27 15.48-.49	Remove equipment from service immediately if it meets rejection criteria.
	13.21	Do not use worn or damaged hooks that fail to meet WORKSAFEBC regulations.	√	S	15.29	Remove rejected hooks from service immediately.
	13.22	Protect slings from damage if passing over a sharp edge and store properly.	√	S	15.37 15.39	
	13.23	Follow WORKSAFEBC rules for slinging to prevent slipping or overstressing the sling and when lifting multiple piece lifts.	√	S	15.40 15.41	
	13.24	Hooks must have safety latches unless meeting the exemption of WORKSAFEBC 15.10(2)	√	S	15.10	
	13.25	Consider effect of wind on loads	√	S		Crane operator to use judgement and consider wind velocity in determining if lift can be safely made. Crane operator has final decision on making any lift.
MOBILE EQUIPMENT & TRANSPORT OF WORKERS	14.1	Does the contractor intend to use any mobile equipment on site other than trucks for transporting workers?	TBD	S	PART 16	To be determined. Define equipment to be used and any special requirements.
	14.2	Are contractor's vehicles safe for transport of worker's?	√	S	16.3	Contractor to ensure vehicles are properly equipped and maintained.
	14.3	Are workers obeying speed limits? Max speed 20kph	√	*	PART 16	Cover at start up orientation meeting.
	14.4	Are vehicles properly parked?	√	*	PART 16	Workers will be shown the designated parking areas. Do not park in areas where crane travels, Fire Lanes, blocking fire hydrants, fire/emergency alarm pull stations or fire extinguishers.
	14.5	Elevating work platform(s) operations manual and inspection certificate on site? Daily inspection log available?	√	S	PART 16	Requirements depend on contractor use of this type of equipment. TBD in final JHA
	14.7	Suspended work platforms/chairs used? Conform to specifications? Verify engineering design. Support structures in place?	NA	S	PART 16	Generally, not planned to be used. Check WORKSAFEBC regulations if suspended platforms to be used.

	14.8	Do not leave delivery vehicles unattended for extended periods.	√	*		
	14.9	Do not hitch a ride on forklifts unless proper seats exist for this purpose.	√	*		Contractor to enforce.
	14.10	Ensure volatile, flammable, or hazardous materials transported in isolated compartment accessible only from outside & properly ventilated & drained	√	S	17.6	Contractor to ensure vehicles meet WORKSAFEBEC requirements.
	14.11	Ensure tools/materials/ equipment are carried in separate designated area for that purpose.	√	S	17.5	Contractor to ensure workers cannot be injured by unsecured items in the vehicle.
	14.12	Equipment properly secured if elevated? No use of hydraulic or pneumatic lifts as blocks unless collapse not possible.	√	S	16.37	Ensure workers do not leave equipment parts unattended in an elevated condition or work under equipment unless properly secured.
	14.13	Loads secured according to regulations? Loads do not interfere with lift truck operation?	√	S	16.44-16.46	Contractor to ensure loads are properly secured.
	14.14	Workers have procedures, equipment and training for tire repairs?	√	S	16.47-16.48	Contractor to ensure workers have training & equipment if they will change tires.
TRAFFIC CONTROL	15.1	Is there any blocking of roadways, or aisles during the project? If so install signs, barricades etc.	√	S&O		Define road blocking and traffic control requirements. Contractor to ensure proper traffic control if temporary road blocking is required to deliver materials etc. Contractor to ensure non-project personnel are kept out of the work area as agreed with the P.M. before starting work.
	15.2	Will gantry crane travel through the work area? Coordinate with the crane supervisor.	√	*		Workers to be instructed regarding crane travel and alarms during pre-startup meeting as they may encounter them enroute to work location. Ensure work is planned and communicated to crane supervisor before start.
	15.3	Is there operations activity near the project site? Ensure coordination and minimize impact.	√	S&O		The Engineer will ensure all supervisors and contractors on site are aware of the work and schedule.
	15.4	Is there a defined inspection program for traffic control devices to ensure they are well maintained and effective under all weather and light conditions? Documentation of inspections & repairs made kept?	√	S&O		Contractor to define an inspection program including repair/replacement procedures, inventory of devices, Contractor to ensure documentation is maintained including follow-up to ensure work has been done.
	15.10	Are there risks to workers due to vehicles/equipment operating on the construction work site?	√	S&O		Contractor to define risks to workers on the construction site due to vehicles and measures to minimize risks of injury. Risks to employees of other companies to be acknowledged, minimized and communicated to appropriate supervisors.

<b>EVACUATION &amp; RESCUE</b>	<b>16.1</b>	<b>Written procedures developed?</b>	√	<b>S&amp;O</b>	<b>4.13</b>	<b>Contractor to ensure need for emergency rescue assessed and procedures for rescue documented. Call 911. Rescue will be by DND/Esquimalt Fire Dept. Ensure all workers understand process to call for assistance and have emergency numbers. Review emergency procedures at orientation session.</b>
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CONSTRUCTION, EXCAVATION & DEMOLITION	18.1	Protection from falling materials	√	S	20.9	Requirements to be determined in final JHA based on detailed construction plans.
	18.2	Safe access/ egress to worksite? Ramps at least 20" wide with guardrails & cleats.	√	S		Requirements to be determined in final JHA based on detailed construction plans.
	18.8	Temporary support of partially assembled components adequate?	√	S	20.14	Requirements to be determined in final JHA based on detailed construction plans. Ensure partially assembled components are properly supported and braced including for possible wind loading.
	18.9	All construction details available on site including drawings, erection procedures, temp. bracing, falsework	√	O	20.15	All drawings and specifications will be available on site at the project office. Contractor will also ensure his Superintendent has latest copies on site.
	18.10	Walkways /runways provided on structural members to prevent tripping?	√	S	20.16	Requirements to be determined in final JHA based on detailed construction plans.
	18.13	Erection drawings, design responsibility, continuity of engineering complies?	√	S	20.19-20.21	PWGSC will ensure continuity of design services.
	19.21a	Roof edge guarded?	√	S	20.76	The roof edge about a chute, bitumen spout and material hoist must have guardrails meeting the requirements of Part 4 (General Conditions) or barriers of at least equivalent strength to at least 2 m (6.5 ft) on each side of such a work area.
	18.22	Mechanical or powered equipment that has the potential to push or pull a worker over an unguarded roof edge, must not be used unless operated according to procedures acceptable to the Board.	√	S	20.77	Secure WORKSAFEBC approval of procedures if using this equipment.
	18.23	Loose insulation, polyethylene, roofs with smooth surfaces, asphalt and surfaces with water, snow, ice or frost increase the risk of losing footing.	√	S		Work under severe weather conditions will be under the control and advisement of their supervisor
	18.24	Avoid walking backwards on roofs.	√	S		Contractor's Supervisor will advise all workers of safe working practices

EXCAVATION /DEMOLITION	19.0	Excavation work to be carried out?	√	S		Shallow excavation for load cell concrete base required
	19.2	All utilities accurately located & danger determined?	√	S&O	20.79	Contractor to get details on utility location and necessary approvals before digging.
	19.3	Utilities instructions followed regarding excavation?	√	S	20.79	Obtain necessary approvals and instructions.
	19.11	Are there soil contaminants expected or chance of encountering archeological materials?	√	O		Workers to be shown sample of archeological materials and instructed to stop excavating if they encounter possible archeological materials. Also provide workers with details of soil contaminants and potential risks. Stop work and immediately report to P.M. if anything is encountered including suspected soil contaminants.
	19.12	All Workers must be aware that soils on the site may contain hydrocarbons and metals such as arsenic, zinc, copper, lead.	√	O		All excavation and management of soils must be in compliance with the Interim Soil Management Plan for Munroe Head, Esquimalt Graving Dock and North Naden - stored fully contained and disposed in designated area on site. Project Manager to provide guidance. See Specification 013533.
	19.14	Ensure hazardous materials are identified before beginning demolition or salvage of machinery, equipment, buildings or structures.	√	S	20.112	Hazardous substances will be defined in the Environmental Assessment as well as by inspection with the Contractor. Details will be available at the site and procedures identified for safe containment and removal.
	19.15	Stop all work if hazardous materials are discovered during demolition and not previously identified.	√	O		Report to Project Manager immediately.
	19.16	Ensure all electric, gas, water and other services are disconnected	√	O	20.113	Contractor to ensure all services are properly disconnected before starting work.
HOUSEKEEPING; MATERIALS STORAGE	20.1	Refuse spills and waste materials not allowed to accumulate and create a hazard	√	O	4.41	Cover at start up orientation meeting.
	20.2	No use of compressed air to clean clothing of any potentially hazardous dusts etc.	√	O	4.42	Compressed air can penetrate skin, enter bloodstream and result in death. Do not use compressed air to clean work surfaces. Cover at start up orientation meeting.
	20.3	Check state of repair of floors, ramps, stairs and free of tripping and slipping hazards	√	O	4.39	Cover at start up orientation meeting.
	20.4	Material stacked securely and stable?	√	S	4.43	Check plans for stacking materials. Also Inspection item.
	20.5	Are areas free of risk of entrapment or falling materials? If not take appropriate measures per 4.44 and 4.45	√	S	4.44-4.45	Evaluate risks. Also Inspection item.
	20.6	Use metal containers with tight fitting lids for oily or painting rags & empty daily.	√	O		Oily or paint soaked rags can ignite through spontaneous combustion. Store properly. Also Inspection item
	20.7	Use proper containers for refuse.	√	O		Inspection item

	20.8	Are work areas free of protruding nails?	√	O		Ensure nails are either removed or bent over to eliminate the hazard of stepping on them.
	20.9	Are nuts/bolts etc. stored in containers to reduce tripping hazards?	√	O		Clean up components frequently to reduce risks.
	20.10	Returned tools to proper place after use.	√	O		Ensure tools are properly stored.
EQUIPMENT MAINTENANCE & USE	21.1	Equipment operator's manuals at site?	√	S		Keep manuals on site with equipment. Includes equipment like concrete pumping trucks
	21.2	Equipment operated by qualified persons?	√	S		Contractor to provide proof of qualification of equipment operators.
	21.3	Equipment maintained according to manufacturer's instructions?	√	S		Maintain equipment as specified by manufacturer and maintain a record of maintenance.
	21.4	Equipment inspection before use carried out?	√	S	16.34	Operators inspect equipment before use, record results (where required by WORKSAFEBEC) and report any defects to Supervisor. Do not use defective equipment until defect is remedied.
	21.5	Explosive operated tools maintained, and used properly? Operator's trained? Equipment & shots stored in restricted area?	√	S		Provide proof of training to Project Manager for users of this equipment before starting work. Check with P.M. for Hot Work permit requirement also.
	21.6	Air operated nailing guns trigger mechanism working properly?	√	S		Ensure safety mechanisms working properly.
	22.0	Follow safe lifting practices. Use mechanical lifting assist wherever feasible or get assistance.	√	S		Contractor to train all workers in safe lifting practices and monitor for compliance.
ASBESTOS	25.1	Workers possibly exposed to potentially hazardous levels of asbestos? E.g. <ul style="list-style-type: none"> <li>- workplace has asbestos-containing materials present or used</li> <li>- operation involves abatement of asbestos-containing materials</li> <li>- exposure to asbestos fibre in excess of 50% of exposure limits may occur</li> </ul>	√	O	PART 6 6.2	No Asbestos contact is expected. Should the Contractor encounter any questionable situation involving asbestos, lead paints or other potentially hazardous substance, immediately stop work and report to Project Manager for direction.

<b>MUSCULOSKELETAL INJURY</b>	<b>30.1</b>	<b>Is there a risk of musculoskeletal injury?</b>	<b>TBD</b>	<b>S</b>	<b>4.47</b>	<b>Contractor to eliminate or control risk</b>
	<b>30.2</b>	<b>Are controls required?</b>	<b>TBD</b>	<b>S</b>	<b>4.50-4.52</b>	<b>Contractor to define control measures and train workers in risks and safe work procedures, use of PPE etc.</b>  <b>Contractor to monitor for compliance and effectiveness.</b>

**Contractor's Superintendent:** \_\_\_\_\_ **Date:** \_\_\_\_\_.

**Distribution:**

EGD Operations Manager  
EGD Supervisors  
Engineer-of Record  
Resident Engineer/Construction Coordinator  
Project File

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Public Works and      Travaux publics et  
Government Services    Services gouvernementaux  
Canada                      Canada

PROJECT # R.057890.003  
PWGSC  
ESQUIMALT GRAVING DOCK (EGD)  
SSES – STANDBY POWER GENERATION SYSTEM

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APPENDIX C

## **APPENDIX C**

### **SCHEDULE OF DOCK CHARGES**

SCHEDULE  
(section 2, paragraphs 4(2)(e) and 5(1)(c) and sections 34 and 36.1)

DOCK CHARGES (\$)

Item	Column 1 Services and Facilities	Column 2 April 1, 2010 – March 31, 2011	Column 3 April 1, 2011– March 31, 2012	Column 4 April 1, 2012– March 31, 2013	Column 5 April 1, 2013– March 31, 2014	Column 6 April 1, 2014– March 31, 2015
1.	Booking	4,200.00	4,400.00	4,600.00	4,800.00	5,000.00
2.	Draining, per section	3,800.00	4,100.00	4,400.00	4,700.00	5,000.00
3.	Berthage, per metre, per day	5.19	5.35	5.51	5.67	5.84
4.	Rail-mounted crane, per hour					
	(a) with light hook	407.88	420.12	432.72	445.70	459.07
	(b) with main hook, up to 50 tonne lift	589.16	606.83	625.04	643.79	663.10
	(c) with main hook, over 50 tonne lift	906.40	933.59	961.60	990.45	1 020.16
5.	Mobile crane, per hour					
	(a) 9-tonne crane	113.30	116.70	120.20	123.81	127.52
	(b) 20-tonne crane	145.02	149.37	153.86	158.47	163.23
	(c) 30-tonne crane	176.74	182.04	187.52	193.13	198.94
	(d) Forklift	86.11	88.69	91.35	94.09	96.92
	(e) Tower crane	145.02	149.37	153.86	158.47	163.23
6.	Air compressor (first), per manifold hour	99.70	102.70	105.78	108.95	112.22
7.	Air compressor (second), per manifold hour	95.17	98.03	100.97	104.00	107.12
8.	Air compressor (wheeled), per manifold hour	49.85	51.35	52.89	54.47	56.11
9.	Motorized vessel, per hour	164.80	169.74	174.84	180.08	185.48
10.	Fresh water, per cubic metre	1.13	1.17	1.20	1.24	1.28
11.	Electric power, per kilowatt hour	0.13	0.14	0.14	0.15	0.15
12.	Tie-up or letting go	721.00	742.63	764.91	787.86	811.49
13.	Overtime labour services, drydock employee, per hour	88.99	91.66	94.41	97.24	100.16
14.	Security services, per vessel, per day	407.88	420.12	432.72	445.70	459.07
15.	Dockage, 1 section, per day	2,200.00	2,400.00	2,600.00	2,800.00	3,000.00
16.	Dockage, 2 sections, per day	8,400.00	8,800.00	9,200.00	9,600.00	10,000.00
17.	Dockage, 3 sections, per day	11,600.00	12,200.00	12,800.00	13,400.00	14,000.00
18.	Dockage per tonne, per day: under 5,000 gross tonnage	0.00	0.00	0.00	0.00	0.00
19.	Dockage per tonne, per day: 5,000-34,999 gross tonnage	0.12	0.12	0.12	0.12	0.12
20.	Dockage per tonne, per day: 35,000-69,999 gross tonnage	0.11	0.11	0.11	0.11	0.11
21.	Dockage per tonne, per day, 70,000-89,999 gross tonnage	0.10	0.10	0.10	0.10	0.10
22.	Dockage per tonne, per day: over 89,999 gross tonnage	0.09	0.09	0.09	0.09	0.09
23.	Sewer discharge, per litre	0.01	0.01	0.01	0.01	0.01
24.	Vacuum loader	58.92	60.88	62.50	64.38	66.31

SOR/2009-324, s. 16.



Public Works and      Travaux publics et  
Government Services   Services gouvernementaux  
Canada                      Canada

PROJECT # R.057890.003  
PWGSC  
ESQUIMALT GRAVING DOCK (EGD)  
SSES – STANDBY POWER GENERATION SYSTEM

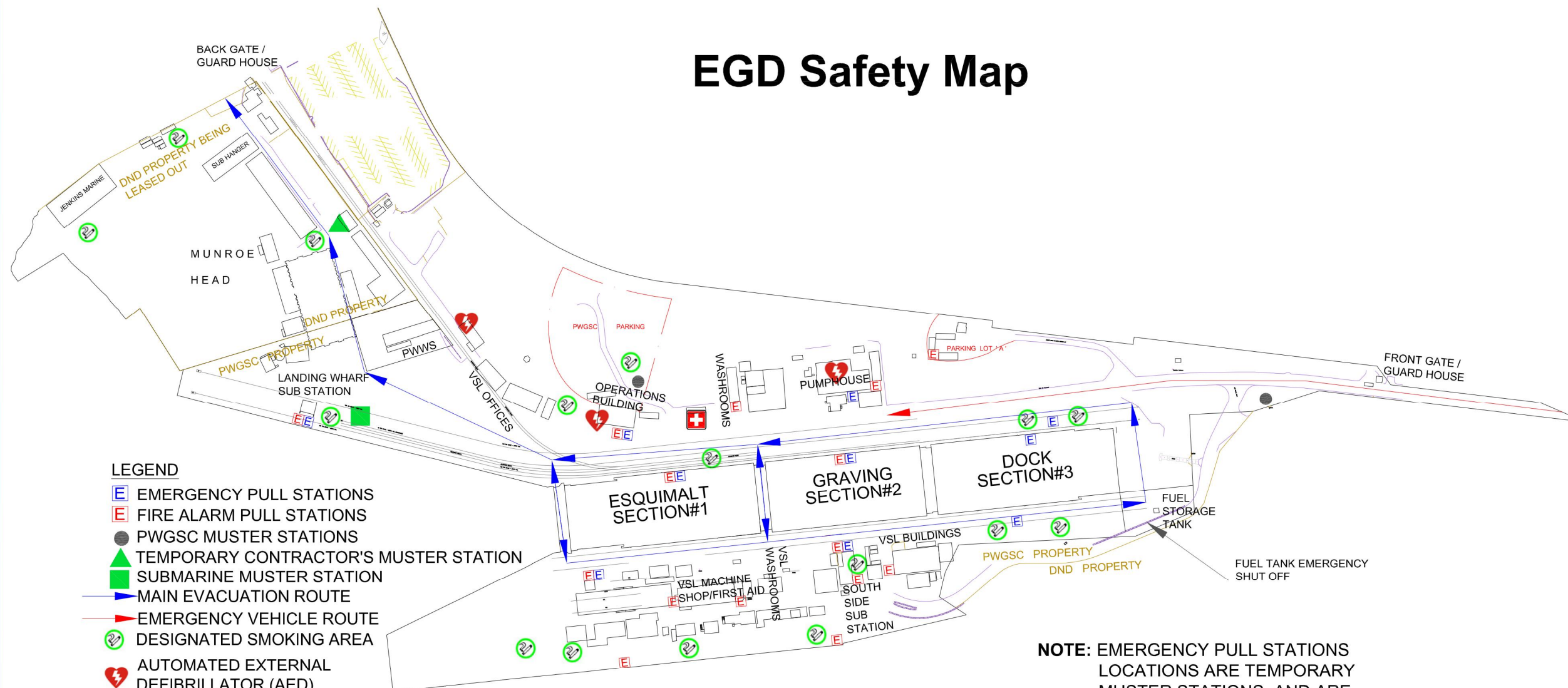
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APPENDIX D

## **APPENDIX D**

### **ESQUIMALT GRAVING DOCK FIRE SAFETY MAP**

# EGD Safety Map



### LEGEND

- E EMERGENCY PULL STATIONS
- E FIRE ALARM PULL STATIONS
- PWGSC MUSTER STATIONS
- ▲ TEMPORARY CONTRACTOR'S MUSTER STATION
- SUBMARINE MUSTER STATION
- ➡ MAIN EVACUATION ROUTE
- ➡ EMERGENCY VEHICLE ROUTE
- 🚭 DESIGNATED SMOKING AREA
- 🚑 AUTOMATED EXTERNAL DEFIBRILLATOR (AED)
- 🏠 ONSITE FIRST AID SERVICES

**NOTE:** EMERGENCY PULL STATIONS LOCATIONS ARE TEMPORARY MUSTER STATIONS, AND ARE SUBJECT TO CHANGE.

revisions	date
3	05/13
2	11/05
1	10/05

A detail no. no. du détail	A
B location drawing no. sur dessin no.	B
C drawing no. dessin no.	C

drawing / dessin  
**ESQUIMALT, B.C. GRAVING DOCK SITE PLAN**

designed / conçu	
date	
drawn / dessiné	
date	
approved / approuvé	
date	
Tender / Soumission	
PWC Project Manager / no. du projet	
drawing no. / no. du dessin	