



**Public Works and  
Government Services Canada**

Requisition No. EZ108-161322

MERX I.D. No. \_\_\_\_\_

**SPECIFICATIONS**

For  
Pacific Forestry Centre  
506 West Burnside  
Main Breaker Replacement

Victoria, BC  
Project No. R.075164.001

June 02, 2015

**APPROVED BY:**

  
Regional Manager, A&E Services

  
Date

  
Construction Safety Coordinator

  
Date

**TENDER:**

  
Project Manager

  
Date

ISSUED FOR TENDER

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<b>DRAWING NO.</b>	<b>DRAWING TITLE</b>
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E300	Level 0 Electrical Work Details
E400	Pacific Forestry Centre Existing and Revised Electrical Room
E500	Existing Single Line Diagram
E600	Revised Single Line Diagram

**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 a new primary voltage service entrance and associated equipment, and further identified as:  
**Pacific Forestry Centre 506 West Burnside  
Main Breaker Replacement  
Job No. R.075164.001**
- .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 a replacement service entrance rated primary voltage circuit breaker.
  - .2 Modifications to existing service entrance conduits and installation of pullbox.
  - .3 Digital protection relay, remote breaker operator, current transformers and associated control wiring.
  - .4 Supply and installation of lightning arrestors into existing dry type transformer.
  - .5 Upgrade of existing panelboard.
  - .6 Commissioning and testing of all equipment installed as part of this contract.
  - .7 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 Use materials/products containing highest percentage of recycled and recovered materials practicable - consistent with maintaining cost effective satisfactory levels of competition.
  - .3 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 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.
  - .3 All work impacting provision of power to the building and it's users must be fully coordinated to the benefit of the building occupants. Contractor shall assume that all outages will be during weekends or evenings.

#### **1.6 WORK SCHEDULE**

- .1 Do not change approved Schedule without notifying Departmental Representative.
- .2 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.

#### **1.7 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.

#### **1.8 CODES, BYLAWS, STANDARDS**

- .1 Perform work in accordance with the Canadian Electrical Code 2012, 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.

#### **1.9 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 2012.
  - .13 Current construction standards of workmanship listed in technical Sections.
  - .14 Contractor Safety Plan.

#### **1.10 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.

#### **1.11 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 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .12 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work.
- .13 Condition of existing work at completion of operations to be equal to or better than that which existed before new work started.
- .14 Provide necessary protection and hoarding to prevent unauthorized entry into areas of work at all times by staff and public.
- .15 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.
- .16 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.
- .17 Adjacent portions of building and property will remain in use during Work.
- .18 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.
- .19 Do work in a manner that will minimize creation of noise that would disturb day-to-day operation of building and adjacent property.
- .20 Locate stationary noise generating equipment as far away as practical from occupied parts of building, or where directed by the Departmental Representative.
- .21 Co-ordinate with the Departmental Representative for necessary shutdown of services affecting occupied parts of building and adjacent property where serviced from building. Provide 14 days of notice prior to shutdown. Minimize occurrences and durations of shutdowns.
- .22 Co-ordinate with the Departmental Representative to ensure that construction activities do not compromise security of building and site.
- .23 Ensure that construction activities do not compromise other active systems within the building and site.

#### **1.12 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.

#### **1.13 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.

#### **1.14 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.

#### **1.15 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.

#### **1.16 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.

#### **1.17 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.

#### **1.18 WORKS COORDINATION**

- .1 Coordinate work of subtrades:
  - .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 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.

#### **1.19 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.

#### **1.20 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.

#### **1.21 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.

#### **1.22 PROJECT MEETINGS**

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

#### **1.23 TESTING AND INSPECTIONS**

- .1 The Contractor will appoint and pay for the services of the factory technical representative for the following:
  - .1 Inspection and testing required of individual door controllers.
  - .2 Inspection and testing of the system software.
  - .3 Testing, adjustment and balancing of overhead door/gate and associated electrical equipment and systems.
    - .1 Tests specified to be carried out by Contractor under the 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.

#### **1.24 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.

#### **1.25 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.

#### **1.26 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.

#### **1.27 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.

#### **1.28 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.

#### **1.29 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 10 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.

**1.30 BUILDING SMOKING ENVIRONMENT**

- .1 Smoking on the site is not permitted.

**1.31 SYSTEM OF MEASUREMENT**

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

**1.32 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.**

**1.33 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 the facility, Safety and Security Procedures and Restrictions.
  - .1 The parking area(s) to be used by construction employees will be designated by the Departmental Representative. 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.

**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.

**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 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 Facility operations, occupants, and normal use. Arrange with Departmental Representative to facilitate execution of work.

**1.5 EXISTING SERVICES**

- .1 Notify Departmental Representative and utility companies 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 Pacific Forestry Centre.

#### **1.7 NOISE CONTROL**

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

#### **1.8 PARALLEL PROJECTS**

- .1 Additional projects will be underway at the Pacific Forestry Centre 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.

**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 Pacific Forestry Centre 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, PFC and consultants.
      - .2 Communication protocol for submittals.
      - .3 Start date on site.
      - .4 PFC 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 PFC, location to be determined. 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 Pacific Forestry Centre (PFC) 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    PFC 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, 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 Pacific Forestry Centre 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 Pacific Forestry Centre.
  - .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 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 projected percentage of completion of each item as of first day of week.
- .4 Indicate progress of each activity to date of submission schedule.
- .5 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.
- .6 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, 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**

## 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):
  - .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 Structure
  - .4 CSA Z1006-10 – Management of Work In Confined Space
- .4 National Fire Code of Canada 2010 (as amended):
  - .1 Part 5 – Hazardous Processes and Operations and Division B as applicable and required.
- .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 NMS Section 00 10 10 Specification Index (Appendix A thru Appendix E).

## 1.2 RELATED SECTIONS

- .1 Refer to the current NMS Sections as indicated in Section 00 01 10 Specification Index.

## 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 Site Specific 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 Materials Information System (WHMIS) requirements.
  - .5 Copy of Contractors' Construction Safety Manual Emergency Procedures.
- .4 The Departmental Representative will review the Contractor's Site Specific Project Health and Safety Plan and Emergency Procedures, and provide comments to the Contractor within 5 (five) 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 Site Specific 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
- .4 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 contractor shall appoint a Health and Safety Coordinator who is a Registered Occupational Hygienist and shall:
  - .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 the work site (as required) and the Contractor Off-Site Offload Facility (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 sites.
  - .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 or provide security guard as deemed necessary to protect work sites against entry.

**1.9 UTILITY CLEARANCES**

- .1 The Contractor is solely responsible for all utility detection and clearances prior to starting the work
- .2 The Contractor will not rely solely upon the Reference Drawings or other information provided for utility locations.

**1.10 PROJECT/SITE CONDITIONS**

- .1 Work at site will involve contact with:
  - .1 PWGSC and other Federal employees,
  - .2 PFC (federal) operational staff,
  - .3 Other contractors,
  - .4 Unpredictable weather conditions,
  - .5 Threat of tsunami and earthquake,
  - .6 Restricted access space,
  - .7 Possible lead in paint in interior work areas,
  - .8 Contact with PFC (federal) staff moving chemicals in service hallways,
  - .9 Concealed and buried electrical services,
  - .10 Excavating and trenching,
  - .11 Noise levels Issue's.

**1.11 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.

## **1.12 WORK PERMITS**

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

## **1.13 FILING OF NOTICE**

- .1 The Prime 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.

## **1.14 HEALTH AND SAFETY PLAN**

- .1 Conduct a site-specific hazard assessment for the Work Site and the Contractors' Off-Site Offload Facility based on a review of Contract documents, required work, and both project work sites. Identify any known and potential health risks and safety hazards.
- .2 Develop, implement, and enforce 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 communication 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 Site Specific Project Health and Safety 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 Site Specific Project Health and Safety Plan as required, and re-submit to the Departmental Representative.
- .5 Departmental Representative's review: the review of the contractors' Site Specific Safety Project 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 Site Specific Project Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

### **1.15 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 other PWGSC staff as required.
- .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 PWGSC 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 At least once each year, emergency drills must be held to ensure awareness and effectiveness of emergency exit routes and procedures, and a record of the drills must be kept.
- .6 Revise and update emergency procedures as required, and re-submit to the Departmental Representative.



**1.16 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 tenants have left the building.
  - .3 Provide adequate means of ventilation in accordance with NMS Sections as indicated in Section 00 01 10 Specification Index.

**1.17 OFF SITE CONTINGENCY AND EMERGENCY RESPONSE PLAN**

- .1 Prior to commencing Work involving handling of hazardous materials, develop off site Contingency and Emergency Response Plan.
- .2 Plan must provide immediate response to serious site occurrence such as explosion, fire, or migration of significant quantities of toxic or hazardous material from Site.

**1.18 PERSONNEL HEALTH, SAFETY, AND HYGIENE**

- .1 Training: ensure personnel entering Site are trained in accordance with specified personnel training requirements. Training session must be completed by Health and Safety Officer.
- .2 Levels of Protection: establish levels of protection for each Work area based on planned activity and location of activity.
- .3 Personal Protective Equipment
- .4 Furnish site personnel with appropriate PPE as specified above. Ensure that safety equipment and protective clothing is kept clean and maintained.
- .5 Develop protective equipment usage procedures and ensure that procedures are strictly followed by site personnel; include following procedures as minimum:
- .6 Ensure prescription eyeglasses worn are safety glasses and do not permit contact lenses on site within work zones.
- .7 Ensure footwear is steel-toed safety shoes or boots and is covered by rubber overshoes when entering or working in potentially contaminated work areas.
- .8 Dispose of or decontaminate PPE worn on site at end of each workday.
- .9 Decontaminate reusable PPE before reissuing.
- .10 Ensure site personnel have passed respirator fit test prior to entering potentially contaminated work areas.

- .11 Ensure facial hair does not interfere with proper respirator fit.
  - .1 Respiratory Protection:
    - .1 Provide site personnel with extensive training in usage and limitations of, and qualitative fit testing for, air purifying and supplied-air respirators in accordance with specified regulations.
    - .2 Develop, implement, and maintain respirator program.
    - .3 Monitor, evaluate, and provide respiratory protection for site personnel.
    - .4 Ensure levels of protection as listed have been chosen consistent with site-specific potential airborne hazards associated with major contaminants identified on site.
    - .5 In absence of additional air monitoring information or substance identification, retain an industrial hygiene specialist to determine minimum levels of respiratory protection required.
    - .6 Immediately notify Departmental Representative when level of respiratory protection required increases.
    - .7 Ensure appropriate respiratory protection during Work activities. As minimum requirement, ensure that persons entering potentially contaminated work areas are supplied with and use appropriate respiratory protection.
  - .2 Heat Stress/Cold Stress:
    - .1 Implement heat stress or cold stress monitoring program as applicable and include in site-specific Health and Safety Plan.
  - .3 Personnel Hygiene and Personnel Decontamination Procedures. Provide minimum as follows:
    - .1 Suitable containers for storage and disposal of used disposable PPE.
    - .2 Potable water and suitable sanitation facility.
  - .4 Emergency and First-Aid Equipment:
    - .1 Locate and maintain emergency and first-aid equipment in appropriate location on site including first-aid kit to accommodate number of site personnel; portable emergency eye wash; 9 kg ABC type dry chemical fire extinguishers as required.

## 1.19 ASBESTOS HAZARD

- .1 Modifications to spray- or trowel-applied asbestos surfaces can be hazardous to health.
- .2 Removal and handling of asbestos will be performed as per Worksafe B.C. Regulations Part 6 Asbestos.

## 1.20 PCB REMOVALS

- .1 Mercury-containing fluorescent tubes and ballasts which contain polychlorinated biphenyls (PCBs) are classified as hazardous waste.
- .2 Remove, handle, transport and dispose of as indicated in Section 00 01 10 Specification Index.

**1.21 REMOVAL OF LEAD-CONTAINING PAINTS**

- .1 All paints containing TCLP lead concentrations above 5 ppm are classified as hazardous.
- .2 Carry out demolition activities involving lead-containing paints in accordance with applicable Provincial regulations.

**1.22 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.
  - .3 Develop, implement and enforce a communication plan with Departmental representative and PFC maintenance staff for all electrical work and lockout procedures.
  - .4 Follow the Isolation procedure forms for high voltage isolation supplied by PWGSC.

**1.23 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.

**1.24 OVERLOADING**

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

**1.25 FALSEWORK**

- .1 Design and construct falsework in accordance with CSA S269.1- 1975 (R2003).

**1.26 SCAFFOLDING**

- .1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CSA Z797-2009 and B.C. Occupational Health and Safety Regulations.

**1.27        CONFINED SPACES**

- .1        Carry out work in confined spaces in compliance with Worksafe B.C. Part 9 Confined Spaces and CSA Z1006-10 Management of Work in Confined Space.

**1.28        RESTRICTED ACCESS**

- .1        Contractor shall perform a hazard assessment and develop an appropriate restricted access entry plan in accordance with Worksafe B.C. regulations.

**1.29        CONFINED SPACE AND RESTRICTED SPACE OUTSIDE OF DEFINED WORK SITE**

- .1        Carry out work in confined spaces in compliance with Worksafe B.C. Part 9 Confined Spaces and CSA Z1006-10 Management of Work in Confined Space. Coordinate all confined space entry work with PWGSC Departmental Representative through the contractor's confined space entry permit system.
- .2        Contractor shall perform a hazard assessment and develop an appropriate restricted access entry plan in accordance with Worksafe B.C. regulations. Coordinate all restricted access space entry work with the PWGSC Departmental Representative prior to entry.
- .3        The Contractor is required to provide a reasonable amount of time to the Departmental Representative for making arrangements for entry and/or access to Confined Space or Restricted Access spaces located outside the designated work site.

**1.30        POWDER-ACTUATED DEVICES**

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

**1.31        FIRE SAFETY AND HOT WORK**

- .1        Coordinate all hot work with PWGSC Departmental Representative through the contractors' hot work permit system.
- .2        Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.
- .3        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.

**1.32        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.

**1.33        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.

#### **1.34 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.

#### **1.35 POSTED DOCUMENTS**

- .1 Post legible versions of the following documents on site:
  - .1 Site Specific 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 Health and Safety Coordinator, 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.

#### **1.36 MEETINGS**

- .1 Attend health and safety pre-construction meeting and all subsequent meetings called by the Departmental Representative.
- .2 All personnel employed by the contractor and its subcontractors shall attend the PFC Safety Orientation presentation prior to starting work at the PFC Work Site.

#### **1.37 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 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.
- .2 Use of the Pacific Forestry Centre 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.
- .3 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.
- .4 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 Facility.

**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 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 Pacific Forestry Centre's washrooms.

**1.5 HEATING AND VENTILATION**

- .1 Do not begin work until arrangements have been made with the Departmental Representative for protection of on-floor 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.

**1.6 SCAFFOLDING**

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

**1.7 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.

**1.8 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.

**1.9 SITE OFFICE**

- .1 Contractor to provide their own trailer as temporary site office in an area to be designated by the Departmental Representative.
- .2 Contractor should clear and demolish site office at end of project according to contract requirement.

**1.10 REMOVAL OF TEMPORARY FACILITIES**

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

**1.11 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.

**1.12 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

**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 Bolts may 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.

## **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 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.
- .2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

**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 which 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 work 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 RELATED WORK**

- .1 Refer to every technical section for waste management and disposal requirements.

**1.2 DEFINITIONS**

- .1 Waste Reduction Workplan: written report which 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, 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.

**1.9 TIME ALLOCATED FOR INSTRUCTIONS**

- .1 Contractor shall provide for a total of 1 working day of demonstration and training for all systems in the project, including but not limited to:
  - .1 Primary Voltage Switchgear
  - .2 Primary Voltage Cables
  - .3 Transformers
  - .4 Protection Relays
  - .5 Underground Ductbank and Manhole Systems

**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:**

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 01 91 31- Commissioning (Cx) Plan
- .4 Section 26 05 00 - Common Work Results - Electrical.
- .5 Section 26 05 14 - Power Cables (1001V-27kV)
- .6 Section 26 05 27 - Grounding – Primary
- .7 Section 26 05 44 - Installation of Cables in Trenches and Ducts
- .8 Section 26 12 16 - Dry Type, Medium and High Voltage Transformers
- .9 Section 26 13 18 - Primary Switchgear Assembly to 27kV
- .10 Section 26 29 05 - Protective Relays

**.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 PI - Product Information.
- .7 PV - Performance Verification.
- .8 TAB - Testing, Adjusting and Balancing.

**1.2 REFERENCE****.1 Public Works and Government Services Canada (PWGSC)**

- .1 CSA 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 after work is completed and prior to energizing any equipment. The General Contractor is to engage and hire the services of the independent third party Commissioning Authority and commissioning Provider. The independent third party must have performed similar HV work for a minimum of 5 years. Contractor shall provide documentation attesting to the qualifications and experience of the proposed Testing Agency(ies) performing all commissioning work and preparing commissioning documents. These references shall be reviewed by the Consultant and Departmental Representative confirming the suitability of the Testing Agencies. The Testing Agency may only be engaged after review and approval of these documents by the Consultant and Departmental Representative.
- .3 Retain the services of a qualified Testing Agency 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 Testing 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.
- .4 Furnish Independent Testing 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 Departmental Representative
- .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 to be interactively with each other as intended in accordance with Contract Documents and design criteria.

- .2 During these checks, adjustments to 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 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 Interim Acceptance Certificate of Substantial Completion when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M 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 unfunctional system, including related systems as deemed required by Cx Authority and Departmental Representative, Cx 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 Departmental Representative.
  - .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.
- .3 Before start of Cx:
  - .1 Have completed Cx Plan up-to-date.
  - .2 Ensure installation of related components, equipment, sub-systems, 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 breakers accordingly. The study shall be performed at both 12.5 kV and 25 kV distribution voltages.
  - .13 Factory test each transformer, switchgear assembly, and motor controller assembly and all accessories. Notify Departmental Representative 7 days in advance of tests and confirm 2 days in advance. Departmental Representative and Engineer will attend/witness tests. Tests must be conducted in the Lower Mainland 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 Departmental Representative's and engineer's attendance at factory tests and at repeat tests if necessary.
- .4 Inform Departmental Representative 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 Cx Authority and General Contractor's Cx Provider.
    - .2 Draft Cx documentation.
    - .3 Preliminary Cx schedule.
  - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
  - .3 Submit proposed Cx procedures to Departmental Representative 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 Departmental Representative, 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 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.
- .2 General Contractor to review and approve Cx documentation submitted by Cx Provider prior to submission to Departmental Representative for review.
- .3 Provide completed and approved Cx documentation to Departmental Representative.

**1.10 COMMISSIONING SCHEDULE**

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 17 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 17 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 17 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 Provider, 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 Cx Authority and Departmental Representative to witness of start-up and testing.
- .3 Cx Authority and Departmental Representative shall be advised of and shall be in attendance during energization of any and all equipment as part of this project.
- .4 General Contractor's Cx Provider 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 startup:
  - .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 Refer to the NETA Acceptance Testing specifications for detailed commissioning requirements for the following equipment:
    - .1 Cables, High Voltage.
    - .2 Switches, Air, High Voltage
    - .3 Circuit Breakers, Air, Insulated/Molded Case, High Voltage.
    - .4 Instrument Transformers
    - .5 Digital Protection Relays.
  - .4 Startup: follow accepted start-up procedures.
  - .5 Operational testing: document equipment performance.
  - .6 System PV: include repetition of tests after correcting deficiencies.
  - .7 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 Systems: fire alarm system communications.
  - .6 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 Conduct additional start-up and specific testing in following:
  - .1 Provide Main Dewatering Pumps 1, 2, and 3 Test Reports prior to and after completion. Tests to include but not limited to:
    - .1 Motor Starting Curves. Record voltage, amps, power, and kVA on a typical start using a high speed data recorder.



- .2 Insulation resistance of Stator and Rotor.
  - .3 Winding resistance of Stator and Rotor.
  - .4 Insulation and winding resistance of DC Exciter.
  - .5 Resistance of exciter field rheostat and Motor field resistor.
- .5 Correct deficiencies and obtain approval from Cx Authority and Departmental Representative after distinct phases have been completed and before commencing next phase.
- .6 Document requires tests on approved PV forms.
- .7 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. 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 Departmental Representative.
  - .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 Cx Authority and Departmental Representative for approval before commencement of commissioning.
- .2 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 Cx Authority and 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 Cx Authority for review and 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 Cx Authority and Departmental Representative 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 Departmental Representative for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, 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.

**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 EMCS trending to be available as supporting documentation for performance verification.

**1.21 WITNESSING COMMISSIONING**

- .1 Cx Authority to witness activities and verify results. Departmental Representative to witness activities and verify results as required.

**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 Departmental Representative 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 Cx Authority and Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Cx Authority and Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

### **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 Departmental Representative.

### **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 Departmental Representative.

### **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 Cx Authority and Departmental Representative 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:
  - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

**1.2 REFERENCES**

- .1 PWGSC Cx manual CP-1 with CSA Z320-11.
- .2 Public Works and Government Services Canada (PWGSC)
  - .1 PWGSC - Commissioning Guidelines CP.3 -3rd edition-03.
- .3 Underwriters' Laboratories of Canada (ULC)
- .4 ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.

**1.3 GENERAL**

- .1 Provide fully functional facilities:
  - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
  - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
  - .3 Optimized life cycle costs.
  - .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
  - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
  - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
  - .3 Sets out deliverables relating to O&M, process and administration of Cx.
  - .4 Describes process of verification of how built works meet design requirements.
  - .5 Produces a complete functional system prior to issuance of Certificate of Substantial Performance.
  - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
    - .1 Overview of Cx.
    - .2 General description of elements that make up Cx Plan.
    - .3 Process and methodology for successful Cx.
- .4 Acronyms:
  - .1 Cx - Commissioning.

- .2 BMM - Building Management Manual.
- .3 EMCS - Energy Monitoring and Control Systems.
- .4 MSDS - Material Safety Data Sheets.
- .5 PI - Product Information.
- .6 PV - Performance Verification.
- .7 TAB - Testing, Adjusting and Balancing.
- .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
  - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
  - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

#### **1.4 DEVELOPMENT OF 100% CX PLAN**

- .1 Cx Plan to be 100% completed within 12 weeks of award of contract to take into account:
  - .1 Approved shop drawings and product data.
  - .2 Approved changes to contract.
  - .3 Contractor's project schedule.
  - .4 Cx schedule.
  - .5 Contractor's, sub-contractor's, suppliers' requirements.
  - .6 Project construction team's and Cx team's requirements.
- .2 Submit completed Cx Plan to Cx Authority for review and obtain written approval from and Departmental Representative.

#### **1.5 REFINEMENT OF CX PLAN**

- .1 During construction phase, revise, refine and update Cx Plan to include:
  - .1 Changes resulting from Client program modifications.
  - .2 Approved design and construction changes.
- .2 Revise, refine and update every 3 months during construction phase. At each revision, indicate revision number and date.
- .3 Submit completed Cx Plan to Cx Authority for review and obtain written approval from and Departmental Representative.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

#### **1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM**

- .1 General Contractor to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 General Contractor is to engage and hire the services of an independent third party Commissioning Authority to ensure Cx activities are carried out to ensure delivery of a fully operational project including:
  - .1 Organizing Cx.

- .2 Monitoring operations Cx activities.
- .3 Review of Cx documentation from operational perspective.
- .4 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
- .5 Protection of health, safety and comfort of occupants and O&M personnel.
- .6 Monitoring of Cx activities, training, development of Cx documentation.
- .7 Work closely with members of Cx Team.
- .8 Certifying accuracy of reported results
- .9 Certifying tabs and other results
- .10 Developing BMM.
- .11 Ensuring implementation of final Cx Plan.
- .12 Implementation of Training Plan
- .3 Departmental Representative is responsible for:
  - .1 Witnessing reported results.
  - .2 Witnessing TAB and other tests.
  - .3 Provides basis of design data not included in the Contract Documents.
  - .4 Reviews commissioning checklists and test forms to ensure applicability to the project and provide comments to the Commissioning Agent.
  - .5 Attends commissioning activities as required to certify the site adaptation and related work meet the design intent and the project requirements.
- .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
  - .1 Testing.
  - .2 TAB.
  - .3 Performance of Cx activities.
  - .4 Delivery of training and Cx documentation.
  - .5 Assigning one person as point of contact Departmental Representative for administrative
  - .6 and coordination purposes.
- .5 General Contractor it to engage and hire the services of an independent third party Commissioning Provider to implement specified Cx activities including:
  - .1 Demonstrations.
  - .2 Training.
  - .3 Testing.
  - .4 Preparation, submission of test reports.
  - .5 Performing verification of performance of installed systems and equipment.
- .6 PFC Facility Manager: represents lead role in Operation Phase and onwards and is responsible for:
  - .1 Receiving facility.

- .2 Day-To-Day operation and maintenance of facility.

## **1.7 EXTENT OF CX**

- .1 The General Contractor shall provide commissioning services for the following items .

- .1 List of Electrical Equipment and Acceptance Tests:
  - .1 Preventable Inspections - Box, Conduit & Cable Installations
  - .2 Underground Services/Manholes
  - .3 Ground system inspection/report
  - .4 Protective Relay System
  - .5 Instrument Transformers
  - .6 25kV Switchgear and Circuit Breakers
  - .7 Dry Type Transformer: Preventable Inspection
  - .8 Meggering and Hi-Pot Report
  - .9 Implementation of Coordination Study Settings
  - .10 Certificates and/or Equipment Test Report
  - .11 Equipment Spare Parts Report
  - .12 Generic Acceptance Report
  - .13 Twelve Step Final Acceptance Report

## **1.8 DELIVERABLES RELATING TO O&M PERSPECTIVES**

- .1 General requirements:
  - .1 Compile English documentation.
  - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
  - .1 Warranties.
  - .2 Project record documentation.
  - .3 Inventory of spare parts, special tools and maintenance materials.
  - .4 Maintenance Management System (MMS) identification system used.
  - .5 WHMIS information.
  - .6 MSDS data sheets.
  - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

## **1.9 DELIVERABLES RELATING TO THE CX PROCESS**

- .1 General:
  - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.



- .2 Definitions:
  - .1 Cx as used in this section includes:
    - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
    - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
  - .1 Cx Specifications.
  - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
  - .3 Completed installation checklists (ICL).
  - .4 Completed product information (PI) report forms.
  - .5 Completed performance verification (PV) report forms.
  - .6 Results of Performance Verification Tests and Inspections.
  - .7 Description of Cx activities and documentation.
  - .8 Description of Cx of integrated systems and documentation.
  - .9 Tests witnessed by Departmental Representative.
  - .10 Training Plans.
  - .11 Cx Reports.
  - .12 Prescribed activities during warranty period.
- .4 Cx Authority to witness and certify tests and reports of results provided to Departmental Representative.

#### **1.10 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION**

- .1 Items listed in this Cx Plan include the following:
  - .1 Pre-Start-Up inspections: by Cx Authority prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
  - .2 Cx Authority to use approved check lists.
  - .3 Cx Authority will monitor some of these pre-start-up inspections.
  - .4 Include completed documentation with Cx report.
  - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Cx Authority and does not form part of Cx specifications.
  - .6 Cx Authority will monitor some of these inspections and tests.
  - .7 Include completed documentation in Cx report.
- .2 Pre-Cx Activities - ELECTRICAL:
  - .1 Low voltage, medium voltage and high voltage distribution systems require independent testing agency to perform pre-energization and post-energization tests.

## **1.11 START-UP**

- .1 Start up components, equipment and systems.
- .2 Cx Authority to monitor some of these start-up activities.
  - .1 Rectify start-up deficiencies to satisfaction of Cx Authority Departmental Representative.
- .3 Performance Verification (PV):
  - .1 Approved Cx Provider to perform.
    - .1 Repeat when necessary until results are acceptable to Departmental Representative.
  - .2 Use procedures modified generic procedures to suit project requirements.
  - .3 Cx Authority to witness and certify reported results using approved PI and PV forms.
  - .4 Cx Authority to approve completed PV reports and provide to Departmental Representative.
  - .5 Cx Authority and Departmental Representative reserves the right to verify up to 30% of reported results at random.
  - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

## **1.12 CX ACTIVITIES AND RELATED DOCUMENTATION**

- .1 Perform Commissioning by specified Cx Provider using procedures developed by Cx Authority.
- .2 Cx Authority to monitor Cx activities.
- .3 Upon satisfactory completion, Cx Provider performing tests to prepare Cx Report using approved PV forms.
- .4 Cx Authority to witness, certify reported results of, Cx activities and forward to Cx Authority.
- .5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

## **1.13 MECHANICAL SYSTEMS TESTING, ADJUSTING AND BALANCING**

- .1 Testing:
  - .1 Quality Assurance:
    - .1 Test equipment and material where specified or required by authority having jurisdiction to demonstrate its proper and safe operation.
    - .2 Test procedures shall be in accordance with applicable portions of NFPA, NETA, CSA and other recognized test codes as far as field conditions permit.
    - .3 Provide notice to the Cx Authority before tests.
  - .2 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

**1.14 ELECTRICAL TESTING, ADJUSTING AND BALANCING**

- .1 Conduct and pay for tests of the following:
  - .1 Distribution system including phasing, voltage, grounding, load balancing, hi-pot testing of the 12.5/25kV system and transformer prior to energizing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .2 Furnish manufacturers certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer' s instructions .
- .3 Carry out tests in presence of the Cx Authority and Departmental Representative.
- .4 Give advance notice of proposed time of tests so that the Cx Authority and Departmental Representative can be represented at the tests.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for review by the Cx Authority and Departmental Representative.
- .7 Test all systems in accordance with details in appropriate sections.
- .8 Testing methods and test results: in accordance with CSA, CEC, NETA MTS, and regulations of the supply authority and other authorities having jurisdiction.
- .9 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration .
- .10 Remove and replace with new materials all conductors that are found to be shorted or grounded.
- .11 Conduct dielectric tests, hi-pot tests, insulation resistance tests and ground continuity tests as required by the nature of the various systems and equipment.
- .12 With the systems completely connected and lamped, conduct the following tests on the power system:
  - .1 Control and Switching: test all circuits for the correct operation of devices, switches and controls.
  - .2 Polarity Tests: test all circuits for correct operation of devices, switches and controls.
  - .3 Voltage Tests: make a voltage test at the last outlet of each circuit. Maximum drop in potential permitted will be 2% on 120V, and 208V branch circuits. 2% on 208V feeder circuits, and 5% on 600V feeder circuits. Correct any deficiency in this respect.
  - .4 Phase Balance: measure the load on each phase at each switchboard, splitter, distribution panel board and lighting and power panel board. Report results in writing to the Cx Authority and Departmental Representative. Re-arrange phase connections as necessary to balance the load on each phase as instructed by the Cx Authority and Departmental Representative with the re-arrangement being restricted to the exchanging of connections at the distribution points mentioned in this

- paragraph. After marking any such changes, make available to the Cx Authority and Departmental Representative, drawings or marked prints showing the modified connections.
- .5 Supply Voltage: measure the line voltage of each phase at the load terminals of the main breakers and report the results in writing to the Cx Authority and Departmental Representative. Perform this test with the majority of electrical equipment in use.
  - .6 Motor Loading: measure the line current of each phase of each motor with the motor operating under load and report the results in writing to the Cx Authority and Departmental Representative. Upon indications of any imbalance or overload, thoroughly examine electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the Cx Authority and Departmental Representative. Verify motor full load amps and overload
  - .7 Relays are properly sized and adjusted accordingly.
  - .8 General Operations: energize and put into operation each and every electrical circuit and item. Make repairs, alterations, replacements, tests and adjustments necessary for a complete and satisfactory operating electrical system.
- .13 Carry out tests covering "General Operation" at the time of acceptance of the work.
  - .14 Test all systems and obtain written confirmation from the manufacturer of each system that all components have been installed correctly and that the system is functioning as intended. Present separate certification for all systems including: fire alarm, power distribution, to the Cx Authority and Departmental Representative.
  - .15 Provide labour, instruments, apparatus and pay all expenses required for the tests. The Cx Authority and Departmental Representative reserves the right to demand proof of the accuracy of all instruments used.
  - .16 When tests are performed, the Cx Authority and Departmental Representative may require that equipment be opened and removed from their housings to examine interior of equipment, terminations and connections. Provide all required labour and tools.
  - .17 Co-ordinate the testing of motors with the trades providing the equipment driven by the motors so that they are carried out at the time the driven equipment is put on test. In addition to the motor loading tests, provide labour and instruments to take and record all motor load readings required to supplement the tests on the driven equipment through various load sequences, as required by the trades involved.
  - .18 Insulation Resistance Testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 351-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Megger 601-25kV circuits, feeder and equipment with 5000 V instrument.

- .4 Check resistance to ground before energizing.

#### **1.15 INSTALLATION CHECK LISTS (ICL)**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

#### **1.16 PRODUCT INFORMATION (PI) REPORT FORMS**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

#### **1.17 PERFORMANCE VERIFICATION (PV) REPORT**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

#### **1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX**

- .1 General:
  - .1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

#### **1.19 CX SCHEDULES**

- .1 Prepare detailed Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
  - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
    - .1 Design criteria, design intents.
    - .2 Pre-TAB review: 28 days after contract award, and before construction starts.
    - .3 Cx agents' credentials: 60 days before start of Cx.
    - .4 Cx procedures: 3 months after award of contract.
    - .5 Cx Report format: 3 months after contract award.
    - .6 Discussion of heating/cooling loads for Cx: 3 months before start-up.
    - .7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
    - .8 Notification of intention to start TAB: 21 days before start of TAB.
    - .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
    - .10 Notification of intention to start Cx: 14 days before start of Cx.
    - .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
    - .12 Identification of deferred Cx.
    - .13 Implementation of training plans.

- .14 Cx reports: immediately upon successful completion of Cx.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
- .3 Six (6) months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Consultant, Contractor, Contractor's Cx Provider, Cx Authority, and Departmental Representative will monitor progress of Cx against this schedule.

#### **1.20 CX REPORTS**

- .1 Submit reports of tests, witnessed and certified by Cx Authority and Departmental Representative to Departmental Representative who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Cx Authority.

#### **1.21 TESTS TO BE PERFORMED BY OWNER/USER**

- .1 None is anticipated on this project.

#### **1.22 TRAINING PLANS**

- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

#### **1.23 FINAL SETTINGS**

- .1 Upon completion of Cx to satisfaction of Cx Authority and Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Commissioning forms to be completed for equipment, system and integrated system.

**1.2 INSTALLATION/START-UP CHECK LISTS**

.1 Include the following data:

- .1 Product manufacturer's installation instructions and recommended checks.
- .2 Special procedures as specified in relevant technical sections.
- .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Cx Authority and Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Cx Authority and Departmental Representative. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

**1.3 PRODUCT INFORMATION (PI) REPORT FORMS**

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Cx Authority and Departmental Representative's approval.

**1.4 PERFORMANCE VERIFICATION (PV) FORMS**

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Cx Authority and Departmental Representative approval.

## **1.5 COMMISSIONING FORMS**

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
  - .1 Contractor provides project-specific Commissioning forms with Specification data included.
  - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
  - .3 Confirm operation as per design criteria and intent.
  - .4 Identify variances between design and operation and reasons for variances.
  - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
  - .6 Record analytical and substantiating data.
  - .7 Verify reported results.
  - .8 Form to bear signatures of recording technician.
  - .9 Submit immediately after tests are performed.
  - .10 Reported results in true measured SI unit values.
  - .11 Provide Cx Authority and Departmental Representative with originals of completed forms.
  - .12 Maintain copy on site during start-up, testing and commissioning period.

## **1.6 LANGUAGE**

- .1 To suit the language profile of the awarded contract.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 This Section specifies roles and responsibilities of Commissioning Training.
- .2 Related Sections:
  - .1 General Commissioning (Cx) Requirements Section 01 91 13
  - .2 Commissioning (Cx) Plan Section 01 91 31

**1.2 TRAINEES**

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, 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 Engineer 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 certified installation, started up and carried out PV tests.

**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, Cx Authority and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of
- .5 detail.
- .6 Supplement 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 Departmental Representative 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 Departmental Representative. Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.
- .6 Systems Course: Allow a minimum of 8 hours of instruction (One 8-hour training sessions) to conduct systems training courses addressing the following topics
  - .1 Standard Power Systems:
    - .1 Review operation of systems and equipment.
  - .2 Protective Relay System:
    - .1 Review operation of systems and equipment.
    - .2 Review of setting adjustment.
    - .3 Review of control software.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 01 31 19 – Project Meetings.
- .2 Section 01 33 00 – Submittal Procedures.
- .3 Section 01 35 43 – Environmental Procedures.
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .5 Section 01 74 11 – Cleaning.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA S350-M1980 (R2003), Code of Practice for Safety in Demolition of Structures.
- .2 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.
- .3 Canadian Environmental Protection Act (CEPA), 1999, C.33.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section:
  - .1 01 33 00 - Submittal Procedures.
  - .2 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .3 01 35 43 - Environmental Procedures.
- .2 Submit demolition drawings for existing retaining wall:
  - .1 Submit for review and approval by Departmental Representative shoring and underpinning drawings stamped and signed by professional engineer registered or licensed in the Province of BC, Canada, showing proposed method.

**1.4 SITE CONDITIONS**

- .1 Review "Designated Substance Report" and take precautions to protect environment.
- .2 If material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous is encountered, stop work, take preventative measures, and notify Departmental Representative immediately.
  - .1 Proceed only after receipt of written instructions have been received from Departmental Representative.
- .3 Notify Departmental Representative before disrupting building access or services.

**Part 2 Products****2.1 NOT USED**

- .1 Not used.

**Part 3 Execution****3.1 EXAMINATION**

- .1 Inspect site with Departmental Representative and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.
- .2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.
- .3 Notify and obtain approval of utility companies before starting demolition.
- .4 Disconnect, cap, plug or divert, as required, existing public utilities within the property where they interfere with the execution of the work, in conformity with the requirements of the authorities having jurisdiction. Mark the location of these and previously capped or plugged services on the site and indicate location (horizontal and vertical) on the record drawings. Support, shore up and maintain pipes and conduits encountered.
  - .1 Immediately notify Departmental Representative and utility company concerned in case of damage to any utility or service, designated to remain in place.
  - .2 Immediately notify the Departmental Representative should uncharted utility or service be encountered, and await instruction in writing regarding remedial action.

**3.2 PREPARATION**

- .1 Temporary Erosion and Sedimentation Control:
  - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to: requirements of authorities having jurisdiction.
  - .2 Inspect, repair, and maintain erosion and sedimentation control measures during demolition.
  - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal after completion of demolition work.
- .2 Protection of In-Place Conditions:
  - .1 Prevent movement, settlement, or damage to adjacent structures, utilities, and landscaping features and parts of building to remain in place. Provide bracing and shoring required.
  - .2 Keep noise, dust, and inconvenience to occupants to minimum.
  - .3 Protect building systems, services and equipment.

- .4 Provide temporary dust screens, covers, railings, supports and other protection as required.
- .5 Do Work in accordance with Section 01 35 33 - Health and Safety Requirements.
- .3 Demolition/Removal:
  - .1 Remove items as indicated.
  - .2 Removal of Pavements, Curbs and Gutters:
    - .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Departmental Representative.
    - .2 Protect adjacent joints and load transfer devices.
    - .3 Protect underlying and adjacent granular materials.
  - .3 Trim edges of partially demolished building elements to tolerances as defined by Departmental Representative to suit future use.

### **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 Refer to demolition drawings and specifications for items to be salvaged for reuse.
- .4 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - 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 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-2012, Canadian Electrical Code, Part 1 (21st 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 Submit for review single line electrical diagrams under plexiglass and locate as indicated.
  - .1 Electrical distribution system in Main Electrical Room.
- .3 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.
- .4 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.
- .5 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.

**1.9 RECORD DRAWINGS**

- .1 In addition to requirements for record drawings noted in Section 01 78 00 - Closeout Submittal, the following shall also be completed as per 01 78 00 - 1.4.3:
  - .1 Complete, detailed single line, three line and wiring diagrams for all new equipment installed as part of this project including: protection relays and controls; primary voltage switching devices and internal control wiring; interface to existing systems.
  - .2 Review and document existing systems providing detailed single line, three line and wiring diagrams for the following: 600V main distribution protection, metering and connections including documentation of single phase protection scheme; metering arrangements and devices.

**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 are 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 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 or in conduits 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.

**3.3 TESTING AND COMMISSIONING**

- .1 Underground power cables shall be tested after completion of all terminations, connectors or elbows prior to connection to other system components.
- .2 Cables shall be tested one at a time, not as a set, providing test results for each piece of cable.
- .3 Cables shall be tested using a 5kV DC insulation tester to confirm suitability for proceeding with hipot testing. Any insulation reading less than 100 Megohms shall warrant further inspection of the cable and connections prior to proceeding with hi potential testing.
- .4 Primary voltage cables shall be tested using a polarization index method. Each 12/25kV cable shall be hipot tested using a DC hi-pot 5kV for ten minutes with readings at one and ten minutes. Minimum acceptable polarization index value is 5 (five).

**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.

### **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 Site services sub-circuits, including site lighting, to be minimum #10 AWG for power and #12 for controls. 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 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.
- .7 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 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 All wires are to be pulled in together in a common raceway, using liberal amounts of lubricant.
  - .3 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.
  - .4 Ensure that all single phase loadings are reasonably closely balanced over the main feeders.

### **3.2 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.

**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 Rod electrodes: copper clad steel, 19 mm diameter by 3 m long.
- .2 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.
- .3 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.
- .4 Conductors: PVC insulated coloured green, stranded soft annealed copper wire No. 10 AWG for grounding meter and relay cases.
- .5 Bolted removable test links.
- .6 Gradient control mat: copper.
- .7 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 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.
- .8 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 Ground fences to grounding system independent of station ground.
- .3 Install connectors and irreversibly connect in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors during and after construction. Make buried connections, and connections to electrodes, structural steel work, using copper welding by Thermit process or permanent mechanical connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 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 ELECTRODE INSTALLATION**

- .1 Install ground rod electrodes. Make grounding connections to station equipment.
- .2 Install ground rod electrodes at transformer and switchgear locations.

#### **3.3 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 cutout 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.

### **3.4 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 station service transformer to main neutral 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.

### **3.5 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.

### **3.6 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Engage an independent testing agent to inspect grounding and perform ground resistance test before backfill.
- .3 Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction.
- .4 Perform test before energizing electrical system.
- .5 Provide step-and-touch potential calculations using measured station ground resistance measurements. Submit test result and inspection certificate before energizing electrical system.

**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 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Rod electrodes: copper clad steel 19 mm diameter by minimum 3 m long.
- .3 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .4 Insulated grounding conductors: green, copper conductors, size as indicated.
- .5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.

- .3 Bolted type conductor connectors.
- .4 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 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 thermit 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 MAINTENANCE HOLES**

- .1 Install conveniently located grounding stud, electrode, size as indicated stranded copper conductor in each maintenance hole.
- .2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug to which grounding connection can be made. Confirm ground resistance meets or exceeds Canadian Electrical Code minimum requirements.

### **3.4 ELECTRODES**

- .1 Install rod electrodes and make grounding connections as indicated.
- .2 Bond separate, multiple electrodes together.
- .3 Use size 3/0AWG copper conductors for connections to electrodes.
- .4 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

### **3.5 SYSTEM AND CIRCUIT GROUNDING**

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

### **3.6 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.

### **3.7 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.

### **3.8 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 either surface mounted. Suspended or set in poured concrete walls or ceilings.

**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 surfaces with lead anchors or nylon shields as required.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 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.
- .7 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.
- .8 For surface mounting of two or more conduits use channels at 1.5m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 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.

- .13      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 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 347V outlet boxes for 347V switching devices.
- .6 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 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 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 Partition walls and ceilings:
  - .1 All wiring to be run in EMT conduit for:
    - .1 Branch circuits.
    - .2 Low voltage systems.
    - .3 Distribution feeders and sub-feeders.
    - .4 Surface wiring in electrical and mechanical rooms.
- .3 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.
- .4 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.
- .5 Primary Voltage - Surface Mounted:
  - .1 All conduit containing primary voltage wiring shall be galvanized rigid steel with threaded couplings and connections.

**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 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.

### **2.2 RIGID METAL CONDUIT**

- .1 Rigid metal conduit to be hot dip galvanized steel, fully taper threaded ends, couplings and connections.
- .2 Schedule 40 steel.
- .3 Size as noted in drawings.
- .4 All 90 degree bends to be factory fabricated.

### **2.3 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.

### **2.4 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.

**2.5 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.

**2.6 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 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.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .6 Minimum conduit size for lighting and power circuits: 19mm.
- .7 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .9 Install fish cord in empty conduits.
- .10 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .11 Dry conduits out before installing wire.
- .12 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.
- .13 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.
- .14 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.
- .15 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).

- .16 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all manufacturers fittings to secure channel to structure and to conduit.
- .17 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 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.3 CONCEALED CONDUITS**

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

### **3.4 CONDUITS UNDERGROUND**

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

**END OF SECTION**



**Part 1 General****1.1 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 Plastic burial marker tape. 150mm wide, yellow in color indicating "Electrical Line Buried Below – High Voltage".

**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 MARKERS**

- .1 Install continuous plastic marker tape with metallic strip along entire length of underground conduit run. Marker tape shall be 300mm below grade.

**3.3 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 REFERENCES**

- .1 National Electrical Manufacturers Association (NEMA)

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (Latest Edition), Safety Standard for Electrical Installations.

**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 product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.
    - .2 Technical data:
      - .1 Product Information, dimensions, connection requirements.

**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 dry type transformers for incorporation into manual.
- .3 Operation and maintenance instructions to include:
  - .1 Installation manual.
  - .2 Operational information.
  - .3 Maintenance recommendations.

**1.5 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 transformers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**1.6 EXTRA MATERIALS**

- .1 Supply maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

**Part 2 Products****2.1 ACCESSORIES**

- .1 Winding temperature detector relay and sensing elements with 2 sets of SPDT alarm and 2 sets of SPDT trip contacts.
- .2 Wiring and terminal box for thermal protective devices.
- .3 Digital type winding temperature indicator.
- .4 Capillary type thermal sensor bulb to be fastened to existing transformer windings or inserted into existing transformer winding sensor well.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

**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 transformers 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 Replace existing transformer winding thermal protection and indication device with new.
- .2 Connect exiting and new alarm and trip wiring to device.
- .3 Mount device in existing mounting arrangements on transformer enclosure. Provide replacement faceplate as required to adapt new device to existing cutout and mountings.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
  - .1 Simulate full range of thermal sensing using a temperature controlled heat gun ( or similar ) and calibrated thermal sensing device.
  - .2 Confirm all alarm and set points for correct operation and reset and prescribed temperature settings.

- .3 Ensure correct operation of tripping functions with all electrical components, relays and devices in circuit.

### **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.

### **3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by transformers installation.

**END OF SECTION**

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

- .1 Section 26 05 00 Common Work Results - Electrical.
- .2 Section 26 05 14 Power Cables and Overhead Conductors.
- .3 Section 26 05 22 Connectors and Terminations.
- .4 Section 26 05 27 Grounding-Primary.
- .5 Section 26 05 30 Seismic Restraints.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.14-13, Industrial Control Equipment.
  - .2 CSA C22.2 No.31-10, Switchgear Assemblies.
  - .3 CSA C22.2 No.58-M1989 (R2010), High-Voltage Isolating Switches.
  - .4 CSA G40-20/G40.21-04 (R2009) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC G1-1-1958, Indoor and Outdoor Switch and Bus Insulators.
  - .2 EEMAC G8-3.3, Metal-Enclosed Interrupter Switchgear Assemblies.
- .3 National Electrical Manufacturers Association (NEMA).
- .4 BC Hydro Primary Guide.

**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 switchgear assembly and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Primary switchgear assembly to include:
    - .1 Enclosure.
    - .2 Circuit breakers.
    - .3 Busbar.
    - .4 Grounding Studs with insulating boots.
    - .5 Protection relay and interlocks.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Indicate on drawings:
    - .1 Floor anchoring method and dimensioned foundation template.
    - .2 Dimensioned cable entry and exit locations.
    - .3 Dimensioned cable termination height.

- .4 Dimensioned position and size of busbars and details of provision for extension.
  - .5 Dimensioned positions of main connections, including air clearances and support insulators.
  - .6 Layout of internal and front panel components suitably identified.
  - .7 Time current characteristics curves of protection devices.
  - .8 3 Line schematic diagrams
  - .9 Protection and coordination study for 25kV.
  - .10 Proposed mimic diagrams on the front of equipment
- .4 Certificates:
- .1 Submit manufacturer's test certificates.

#### **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 primary switchgear assembly for incorporation into manual.

#### **1.5 QUALITY ASSURANCE**

- .1 Submit manufacturer's type test certificates indicating switchgear cubicles and components tested as integrated assembly.
- .2 Submit test procedures, at least 10 days prior to testing.
- .3 Submit production test results before equipment is shipped from factory.

#### **1.6 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 Ship and store switchgear assembly in upright position.
  - .2 Keep doors locked and protect instruments from damage and dust.
  - .3 Ship channel base sills, anchoring devices in advance of switchgear.
  - .4 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .5 Store and protect switchgear assembly from nicks, scratches, and blemishes.
  - .6 Replace defective or damaged materials with new.

#### **1.7 SCHEDULING**

- .1 Co-ordinate time-current characteristics of protective relays.

#### **1.8 EXTRA MATERIALS**

- .1 Submit maintenance materials in accordance with 01 78 00 - Closeout Submittals.

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

- .1 Switchgear assembly: to CSA C22.2 No.31
- .2 Steel for cubicles: to CSA G40.21
- .3 Insulators: to CSA C22.2 No.58

**2.2 INDOOR SWITCHGEAR ENCLOSURE**

- .1 Primary enclosure: metal clad, free standing, floor mounted, dead front, indoor CSA Enclosure 1 cubicle unit. Constructed from code rolled flat steel sheets review and change as required.
- .2 Ventilating louvres: sprinkler proof with easily replaceable fiberglass filters.
- .3 Use non-corrosive bolts and hardware.
- .4 Access from front and sides and shown in drawings.
- .5 Full height outer doors, gasketed, hinges on right side, provision for multiple padlocking. Three point latch, stops, to open at least 135 degrees with viewing windows of transparent shatterproof material for inspection of disconnecting switch position.
- .6 Hinge doors on same side.
- .7 Gaskets on removable covers.
- .8 Inner door: hinged and bolted mesh steel screens to prevent inadvertent contact with exposed live parts, to open at least 90 degrees.
- .9 Metal pocket with weatherproof envelope and 1 set of drawings and diagram prints on inside surface of door.
- .10 Provide access control as follows:
  - .1 Equip doors providing access to interrupter with key/interlocks to guard against:
    - .1 Opening door if interrupter switch on source side of fuse is closed.
    - .2 Closing interrupter switch if door is open.

**2.3 EXTERIOR RATED SWITCHGEAR ENCLOSURE**

- .1 The housing shall be a minimum 12 gauge, marine-grade (copper free) Aluminum, rigid, free-standing, fabricated to EEMAC 3 standards with sufficient bracing to form a structure capable of withstanding wind, snow and ice loading. Exterior baked powder coat finish: RAL 6000.
- .2 The roof shall have a minimum 25 mm overhang and provide rain gutters over all doors and openings. Gutters shall be oriented that overflow water is diverted away from access door areas.
- .3 All hinges shall be internally mounted and concealed, with grease fittings as required.
- .4 Ventilating louvres: vermin, insect and water proof with easily replaceable fiberglass filters.
- .5 Use stainless steel bolts and hardware.
- .6 Hinged door access from front only. Bolt on wire way access from back as indicated.



- .7 100 mm galvanized steel channel sills for base mounting in single length common to multi-cubicle switch board. Provide suitable surface for a sealing gasket between concrete pad and steel channel to provide an effective seal for prevention of ingress of water.
- .8 Full height outer door reinforced with stiffeners, gasketed, hinges on left or right as required for access, provision for multiple padlocking. Three point latch, stops, to open at least 135 degrees with hydraulic hold opens on all doors.
- .9 Inner doors to open at least 90 degrees. Inner doors to have glass windows to allow viewing of the switch in the open and closed position.
- .10 Thermostat, test switch, meter and operating handle shall be mounted on a fixed panel behind the outer door and adjacent to the inner door.
- .11 Gaskets on removable covers.
- .12 Removable cover bolts not accessible from outside of cubicle.
- .13 Interior hinged and bolted mesh steel screens to prevent inadvertent contact with exposed live parts.
- .14 Metal pocket on inside surface of door of main breaker and secondary breaker compartments to accommodate drawing and diagram prints.
- .15 240V heater shall be mounted inside switch cubicle in an safe, accessible location with the switch in the open position.
- .16 Utility wireway built to BC Hydro standards and as noted in drawings.

## **2.4 BUS BARS**

- .1 Three phase and full capacity neutral insulated busbars, continuous current rating as indicated extending full width of multi-cubicle switchboard suitably supported on insulators.
- .2 Main connections between busbars, major switching components and fuses of continuous current rating to match major switching components.
- .3 High conductivity copper for busbars and main connections.
- .4 Brace busbar system including ground bus to withstand stresses resulting from short circuit currents specified.
- .5 Tin surfaced joints, secured with non-corrosive bolts and washers, tightened with torque wrench in accordance with manufacturer's recommendations.
- .6 Identify phases of busbars by suitable marking.
- .7 Busbar connectors when switchgear shipped in more than one section.
- .8 Maximum symmetrical interrupting: 21 kA at 25kV.

## **2.5 GROUNDING**

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width multi-cubicle switchboard and situated at bottom and top row of breakers complete with ball studs in every cell.
- .2 Lugs at each end for size 4/0 AWG grounding cable.
- .3 Bond non-current carrying parts, including switchgear framework, enclosure and bases to ground bus.
- .4 Readily accessible grounding ball studs when opening cabinet to work on High Voltage connection within cabinet.

- .5 Grounding connectors must be CSA and IEEE 837 station class approved.

## **2.6 CIRCUIT BREAKER**

- .1 Vacuum or magnetic style circuit breaker, 120 VAC solenoid trip, fixed mounting, equipped with interlocks to prevent making or breaking load current with auxiliary contacts and ground switch.
- .2 Future SCADA connection to indicate open, closed tripped, and racking position.
- .3 Trip mechanism, charging motor, remote open and remote close operators for remote operation. All operators shall be 120 VAC.
- .4 Compatible remote operator assembly to include: Trip and close functions.
- .5 27kV voltage class, minimum continuous current rating of 100 amps.
- .6 11kAIC at 25kV
- .7 150kV BIL

## **2.7 LOAD BREAK RATED SWITCH**

- .1 Load break rated, 27kV class three phase fused switch.
- .2 150kV BIL. 500 MVA. 600 amps.
- .3 Fuse sizes as noted in drawings.
- .4 Provide 6 spare fuses mounted in fuse holder.

## **2.8 INTERLOCKS**

- .1 Mechanical, key actuated interlock devices to be provided as noted in drawings.
- .2 Interlocks shall be configured such that key is held captive in interlock device when locked door is in the open position.
- .3 Brass/bronze with unique key coding.
- .4 Flush/recessed mounting inside switchgear, metering compartments or circuit breakers.
- .5 The interlock arrangement shall provide the following:
  - .1 When the disconnect switch is in the closed position Key K1 is held captive.
  - .2 Upon opening of the disconnect switch, key K1 can be withdrawn and inserted into the circuit breaker.
  - .3 With K1 in the circuit breaker, both K1 and K2 can be turned tripping the circuit breaker and holding key K1 captive. Key K2 can now be removed.
  - .4 When key K2 is in the circuit breaker but key K1 is NOT, breaker may be opened or closed.
  - .5 Key K2 can only be removed from circuit breaker when it is in the opened and tripped position.
  - .6 With key K2 withdrawn, breaker cannot be closed.
  - .7 Key K2 can now be used to open BC Hydro instrument transformer enclosure. Key is held captive in this interlock so long as the instrument transformer door is open.
  - .8 In order to reclose breaker and switch, reverse this procedure.

## **2.9 INDICATOR LIGHTS**

- .1 Include 30 mm long life LED indicator lights rated for control voltage to CSA C22.2 No.14-13.
- .2 Include push to test lights with transparent plastic cover.

## **2.10 LIVE LINE INDICATORS**

- .1 Panel/door mounted live line indicators using capacitive (or similar) voltage sensing to provide visual indication of energization status of bus at locations noted.
- .2 Busbar mounted sensors shall be connected to panel mounted indicator using optical fiber or similar non-conductive means of transmitting status.
- .3 Panel mounted visual indicators shall be LED, electroluminescent or fluorescent.
- .4 Panel indicators shall provide three indicators, one for each phase at measurement locations noted.

## **2.11 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results- Electrical.
- .2 Cubicle exteriors: gray.
- .3 Cubicle interiors: white.
- .4 Supply 2 spray cans touch up paint.

## **2.12 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment identification in accordance with Section 26 05 00 - Common Work Results- Electrical.
- .2 Nameplates:
  - .1 Switchgear designation: label - white plate, black letters, size 7, engraved as indicated.
  - .2 Individual cubicle designations: labels - white plate, black letters, size 7, engraved as indicated.

## **2.13 WARNING SIGNS**

- .1 Include warning signs in accordance with Section 26 05 00 - Common Work Results- Electrical.

## **2.14 SOURCE QUALITY CONTROL**

- .1 Switchgear and accessories shall be manufactured and tested under the manufacturer's standard Quality Assurance Program. Program shall generally comply with the intent of CSA CAN3-Z299.3 or ISO 9001. Provide a copy of the manufacturer's Quality Assurance Procedures Manual upon request.
- .2 Factory test each complete controller assembly and all accessories. Notify Departmental Representative 7 days in advance of tests and confirm 2 days in advance. Departmental Representative and Engineer will attend/witness tests. Tests must be conducted in the Lower Mainland 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 Departmental Representative's and engineer's attendance at factory tests and at repeat tests if necessary.

- .3 Maintain a set of working records as inspections and tests proceed. Neatly transfer actual results to clean copy for record submissions and manuals. Provide Departmental Representative with copy of final records.
- .4 Departmental Representative will review results and prepare a deficiency list and requirements for corrective actions if applicable. Repeat applicable portions or complete tests as directed by Departmental Representative following completion of deficiencies.
- .5 Conduct inspections and tests during the course of manufacture to verify quality control requirements and to comply with requirements of relevant Standards and these Specifications.
- .6 Inspections and tests shall include all standard factory acceptance tests per CSA C22.2 No. 31. Record that inspections were conducted. Record test results where appropriate.
- .7 Submit certified copy of inspection and test results to Departmental Representative for review and approval before shipment to Site.
- .8 Include certified copy of inspection and test results in Operating Manuals.

### **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 switchgear assembly 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 Set and secure switchgear assembly in place on channel base, rigid, plumb and square.
- .2 Make field connections in accordance with manufacturer's recommendations.
- .3 Connect ground bus to building system ground.
- .4 Render entire assembly rodent and insect proof by means of plates, screens and grouting.
- .5 Check factory made connections for mechanical security and electrical continuity.
- .6 Check relay settings against shop drawings.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Operate circuit breaker closing and tripping mechanisms, to verify correct functioning.
- .3 Confirm operation of remote open, close devices as well as all remote status indicators.
- .4 Confirm correct operation of all live line indicators, including with single phase events.
- .5 Check insulation of switchgear assembly with DC Hi-Pot tester in accordance with manufacturer's approved methods. If values are not satisfactory, clean, dry and heat switchgear and repeat tests until readings acceptable to Departmental Representative.
- .6 Check insulation of switchgear assembly with appropriate megger. If values not satisfactory, clean, dry and heat switchgear and repeat tests until readings acceptable to Departmental Representative.
- .7 Check phase rotation of each feeder.
- .8 Place primary switchgear in service and check ammeter, voltmeter, wattmeter, power factor meter readings to ensure proper functioning of instruments and satisfactory phase balance and power factor of loads.
- .9 Check fuses for correct type and rating.
- .10 Check for grounding and neutral continuity between station ground and system neutral.
- .11 Have third party commissioning agency commission final installation and certify proper operation and installation.

**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.

**3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by primary switchgear assembly installation.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 13 18 – Primary Switchgear Assembly to 27KV.

**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 DIFFERENTIAL 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 Differential Protection: Six low-impedance current differential elements.
  - .2 Directional Element: Phase-comparator directional elements for each zone.
  - .3 Check Zone: Three dedicated check zones. Each check zone will have its own adaptive differential element and settings.
  - .4 Analog Inputs: 21 current and 3 voltage inputs.
  - .5 Current Transformer Inputs: Accept CTs from different classes and a ratio mismatch of 10:1. Measuring quantities shall be on a phase-segregated basis and not from summation CTs.
  - .6 Minimum CT Requirement: The relay requires primary CTs that shall reproduce the primary current without saturation for at least 2 ms after external fault inception.
  - .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 Overcurrent Fault Protection: Instantaneous and time-overcurrent elements for each of the 21 current inputs. Torque control capability shall be provided for the inverse-time overcurrent elements.
- .13 Voltage Elements: Three phase over- and undervoltage elements as well as negative- and zero-sequence overvoltage elements configured to be measured from the transformer secondary.
- .14 End-Zone Protection: Provide protection for a fault between the open circuit breaker and the CT.
- .15 External Faults: Detection of an external fault and enter into a high-security mode but not block the differential protection at any time.
- .16 Relay shall be configured to provide open and close command for the circuit breaker on the front panel of the relay. These controls will provide a programmable time delay for opening or closing this circuit breaker when in manual operation. The time delay shall be set for six second or as directed by Departmental Representative.
- .17 A hard wired, remote operator station shall be located as noted in drawings. These controls are direct, hardwired into the control circuit of the circuit breaker, not into the protection relay and do not have any time delay function.
- .3 Communications/Integration
  - .1 Network communications: Ethernet (Dual port).

## **2.2 TRANSFORMER WINDING THERMAL SENSING DEVICE**

- .1 Transformer winding temperature sensing device with alarm and trip relays, analog dial-type display and enclosure.
- .2 Device is to be mounting in place of existing transformer thermal device.
- .3 Provide new sensors and leads compatible with new device. Sensors shall be inserted into existing transformer winding hot spot wells.
- .4 Temperature sensing shall be a mechanical capillary-type sensing arrangement.
- .5 Dial indicator shall have resettable peak temperature needle.
- .6 Alarm setting shall be 100 degrees Celsius. Trip setting shall be 120 degrees Celsius.

## **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.
- .3 Extend wiring for transformer thermal device alarm and trip contact to protection relay inputs. Alarm contact shall initiate and alarm recording function in the protection relay. The trip contact shall initiate a remote trip function on the protection relay.

**END OF SECTION**



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

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

**1.2 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.
- .2 Arrester characteristics:
  - .1 Station arrester.
  - .2 System highest voltage line to line 27 kV.
  - .3 MCOV (maximum continuous operating voltage): 18 kV.
  - .4 Indoor type.
  - .5 Radio influence voltage: maximum 20 microvolts at 1.05 x MCOV.
  - .6 Housing: polymer.

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

- .1 Mount three (3) arresters in existing transformer enclosure adjacent to primary buswork and as close to transformer as possible.
- .2 Connect line terminals to phase conductors.
- .3 From arrester ground terminal run 3/0 AWG copper ground wire to ground.

**END OF SECTION**

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

- .1 Section 01 33 00 Submittal Procedures.
- .2 Section 01 35 33 Health and Safety Requirements.
- .3 Section 01 35 43 Environmental Procedures.
- .4 Section 01 45 00 Quality Control.
- .5 Section 01 56 00 Temporary Barriers and Enclosures.
- .6 Section 01 74 21 Construction/Demolition Waste Management and Disposal.
- .7 Section 02 41 99 Demolition for Minor Works.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM C117-04, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .3 ASTM D422-632002, Standard Test Method for Particle-Size Analysis of Soils.
  - .4 ASTM D698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>) (600 kN-m/m<sup>3</sup>).
  - .5 ASTM D1557-02e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>).
  - .6 ASTM D4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
  - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
    - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.
  - .2 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .4 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

### 1.3 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
  - .1 Rock: solid material in excess of 1.00 m; and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m; bucket. Frozen material not classified as rock.
  - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil:
  - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
  - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .7 Unsuitable materials:
  - .1 Weak, chemically unstable, and compressible materials.
  - .2 Frost susceptible materials:
    - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.
    - .2 Table:
 

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45
    - .3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.
- .8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
  - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
  - .2 Submit for review by Departmental Representative proposed dewatering heave prevention methods as described in PART 3 of this Section.
  - .3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
  - .4 Submit to Departmental Representative written notice when bottom of excavation is reached.
  - .5 Submit to Departmental Representative testing inspection results report as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
  - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
  - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.
  - .3 Submit 70 kg samples of type of fill.
  - .4 Ship samples Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.
  - .5 At least 4 weeks prior to beginning Work, inform Departmental Representative source of fly ash and submit samples to Departmental Representative.
    - .1 Do not change source of Fly Ash without written approval of Departmental Representative.

## **1.5 QUALITY ASSURANCE**

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Province of British Columbia, Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional Engineer who is registered or licensed in Province British Columbia, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.

- .6 Do not use soil material until written report of soil test results are reviewed and approved by Departmental Representative.

- .7 Health and Safety Requirements:

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## 1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert materials from landfill to local facility for reuse.

## 1.7 EXISTING CONDITIONS

- .1 Buried services:
  - .1 Before commencing work verify location of buried services on and adjacent to site.
  - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
  - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
  - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
  - .5 Prior to beginning excavation Work, notify applicable Departmental Representative establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during Work.
  - .6 Confirm locations of buried utilities by careful test excavations or soil hydrovac methods.
  - .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
  - .8 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing.
  - .9 Record location of maintained, re-routed and abandoned underground lines.
  - .10 Confirm locations of recent excavations adjacent to area of excavation.
- .2 Existing buildings and surface features:
  - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
  - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
  - .3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

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

- .1 Type 1 and Type 2 fill: properties in accordance with the following requirements:

- .1 Crushed, pit run or screened stone, gravel or sand.  
 .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

- .3 Table:

Sieve Designation	% Passing	
	Type 1	Type 2
75 mm	-	100
50 mm	-	-
37.5 mm	-	-
25 mm	100	-
19 mm	75-100	-
12.5 mm	-	-
9.5 mm	50-100	-
4.75 mm	30-70	22-85
2.00 mm	20-45	-
0.425 mm	10-25	5-30
0.180 mm	-	-
0.075 mm	3-8	0-10

- .2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.
- .3 Unshrinkable fill: proportioned and mixed to provide:
- .1 Maximum compressive strength of 0.4 MPa at 28 days.  
 .2 Maximum cement content of 25 kg/m<sup>3</sup>; to CSA-A3001, Type GU.  
 .3 Minimum strength of 0.07MPa at 24 h.  
 .4 Concrete aggregates: to CSA-A23.1/A23.2.  
 .5 Cement: Type GU.  
 .6 Slump: 160 to 200 mm.
- .4 Shearmat: honeycomb type bio-degradable cardboard 100 mm thick, treated to provide sufficient structural support for poured concrete until concrete cured.

**Part 3 Execution****3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control drawings, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### **3.2 SITE PREPARATION**

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

### **3.3 PREPARATION/PROTECTION**

- .1 Protect existing features in accordance with applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

### **3.4 STRIPPING OF TOPSOIL**

- .1 Begin topsoil stripping of areas as indicated after area has been cleared of brush, weeds, grasses and removed from site.
- .2 Strip topsoil to depths as indicated.
  - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
  - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil as directed by Departmental Representative.

### **3.5 STOCKPILING**

- .1 Stockpile fill materials in areas designated by Departmental Representative.
  - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

### **3.6 COFFERDAMS, SHORING, BRACING AND UNDERPINNING**

- .1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 33 - Health and Safety Requirements and WorkSafe BC.
  - .1 Where conditions are unstable, Departmental Representative to verify and advise methods.
- .2 Obtain permit from authority having jurisdiction for temporary diversion of water course.

- .3 Construct temporary Works to depths, heights and locations as indicated by Departmental Representative.
- .4 During backfill operation:
  - .1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.
  - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
  - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.
- .5 When sheeting is required to remain in place, cut off tops at elevations as indicated.
- .6 Upon completion of substructure construction:
  - .1 Remove cofferdams, shoring and bracing.

### **3.7 DEWATERING AND HEAVE PREVENTION**

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Departmental Representative review details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
  - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water to approved runoff areas and in manner not detrimental to public and private property, or portion of Work completed or under construction.
  - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

### **3.8 EXCAVATION**

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations. Excavate to lines, grades, elevations and dimensions as indicated.
- .2 Remove concrete, masonry, paving, walks, demolished foundations and rubble and other obstructions encountered during excavation offsite.
- .3 Excavation must not interfere with bearing capacity of adjacent foundations.
- .4 Do not disturb soil within branch spread of trees or shrubs that are to remain.
  - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.



- .5 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations. No more than 5 m of trench may be exposed at end of day's operation and must be securely covered. Road plates are to be used to cover exposed excavations in areas of vehicular travel.
- .6 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .7 Restrict vehicle operations directly adjacent to open trenches.
- .8 Dispose of surplus and unsuitable excavated material in approved location on site.
- .9 Do not obstruct flow of surface drainage or natural watercourses.
- .10 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .11 Notify Departmental Representative when bottom of excavation is reached.
- .12 Obtain Departmental Representative approval of completed excavation.
- .13 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
- .14 Correct unauthorized over-excavation as follows:
  - .1 Fill under bearing surfaces and footings with concrete specified for footings Type 2 fill compacted to not less than 100% of corrected Standard Proctor maximum dry density.
  - .2 Fill under other areas with Type 2 fill compacted to not less than 95 % of corrected Standard Proctor maximum dry density.
- .15 Hand trim, make firm and remove loose material and debris from excavations.
  - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
  - .2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.

### **3.9 FILL TYPES AND COMPACTION**

- .1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D698 ASTM D1557.
  - .1 Exterior side of perimeter walls: use Type 3 fill to subgrade level. Compact to 95% of corrected maximum dry density.
  - .2 Within building area: use Type 2 to underside of base course for floor slabs. Compact to 100 % of corrected maximum dry density.
  - .3 Under concrete slabs: provide 150 mm compacted thickness base course of Type 1 fill topped with shearmat filler as indicated to underside of slab. Compact base course to 10 %.
  - .4 Retaining walls: use Type 2 fill to subgrade level on high side for minimum 500 mm from wall and compact to 95 %. For remaining portion, use Type 3 fill compacted to 95 %.

- .5 Place unshrinkable fill in areas as indicated.

### **3.10 BEDDING AND SURROUND OF UNDERGROUND SERVICES**

- .1 Place and compact granular material for bedding and surround of underground services as indicated.
- .2 Place bedding and surround material in unfrozen condition.

### **3.11 BACKFILLING**

- .1 Do not proceed with backfilling operations until completion of following:
  - .1 Departmental Representative has inspected and approved installations.
  - .2 Departmental Representative has inspected and approved of construction below finish grade.
  - .3 Inspection, testing, approval, and recording location of underground utilities.
  - .4 Removal of concrete formwork.
  - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
- .2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 300 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
  - .1 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
  - .2 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.150 m.
  - .3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
    - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative.
- .6 Place unshrinkable fill in areas as indicated.
- .7 Consolidate and level unshrinkable fill with internal vibrators.
- .8 Install drainage system in backfill as indicated.

### **3.12 RESTORATION**

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Replace topsoil as indicated.
- .3 Reinstall lawns to elevation which existed before excavation.

- .4 Reinstall pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstall areas affected by Work as directed by Departmental Representative.
- .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

**END OF SECTION**

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

- .1 Section 01 33 00 Submittal Procedures.
- .2 Section 01 32 17 Construction Progress Schedule Bar (GANTT Chart).
- .3 Section 01 74 21 Construction/Demolition Waste Management Disposal.
- .4 Section 01 74 11 Cleaning.

**1.2 MEASUREMENT PROCEDURES**

- .1 Preparation of sub-grade for placing of topsoil will be measured in square metres of area prepared.
- .2 Topsoil stripping will not be measured.
- .3 Measure supplying, placing and spreading topsoil in cubic metres as determined from actual surface area covered and depth of topsoil specified.
  - .1 Specified depth of topsoil: measured and approved by Departmental Representative, Consultant after settlement and consolidation as specified.
- .4 Measure finish grading in square metres from actual surface measurements as determined by Departmental Representative, Consultant.

**1.3 PAYMENT**

- .1 Testing of topsoil: Contractor will pay for cost of testing.

**1.4 REFERENCES**

- .1 Agriculture and Agri-Food Canada
  - .1 The Canadian System of Soil Classification, Third Edition, 1998.
- .2 Canadian Council of Ministers of the Environment
  - .1 PN1340-2005, Guidelines for Compost Quality.
- .3 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

**1.5 DEFINITIONS**

- .1 Compost:
  - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.
  - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
  - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below (25) (50)), and contain no toxic or growth inhibiting contaminants.

- .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A) (B).

## **1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality control submittals:
  - .1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.
  - .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

## **1.7 QUALITY ASSURANCE**

- .1 Pre-installation meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.

## **1.8 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused soil amendments from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused soil amendments into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

## **Part 2 Products**

### **2.1 TOPSOIL**

- .1 Topsoil for seeded areas: mixture of particulates, micro organisms and organic matter which provides suitable medium for supporting intended plant growth.
  - .1 Soil texture based on The Canadian System of Soil Classification, to consist of 20 to 70 % sand, minimum 7 % clay, and contain 2 to 10 % organic matter by weight.
  - .2 Contain no toxic elements or growth inhibiting materials.
  - .3 Finished surface free from:
    - .1 Debris and stones over 50 mm diameter.
    - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
  - .4 Consistence: friable when moist.

## 2.2 SOIL AMENDMENTS

- .1 Fertilizer:
  - .1 Fertility: major soil nutrients present in following amounts:
  - .2 Nitrogen (N): 20 to 40 micrograms of available N per gram of topsoil.
  - .3 Phosphorus (P): 40 to 50 micrograms of phosphate per gram of topsoil.
  - .4 Potassium (K): 75 to 110 micrograms of potassium per gram of topsoil.
  - .5 Calcium, magnesium, sulfur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
  - .6 Ph value: 6.5 to 8.0.
- .2 Peatmoss:
  - .1 Derived from partially decomposed species of Sphagnum Mosses.
  - .2 Elastic and homogeneous, brown in colour.
  - .3 Free of wood and deleterious material which could prohibit growth.
  - .4 Shredded particle minimum size: 5 mm.
- .3 Sand: washed coarse silica sand, medium to coarse textured.
- .4 Organic matter: compost Category A, in accordance with CCME PN1340, unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.
- .5 Limestone:
  - .1 Ground agricultural limestone.
  - .2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.
- .6 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

## 2.3 SOURCE QUALITY CONTROL

- .1 Advise Departmental Representative of sources of topsoil, manufactured topsoil to be utilized with sufficient lead time for testing.
- .2 Contractor is responsible for amendments to supply topsoil as specified.
- .3 Soil testing by recognized testing facility for PH, P and K, and organic matter.
- .4 Testing of topsoil will be carried out by testing laboratory designated by Departmental Representative.
  - .1 Soil sampling, testing and analysis to be in accordance with Provincial standards.

**Part 3 Execution****3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control drawings, sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

**3.2 STRIPPING OF TOPSOIL**

- .1 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds, grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative, Consultant.
  - .1 Avoid mixing topsoil with subsoil where textural quality will be moved outside acceptable range of intended application.
- .3 Stockpile in locations as directed by Departmental Representative.
  - .1 Stockpile height not to exceed 2 m.
- .4 Disposal of unused topsoil is to be in an environmentally responsible manner but not used as landfill [as directed by Departmental Representative.
- .5 Protect stockpiles from contamination and compaction.

**3.3 PREPARATION OF EXISTING GRADE**

- .1 Verify that grades are correct.
  - .1 If discrepancies occur, notify Departmental Representative, Consultant and do not commence work until instructed by Departmental Representative.
- .2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
  - .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
  - .2 Remove debris which protrudes more than 75 mm above surface.
  - .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.
  - .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

**3.4 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL**

- .1 Place topsoil after Departmental Representative has accepted subgrade.
- .2 Spread topsoil in uniform layers not exceeding 150 mm.
- .3 For sodded areas keep topsoil 15 mm below finished grade.
- .4 Spread topsoil as indicated to following minimum depths after settlement.
  - .1 150 mm for seeded areas.
  - .2 135 mm for sodded areas.
  - .3 300 mm for flower beds.
  - .4 500 mm for shrub beds.
- .5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

**3.5 FINISH GRADING**

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
  - .1 Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Consolidate topsoil to required bulk density using equipment approved by Departmental Representative.
  - .1 Leave surfaces smooth, uniform and firm against deep footprinting.

**3.6 ACCEPTANCE**

- .1 Departmental Representative, Consultant will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

**3.7 SURPLUS MATERIAL**

- .1 Dispose of materials except topsoil not required off site.

**3.8 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

**END OF SECTION**



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

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 33 – Health and Safety Requirements
- .3 Section 01 45 00 – Quality Control
- .4 Section 01 61 00 – Common Product Requirements
- .5 Section 01 74 11 – Cleaning
- .6 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .7 Section 31 23 33.01 – Excavating Trenching and Backfilling.

**1.2 MEASUREMENT PROCEDURES**

- .1 Measure excavation and backfill in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling.
- .2 Measure manholes and catch basins in units within depth classifications as follows, measured from top of cover or grating to lowest pipe invert top of base slab:
  - .1 2 m or less.
  - .2 Greater than 2 m but not more than 2.5 m.
  - .3 Greater than 2.5 m but not more than 3 m.
  - .4 Greater than 3 m but not more than 3.5 m.
  - .5 Further stages in increments of 0.5 m.
- .3 Measure outfall structures in units.
- .4 Measure adjusting tops of existing manholes or catch basins in units adjusted.
- .5 Measure gratings in units supplied and installed.
- .6 Measure I-beam in metres of each size incorporated into work.
- .7 Measure sealing over existing manholes or catch basins in units sealed.

**1.3 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A48/A48M-00, Standard Specification for Gray Iron Castings.
  - .2 ASTM C117-04, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
  - .3 ASTM C136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .4 ASTM C139-05, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.

- .5 ASTM C478M-06, Standard Specification for Precast Reinforced Concrete Manhole Sections Metric.
- .6 ASTM D698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)).
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
  - .2 CAN/CGSB-8.2-M88], Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CAN/CSA-A3000-03(R2005), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
    - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.
    - .2 CSA-A3002-03, Masonry and Mortar Cement.
  - .3 CAN/CSA-A165 Series-04, CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2 and A165.3).
  - .4 CAN/CSA-G30.18-M92 (R2002), Billet Steel Bars for Concrete Reinforcement.
  - .5 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

#### 1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit two copies WHMIS MSDS – Material Safety Data Sheets in accordance with Section 01 33 55 Health and Safety Requirements.
- .3 Quality assurance submittals: submit following in accordance with Section 01 45 00- Quality Control.
  - .1 Submit manufacturer's test data and certification at least 2 weeks prior to beginning Work. Include manufacturer's drawings, information and shop drawings where pertinent.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

## **1.5 QUALITY ASSURANCE**

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Departmental Representative to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Cast-in-place concrete:
  - .1 In accordance with Section 03 30 00 - Cast-in-Place Concrete.
  - .2 Cement: to CAN/CSA-A3001, Type GU.
  - .3 Concrete mix design to produce 21 MPa minimum compressive strength at 28 days and containing 25mm maximum size coarse aggregate, with water/cement ratio to CAN/CSA-A23.1.
    - .1 Air entrainment to CAN/CSA-A23.1, class C-3 exposure.
  - .4 Supplementary cementing materials: with minimum 20% Type F fly ash replacement, by mass of total cementitious materials to CAN/CSA A3001.
  - .5 Concrete reinforcement: in accordance with Section 03 20 00 - Concrete Reinforcing.
- .2 Precast manhole units: to ASTM C478M, circular or oval.
  - .1 Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.

- .2 Monolithic bases to be approved by Departmental Representative.
- .3 Precast catch basin sections: to ASTM C139 and ASTM C478M.
- .4 Joints: made watertight using rubber rings, bituminous compound, epoxy resin cement.
- .5 Mortar:
  - .1 Masonry Cement: to CAN/CSA-A3002.
- .6 Ladder rungs: to CAN/CSA-G30.18, No.25M billet steel deformed bars, hot dipped galvanized to CAN/CSA-G164.
  - .1 Rungs to be safety pattern (drop step type).
- .7 Adjusting rings: to ASTM C478M.
- .8 Concrete Brick: to CAN3-A165 Series.
- .9 Drop manhole pipe: same as sewer pipe.
- .10 Galvanized iron sheet: approximately 2 mm thick.
- .11 Steel gratings, I-beams and fasteners: as indicated.
- .12 Frames, gratings, covers to dimensions as indicated and following requirements:
  - .1 Metal gratings and covers to bear evenly on frames.
    - .1 Frame with grating or cover to constitute one unit.
    - .2 Assemble and mark unit components before shipment.
  - .2 Gray iron castings: to ASTM A48/A48M, strength class 30B.
  - .3 Castings: coated with two applications of asphalt.
  - .4 Manhole frames and covers: cover cast with perforations and complete with two 25 mm square lifting holes.
  - .5 Catch basin frames and covers: ASTM A48 and to withstand H2O loading.
  - .6 Size: 762mm clear diameter.
- .13 Granular bedding and backfill: in accordance with Section 31 23 33.01 Excavating Trenching and Backfilling.
- .14 Unshrinkable fill: in accordance with Section 31 23 33.01 Excavating, Trenching and Backfilling.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 EXCAVATION AND BACKFILL**

- .1 Excavate and backfill in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling and as indicated.
- .2 Obtain approval of Departmental Representative before installing manholes or catch basins.

**3.3 CONCRETE WORK**

- .1 Position metal inserts in accordance with dimensions and details as indicated.

**3.4 INSTALLATION**

- .1 Construct units in accordance with details indicated, plumb and true to alignment and grade.
- .2 Complete units as pipe laying progresses.
  - .1 Maximum of three units behind point of pipe laying will be allowed.
- .3 Dewater excavation to approval of Departmental Representative and remove soft and foreign material before placing concrete base.
- .4 Cast bottom slabs directly on undisturbed ground.
- .5 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% maximum density to ASTM D698.
- .6 Precast units:
  - .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.
  - .2 Make each successive joint watertight with rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.
  - .3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
  - .4 Plug lifting holes with concrete plugs set in cement mortar or mastic compound.
- .7 For sewers:
  - .1 Place stub outlets and bulkheads at elevations and in positions indicated.
  - .2 Bench to provide smooth U-shaped channel.
    - .1 Side height of channel to be 0.75 times full diameter of sewer.
    - .2 Slope adjacent floor at 1 in 20.
    - .3 Curve channels smoothly.
    - .4 Slope invert to establish sewer grade.
- .8 Compact granular backfill to 95% maximum density to ASTM D698.
- .9 Place unshrinkable backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

- .10 Installing units in existing systems:
  - .1 Where new unit is installed in existing run of pipe, ensure full support of existing pipe during installation, and carefully remove that portion of existing pipe to dimensions required and install new unit as specified.
  - .2 Make joints watertight between new unit and existing pipe.
  - .3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready for operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.
- .11 Set frame and cover to required elevation on no more than three courses of brick.
  - .1 Make brick joints and join brick to frame with cement mortar.
  - .2 Parge and make smooth and watertight.
- .12 Place frame and cover on top section to elevation as indicated.
  - .1 If adjustment required use concrete ring.
- .13 Clean units of debris and foreign materials.
  - .1 Remove fins and sharp projections.
  - .2 Prevent debris from entering system.

### **3.5 FIELD QUALITY CONTROL**

- .1 N/A

### **3.6 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

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

- .1 Section 01 33 00 Submittal Procedures
- .2 Section 01 45 00 Quality Control
- .3 Section 31 23 33.01 Excavating, Trenching and Backfilling

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A82/A82M-05a, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
  - .2 ASTM A185/A185M-05a, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
  - .3 ASTM C139-05, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
  - .4 ASTM C 478/C478M-06, Standard Specification for Precast Reinforced Concrete Manhole Sections.
  - .5 ASTM D1056-00, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
  - .6 ASTM D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer and Pipe Fittings.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA B196.3-M.983, PVC Underground Telecommunication Cable Ducting and Fittings
  - .2 CAN/CSA-A3000-03(R2005), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
    - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.
  - .3 CSA A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .4 CSA A23.4-09, Precast Concrete – Materials and Construction
  - .5 CAN/CSA-G30.18-M92(R2002), Billet-Steel Bars for Concrete Reinforcement.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

- .2 Submit two copies WHMIS MSDS - Material Safety Data Sheets.
- .3 Shop Drawings:
  - .1 Submit shop drawings for precast manholes.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 Quality Control.
  - .1 Test reports: submit certified test reports for specified materials from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

#### **1.4 QUALITY ASSURANCE**

- .1 Pre-Installation Meetings: Contractor to attend pre-installation meeting with Consultants one week prior to beginning work of this Section, with contractor's representative and PWGSC representative to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

### **Part 2 Products**

#### **2.1 PVC DUCTS**

- .1 PVC ducts, Rigid PVC – Schedule 40, encased in reinforced concrete.

#### **2.2 PVC DUCT FITTINGS**

- .1 Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2 Expansion joints.
- .3 Rigid PVC 5 degree angle couplings.
- .4 Factory Bends.



**2.3 PULL BOX**

- .1 Cast in Place.
- .2 Walls and bottom: reinforced concrete.
- .3 Walls and bottom: monolithic concrete construction
- .4 Locate duct entrances and windows near corners of structures to facilitate cable racking.
- .5 Form steel and iron to shape and size with sharp lines and angles.
- .6 Castings: warp and blow hole free.
- .7 Exposed metal: smooth finish without sharp lines and arises.
- .8 Provide lugs, rabbets, and brackets.
- .9 Set pulling-in irons and other built-in items in place before depositing concrete.
- .10 Install pulling-in iron in wall opposite each duct line entrance.
- .11 Cable racks, including rack arms and insulators: sized to accommodate cable.

**2.4 DRAINAGE**

- .1 Floor drain fittings: consisting of, back water valve (located inside chamber) and pipe connection to drainage system.
- .2 Storm sewer connection: Manufactured wye connections to PVC mainline pipe to be made with extrusion moulded PVC or fabricated PVC fittings manufactured to ASTM D3034.

**2.5 GROUNDING**

- .1 Ground rods: in accordance with Section 26 05 27 - Grounding - Primary for cable rack grounding.

**2.6 CABLE RACKS**

- .1 Hot dipped galvanized cable racks and supports.
- .2 12 x 100 mm preset inserts for rack mounting.

**2.7 CABLE PULLING EQUIPMENT**

- .1 Pulling iron: galvanized steel rods, size and shape as indicated.
- .2 Pull rope: 6 mm stranded nylon, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

**2.8 MARKERS**

- .1 Brass type cable markers:
  - .1 Brass.
  - .2 5 mm thickness and 100 mm diameter area with 5mmx50mm leg for setting into concrete.
  - .3 Brass marker to have words: "Electric Cable", engraved in top surface, with arrows to indicate direction of duct runs.

- .4 Contractor to submit sample of brass marker and engraving text to Departmental Representative 6 weeks prior to ordering for review and approval by PWGSC.

## **2.9 CONDUIT DIRECTORIES**

- .1 All manholes shall be equipped with engraved lamacoid conduit directories. Each wall of the manhole with conduit entry shall have a directory.
- .2 Directories shall indicate conduit configuration, orientation, and conduit numbering as indicated on drawings.
- .3 Conduit directories shall indicate conduit installed for fibre use only.
- .4 Conduit directories shall be a minimum size of 216mm x 280mm (8.5"x11").
- .5 Conduit directories shall be submitted to the departmental representative in .PDF file format for review and approval prior to engraving and installation.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION GENERAL**

- .1 Install underground duct banks including formwork.
- .2 Build duct bank on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum Modified Proctor dry density.
- .3 Open trench completely between manholes before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Prior to laying ducts, construct "mud slab" not less than 75 mm thick where necessary to protect trench bottom from disturbance due to water intrusion.
- .5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.
- .6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.
- .7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically.
  - .1 Stagger joints in adjacent layers at least 150 mm and make joints watertight.
  - .2 Encase duct bank with 75mm thick concrete cover, or as detailed.
  - .3 Use galvanized steel conduit for sections extending above finished grade level.

- .8 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degrees with duct offset.
- .9 Use bell ends at duct terminations in manholes or buildings.
- .10 Use conduit to duct adapters when connecting to conduits.
- .11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- .12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- .13 Allow concrete to attain 50% of its specified strength before backfilling.
- .14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete.
  - .1 Tie ducts to spacers with twine or other non-metallic material.
  - .2 Remove weights or wood braces before concrete has set and fill voids.
- .15 Clean ducts before laying:
  - .1 Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .16 Duct cleaning:
  - .1 Pull steel mandrel (300 mm long x diameter 6 mm less than internal diameter of duct) through each duct immediately after placing of concrete.
  - .2 Then pull stiff bristle brush through duct; avoid disturbing or damaging ducts where concrete has not set completely.
  - .3 Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .17 Install four 3 m lengths of 15M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings.
  - .1 Wire rods to 15M dowels at manhole or building and support from duct spacers.
  - .2 Protect existing cables and equipment when breaking into existing manholes.
  - .3 Place concrete down sides of duct bank filling space under and around ducts.
  - .4 Rod concrete with flat bar between vertical rows filling voids.
- .18 Install pull rope continuous throughout each duct run with 3 m spare rope at each end.

### 3.3 MANHOLES

- .1 Install precast manholes.
- .2 Install ground rod before placing precast manholes and make manhole to duct connection as indicated.

- .3 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection.
  - .1 Terminate ducts in bell-end fitting flush with window face.
  - .2 Provide four 10M steel dowels at each duct run connection to anchor duct run.
  - .3 On runs of 16 ducts and over, support concrete duct encasement on a 700 mm thick concrete support poured against manhole wall between bottom of trench and bottom of duct run, provide dowels for anchoring.
- .4 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10M x 3m reinforcing rods in duct run at manhole connection.
- .5 Build up concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.
- .6 Install manhole frames and covers for each manhole:
  - .1 Set frames in concrete grout onto manhole neck.
- .7 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
- .8 Install cable racks, anchor bolts and pulling irons as indicated.
- .9 Grout frames of manholes:
  - .1 Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.
- .10 Ensure filling of voids in joint being sealed.
  - .1 Plaster with cement grout, walls, ceiling and neck.
- .11 Spray paint "X" on ceiling of manhole above floor drain or sump pit.

### 3.4 MARKERS

- .1 Mark location of duct runs on face and top of exposed duct bank sections at 3m intervals.
- .2 Mark hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run.
- .3 Mark ducts every 150 m along straight runs and changes in direction.
- .4 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .5 Provide drawings showing locations of all markers.

### 3.5 FIELD QUALITY CONTROL

- .1 Site Tests/Inspections:
  - .1 Inspection of duct will be carried out by PWGSC Representative prior to placing.
  - .2 Placement of concrete and duct cleanout to be done when PWGSC Representative present.

**3.6 CLEANING**

- .1 See Section 01 74 11 Cleaning.

**END OF SECTION**