



Public Works and
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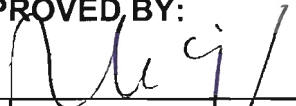
SPECIFICATIONS for:

**PACIFIC AGRI-FOOD RESEARCH CENTRE
SUMMERLAND LAB
MECHANICAL & ELECTRICAL
SYSTEMS UPGRADE**

Project No: R.075862.001

ISSUED FOR TENDER

APPROVED BY:



Regional Manager, AES
PRESTON

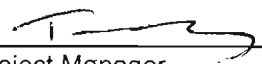
2015-10-13
Date



Construction Safety Coordinator

2015-10-14
Date

TENDER:



Project Manager

15/10/14
Date

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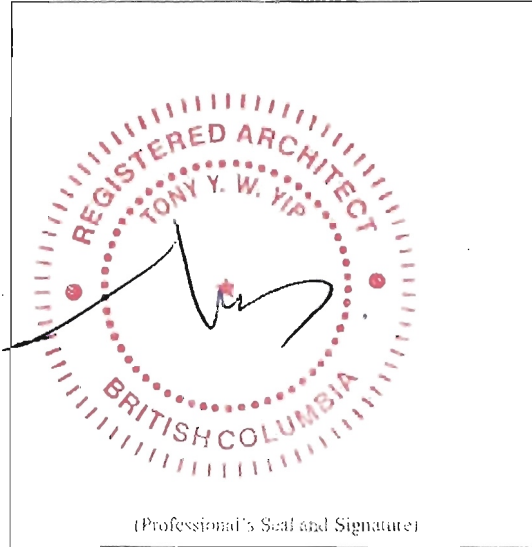
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CONSULTANTS – SEAL & SIGNATURE

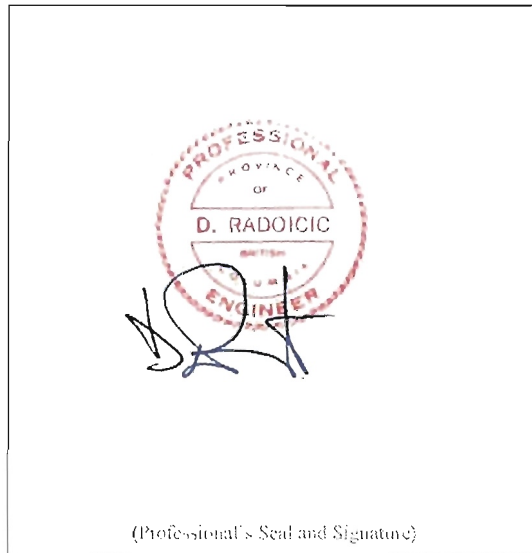
Architectural
Chernoff Thompson Architects



(Professional's Seal and Signature)

OCT 5, 2015
Date

Mechanical
Stantec Consulting Ltd.



(Professional's Seal and Signature)

OCT 05 2015

Date

Electrical
Stantec Consulting Ltd.



Oct 5, 2015

Date

Structural
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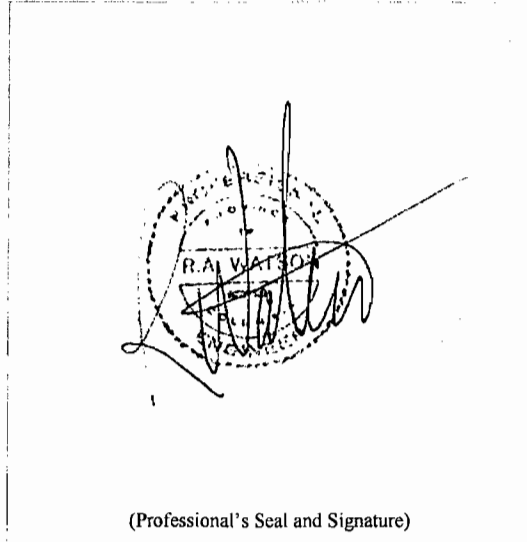


DIVISIONS 03, 04, 05
ONLY

OCT. 5, 2015

Date

Civil
Binnie Consulting Ltd.



10/6/15
Date

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .1 Work covered by Contract Documents;
- .2 Contract Method;
- .3 Work by others;
- .4 Future work;
- .5 Work sequence;
- .6 Contractor use of premises;
- .7 Owner occupancy.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 00 – Special Procedures
- .3 Section 01 35 00 Appendix – PWGSC Contractor Safety Procedures

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises renovation of ventilation system, located at the Summerland Research Centre; Pacific Agri-Food Research Centre at Summerland is further identified as PARC.

The project includes but is not limited to:

- .1 Replacement of existing cooling towers, CT-1 and CT-2. Removal of existing cooling towers and provision of two new cooling towers at new location.
- .2 Provision of new condenser water piping between existing chillers and new cooling towers.
- .3 Provision of new condenser water pumps (serving chillers and process loads).
- .4 Addition of Chemical Storage building and associated services to the building.
- .5 Provision of new control system to the new mechanical equipment.
- .6 Electrical work upgrade to accommodate mechanical system upgrade and new chemical storage building.
- .7 Structural work upgrade for mechanical equipment and new chemical storage building.
- .8 Architectural work upgrade to supplement mechanical system upgrade and to new chemical storage building.
- .9 Phased construction, to accommodate limited interruption to the services of the building.
- .10 Supply and installation of a complete, fully functional, tested, and commissioned mechanical system, with ancillaries.

- .2 All materials and equipment supplied and installed shall be new except the relocated equipment specified in the drawings.
- .3 Commissioning works includes mechanical, electrical, architectural, and structural components and systems.
- .4 Return all reusable removed equipment to PARC as directed by the Departmental Representative. Coordinate and confirm with PARC for all the reusable equipment. Move and store in a location on the premises, designated and coordinated with PARC.

1.4 CONTRACT METHOD

- .1 Construct Work under single, stipulated price contract.

1.5 WORK BY OTHERS

- .1 N/A

1.6 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Coordinate Progress Schedule and coordinate with Owner's Occupancy during construction.
- .3 Maintain fire access/control.
- .4 Required construction phases: Phased construction is required to accommodate limited interruption permitted to the services of the building (condenser water, cooling and electrical). Phased construction is also depicted on the drawings, and includes the following general phases:
 - .1 Phase 1A: Remove existing steam boiler in the boiler room, complete with the steam piping and associated equipment, vessels, PRV-s and valves. Cap off any services to the steam system, such as water supply, controls, compressed air, power, etc. Remove all redundant piping, hangers, braces and brackets.
 - .2 Phase 2A: Provide new connections for the tie-ins of the new system to existing piping with capped and valved connections, and cut in new valves in existing lines to allow changeovers with no need for further shutdowns. The work needs to be completed by the end of phase 2B.
Note: Maximum shutdown for the condenser water system is four (4) hours at any given time; coordinate with the Departmental Representative and PARC. Organize the work to minimize required drainage, minimize the duration of the shutdown, and minimize the number of shutdowns.
 - .3 Phase 2B: Install new cooling towers CT-1 and CT-2 in new location, together with the new structural pad, Storage Shed, fence and cooling tower system ancillaries. Install new pumps P-5, P-6 and P-7 in new location. Construct the condenser water loop and underground piping mains.
Test and commission new pumps and new cooling towers before connecting them to serve the process cooling loop.
Parts of phase 2B work can occur concurrent with work in Phase 1.

- .4 Phase 2C: Connect new cooling towers CT-1 and CT-2 and new pumps P-5, P-6 and P-7 to connections arranged in phase 2A. Activate the new system and connect to serve the process cooling and building cooling loops.
 - .5 Phase 2D: Remove existing pumps P-5, P-6 and P-7, and redundant condenser loop piping. Remove existing cooling towers (this activity is not critical to the project schedule).
 - .6 Phase 2E: Install new pumps P-1, P-2 and P-3 – use space made vacant by removing existing (old) pumps P-5, P-6 and P-7. Test and commission new pumps, connect to connections arranged in phase 2A. Activate the new system and connect to serve the process cooling loop.
 - .7 Phase 2F: Remove existing pumps P-1, P-2, P-3 and P-4, and redundant condenser loop piping.
 - .8 Phase 3A: Remove existing condenser water pumps P-8R, P-9 and P-10 (serving the chillers).
Note: This phase can start after the cooling season is over, and the chillers are not needed for the building cooling – coordinate with the Departmental Representative and PARC.
 - .9 Phase 3B: Install new pumps P-8, P-9 and P-10 and the condenser water piping in chiller room. Connect to the condenser water loop. Test and commission new pumps.
Note: The chiller operation will be re-tested and re-commissioned at the start of the next cooling season (deferred work).
 - .10 Phase 3C: Remove redundant piping and ancillaries in boiler room. Final project cleanup.
- .5 Contractor shall coordinate with the Departmental Representative and PARC, and allow adequate construction stages in the tender prices to meet the site condition, minimal interruption to the building services permitted, and the phased nature of the project, understanding that each phase of the project needs to be fully functional and operating before proceeding with the next phase.
 - .6 Staged testing, balancing, and commissioning shall be provided such that the equipment and the systems are fully functional, tested, balanced, controlled and commissioned after each phase of work, before proceeding with the next phase.

1.7 SITE MEETINGS

- .1 Construction meetings with Departmental Representative to be held on site bi-weekly.
- .2 All contractors shall also attend bi-weekly site meetings.
- .3 Contractors shall attend commissioning meetings.

1.8 CONTRACTOR USE OF PREMISES

- .1 Contractor shall limit use of premises for work, for storage, and for access, to allow:
 - .1 Owner occupancy.
- .2 Coordinate use of premises, such as work areas, storage, delivery of materials and equipment, parking, washroom facilities provision and use, elevator, power and water use

- shall be coordinated with and under direction of Departmental Representative. See Section 01 35 00 for contractor entry/exit of primary staging area, entry log, and contractor parking locations.
- .3 Contractor shall supply all necessary signage, hoarding and fencing.
 - .4 Contractor is responsible for all dust control measures. Contractor shall maintain the work areas under negative pressure to minimize potential for dust spread in the building.
 - .5 Contractor shall coordinate all work during normal hours of operation, 8:00 am - 5:00 pm. Coordinate all deliveries to minimize the disruption to the normal operation of the facility - coordinate with the Departmental Representative.
 - .6 All work to be performed after hours shall be coordinated with the Departmental Representative.
 - .7 Any work performed by the contractor outside of normal working hours requires notification of on-site security commissionaires.
 - .8 A temporary storage area for removed equipment is to be located in a designated storage area (e.g. adjacent to the Pesticide Storage Spray Building); coordinate with, and work under direction of Departmental Representative.
 - .9 Contractor shall supply all hoarding and fencing. See Section 01 35 00.
 - .10 Contractor shall abide by all on-site security provisions and regulations.
 - .11 Contractor entrance shall be at the loading dock for loading and unloading equipment.

1.9 OWNER OCCUPANCY

- .1 PARC will occupy premises, and carry out normal operation of the facility, during entire construction period.
- .2 Cooperate with Departmental Representative in scheduling operations to minimize interruption or conflict and to facilitate Owner usage of the facility.

1.10 CONTRACTOR FURNISHED ITEMS

- .1 Contractor Responsibilities:
 - .1 Designate submittals and delivery date for each product in progress schedule.
 - .2 Review shop drawings, product data, samples, and other submittals. Submit to Departmental Representative notification of any observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
 - .3 Receive and unload products at site.
 - .4 Handle products at site, including uncrating and storage.
 - .5 Protect products from damage and from exposure to elements.
 - .6 Assemble, install, connect, adjust, and finish products.
 - .7 Provide installation inspections required by local authorities.
 - .8 Repair or replace and make good items damaged by contractor on site during construction.

- .9 The word “make good” used in the contract documents means “to restore new or existing work after being damaged, cut, patched or rejected by the Departmental Representative” and also means “using materials identical to the original materials with visible surfaces matching the appearance of the original surfaces in all details and with no apparent junctions between new and original surfaces. Where original materials are no longer available, the Contractor may submit a proposal of materials for review by the Departmental Representative.”

1.11 MOCK-UP

- .1 N/A

1.12 SAFETY WORKING PROCEDURE

- .1 Working process shall follow the “Safe Working Procedures for Contractors when working at an AAFC Laboratory” is provided in the Appendix.

1.13 ASBESTOS REMOVAL

- .1 If the Contractor, during renovations / demolition, should discover asbestos (or material suspected to be asbestos) on piping, ductwork, etc., he shall immediately cease all work in that area and advise the General Contractor. The General Contractor shall take immediate appropriate action to verify presence of friable asbestos and be responsible for the removal of all friable asbestos.
- .2 The Contractor will not be entitled to a claim for any delays resulting from the investigation of or removal of asbestos.
- .3 Asbestos shall be removed in accordance with the regulations for handling hazardous material.
- .4 Asbestos removal will be considered extra cost.

1.14 CONSTRUCTION PERIOD

- .1 Allowable time for construction: expected completion of the project is December 20, 2016.

END OF SECTION

Part 1 General

1.1 CODES

- .1 Perform work in accordance with National Building Code for Canada 2010, Workers' Compensation Board of BC, BC Building Code 2012, and any other code of provincial or local regulation, standard or application provided that, in any case of conflict or discrepancy, the more stringent requirements shall apply.
- .2 Meet or exceed requirements of specified standards, codes, and referenced documents.

1.2 DESCRIPTION OF WORK

- .1 Work under this Contract comprises, but is not limited to, the provision of all labour, materials, services, and equipment necessary for the work for mechanical and electrical system upgrade at Pacific Agri-Food Research Centre, Summerland, BC as fully described in the Tender Documents.

1.3 CONTRACT DOCUMENTS

- .1 The Contract documents, drawings, and specifications are intended to complement each other.
- .2 Drawings are, in general, diagrammatic and are intended to indicate the scope and general arrangement of the work.
- .3 Coordinate with pre-purchased equipment suppliers in carrying out their respective works and carry out instructions from Departmental Representative.
- .4 Coordinate work with that of pre-purchased equipment suppliers. If any part of work under this Contract depends on its proper execution or result upon work of said suppliers, report promptly to Departmental Representative, in writing, any defects which may interfere with proper execution of this Work.

1.4 TIME OF COMPLETION

- .1 Commence work immediately upon official notification of acceptance of offer and complete the project, including testing, adjusting, and commissioning, per Section 01 11 00 – 1.14 – Construction Period.

1.5 HOURS OF WORK

- .1 PARC will occupy premises, and carry out normal operation of the facility, during entire construction period. Cooperate with Departmental Representative in scheduling operations to minimize interruption or conflict and to facilitate Owner usage of the facility.
- .2 All work which generates excessive noise and vibration, including cutting and coring, removal of floor slab shall be executed outside of the normal operating hours, except Saturdays and Sundays.
- .3 All other work, except for that noted in Clause 1.5.1, shall be executed during the normal operating hours:

- Monday through Friday – 0700 to 1700 hours.

- .4 All work conducted during or outside of normal operating hours will be subject to restrictions outlined in Sections 01 14 00 and 01 51 00, including security arrangements.

1.6 WORK SCHEDULE

- .1 Carry out work as follows:

- .1 Within 10 working days after Contract award, provide a “phasing bar chart” and a schedule showing anticipated progress stages and final completion of the work within the time period required by the Contract documents. Indicate the following:

- .1 Submission of shop drawings, product data, MSDS sheets, and samples;
- .2 Commencement and completion of work of each section of the specifications or trades for each phase as outlined;
- .3 Final completion date within the time period required by the Contract documents.

- .2 Do not change approved Schedule without notifying Departmental Representative.
- .3 Interim reviews of work progress based on work schedule will be conducted as decided by Departmental Representative and the schedule updated by Contractor in conjunction with and to approval of Departmental Representative.
- .4 All activities will be coordinated with and to approval of Departmental Representative. Provide minimum 2 week notice for any shutdowns; arrange work to minimize shutdown duration. Coordinate with Departmental Representative

1.7 COST BREAKDOWN

- .1 Before submitting the first progress claim, submit a breakdown of the Contract price in detail as directed by the Departmental Representative and aggregating Contract price. After approval, the cost breakdown will form the basis of progress payments.
- .2 General Contractor, Mechanical and Electrical Sub-Contractor should attend meetings with Departmental Representative, as required, to finalize the breakdown.

1.8 CODE, BYLAWS, STANDARDS

- .1 Perform work in accordance with the National Building Code of Canada (NBC) 2010, 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 one (1) copy each of the following at the job site:
 - .1 Contract drawings;
 - .2 Contract specifications;
 - .3 Addenda to Contract documents;
 - .4 Copy of work schedule;
 - .5 Reviewed shop drawings;
 - .6 Change orders;
 - .7 Other modifications to Contract;
 - .8 Field test reports;
 - .9 Reviewed samples;
 - .10 Manufacturer's installation and application instructions;
 - .11 One set of record drawings and specifications for "as-built" purposes;
 - .12 National Building Code of Canada 2010;
 - .13 Current construction standards of workmanship listed in technical sections;
 - .14 Building Safety Plan.

1.10 REGULATORY REQUIREMENTS

- .1 Building Permit
 - .1 There is no building permit requirement for this project.
- .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 to the requirements of the specification.

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.
 - .4 Coordinate with Departmental Representative for use of storage or work areas needed for operations under this Contract.
- .2 Perform work in accordance with Contract documents. Ensure work is carried out in accordance with approved schedules.
- .3 Do not unreasonably encumber site with material or equipment.

1.12 EXAMINATION

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

1.13 EXISTING SERVICES

- .1 Where Work involves breaking into or connecting to existing services, carry out work as directed in Section 01 14 00 – Work Restrictions.
- .2 Record locations of maintained, re-routed, and abandoned service lines.
- .3 Construct hoarding and barriers in accordance with Section 01 56 00 – Temporary Barriers and Enclosures.

1.14 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 his approval for actual location.
- .4 Submit field drawings or shop drawings to indicate the relative position of various services and equipment when required by the Departmental Representative and/or as specified.

1.15 CUTTING AND PATCHING

- .1 Cut existing surfaces as required to accommodate new work.
- .2 Remove items so shown or specified.
- .3 Do not cut, bore, or sleeve load-bearing members.
- .4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.
- .5 Fit work airtight to pipes, sleeves, ducts and conduits.
- .6 Conceal pipes, ducts and wiring in raised floors, wall, and ceiling construction of finished areas except where indicated otherwise.
- .7 Patch and make good surfaces cut, damaged, or disturbed, to Departmental Representative's approval. Match existing material, colour, finish, and texture.
- .8 “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.

1.16 SETTING OUT OF WORK

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

1.17 ACCEPTANCE OF SUBTRADES

- .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.

1.18 QUALITY OF WORK

- .1 Ensure that quality workmanship is performed through use of skilled tradesmen, under supervision of qualified journeyman.
- .2 The workmanship, erection methods and procedures to meet minimum standards set out in the National Building Code of Canada 2010 and Construction Standards as specified herein.
- .3 In cases of dispute, decisions as to standard or quality of work rest solely with the Departmental Representative, whose decision is final.
- .4 Quality of work shall in no case be of lesser standard compared to the existing.

1.19 WORKS COORDINATION

- .1 Coordinate work of sub-trades:
 - .1 Designate one person to be responsible for review of contract documents and shop drawings and managing coordination of Work.
- .2 Convene meetings between subcontractors whose work interfaces and ensure awareness of areas and extent of interface required.
 - .1 Provide each subcontractor with complete plans and specifications for Contract, to assist them in planning and carrying out their respective work.
 - .2 Develop coordination drawings when required, illustrating potential interference between work of various trades and distribute to affected parties.
 - .1 Pay particularly close attention to overhead work above ceilings and within or near to building structural elements.
 - .2 Identify on coordination drawings, building elements, services lines, rough-in points and indicate location services entrance to site.
 - .3 Facilitate meeting and review 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, nor accountable for, extra costs incurred as a result of Contractor's failure to coordinate Work.
- .6 Maintain efficient and continuous supervision.

1.20 APPROVAL OF SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

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

1.21 PROJECT MEETINGS

- .1 Contractor shall arrange project meetings and assume responsibility for setting times and distributing minutes.
- .2 The contractor shall provide the meeting facilities, record the meeting minutes and issue a meeting agenda three (3) days prior to the meeting to Departmental Representative for review.

1.22 TESTING AND INSPECTION

- .1 Particular requirements for inspection and testing to be carried out by testing service or laboratory approved by the Departmental Representative are specified in Sections 01 45 00 – Quality Control.
- .2 The Contractor will appoint and pay for the services of testing agency or testing laboratory as specified, and where required for the following:
 - .1 Inspection and testing required by laws, ordinances, rules, regulations, or orders of public authorities.

- .2 Inspection and testing performed exclusively for Contractor's convenience.
- .3 Testing, adjustment, and balancing of mechanical and electrical equipment and systems.
 - .1 Mill tests and certificates of compliance.
 - .2 Tests specified in the contract documents to be carried out by Contractor which may be under the Departmental Representative's supervision.
- .3 Within 15 working days after Contract award provide a list of proposed testing services or testing laboratories for Departmental Representative's approval.
- .4 The Departmental Representative may require, and pay for, additional inspection and testing services not included in paragraph 1.22.2.
- .5 Where tests or inspections by designated testing laboratory reveal work is not in accordance with the Contract requirements, Contractor shall pay costs for additional tests or inspections as the Departmental Representative may require to verify acceptability of corrected work.
- .6 Contractor shall furnish labour and facilities to:
 - .1 Notify Departmental Representative in advance of planned testing.
- .7 Where materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.
- .8 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by Departmental Representative.
- .9 Provide Departmental Representative with two (2) copies of testing laboratory reports as soon as they are available.

1.23 AS-BUILT DOCUMENTS

- .1 Keep one set of current white prints of all contract drawings and all addenda, revisions, clarifications, change orders, and reviewed shop drawings in the site office; and have them available at all times for inspection by the Consultant.
- .2 As the 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.
- .3 At completion of the Work, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change order, to a set of Issued for Construction drawings. Submit the 'red-marked' as-built set to the Owner, in hard copy and in PDF.
- .4 Arrange for and be responsible for the preparation of as-built drawings in AutoCAD computerized drafting system. Be responsible for the cost of preparation of as-built drawings. Submit electronic copy of the as-built drawings on CD/DVD media in CAD and PDF format, as well as 2 sets of hard copies. Submit as-built drawings before requesting Substantial Completion.
- .5 Refer to Section 01 78 00 – Close-out Submittals.

1.24 CLEANING

- .1 Refer to Section 01 74 11 - Cleaning.

1.25 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 and equipment within work area with 0.102 mm thick 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.

1.26 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.

1.27 MAINTENANCE MATERIALS, SPECIAL TOOLS AND SPARE PARTS

- .1 Specific requirements for maintenance materials, tools and spare parts are specified in individual technical sections of specifications.

1.28 ADDITIONAL DRAWINGS

- .1 Contractor can obtain and Download Tender Documents from Buy&Sell website, and print the documents as needed.
- .2 The Departmental Representative may furnish additional drawings for clarification. These additional drawings have the same meaning and intent as if they were included with drawings referred to in the Contract Documents. Such documents will also be available on Buy&Sell website.

1.29 BUILDING SMOKING ENVIRONMENT

- .1 Smoking within the building and within 7.5m of all air intakes is not permitted.
- .2 A 'No Smoking' sign to be put up by Contactor.

1.30 SYSTEM OF MEASUREMENT

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

1.31 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.

1.32 SECURITY REQUIREMENTS

- .1 Refer to Section 01 14 00 – Work Restrictions.

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.

1.34 SUBSTANTIAL COMPLETION

- .1 Substantial Completion of work will only apply after all phases are complete, connection of all equipment and piping, the new systems are commissioned and functional, and confirmed that all systems are operational for commissioning by the Departmental Representative.
- .2 All submissions shall be complete prior to requesting Substantial Performance.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .1 Connecting to existing services.
- .2 Special scheduling requirements.

1.2 RELATED SECTIONS

- .1 Section 01 56 00 - Temporary Barriers and Enclosures.

1.3 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 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions to a minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for unobstructed pedestrian and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
- .5 Particular care and coordination is required to maintain condenser water loop (particularly process side) operational at all times. Maximum shutdown permitted is four (4) hours at a time. Coordinate with Departmental Representative if multiple shutdowns are required; timing shall be coordinated with PARC staff to minimize disruption to ongoing work in process areas and labs, which is supported by the condenser water loop. Arrange work to minimize the required drain down.

1.4 SPECIAL REQUIREMENTS

- .1 Paint public or staff occupied areas Monday to Friday from 1800 to 0700 hours only and on Saturdays, Sundays, and statutory holidays. Coordinate with Departmental Representative.
- .2 Carry out noise generating Work (such as drilling and coring building structures or similar noise level generating work) Monday to Friday from 1800 to 0700 hours and on Saturdays, Sundays, and statutory holidays. Coordinate with Departmental Representative.
- .3 Contractor shall only work on the areas for which the construction works are scheduled, and the testing and commissioning are required to perform before occupancy. Refer to Sections 01 11 00 - Summary of Work for the stages and phases of construction.
- .4 Contractor and sub-contractors shall undergo security screening.
- .5 Maintain an acceptable indoor environmental quality during construction. Apply measures such as:
 - .1 Prevention of the construction dust from spreading into the laboratory or other spaces;

- .2 Pressure differential is to be maintained between the construction and the occupied zones;
- .3 Fire protection;
- .4 Prevention of fumes from welding or cutting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .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.

1.2 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.

1.3 PRE-CONSTRUCTION MEETING

- .1 Within 10 days after award of Contract, Departmental Representative will arrange pre-construction meeting.
- .2 Departmental Representative, Contractor and representatives from Agriculture and Agri-Food Canada (AAFC) 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, AAFC representatives, and consultants.
 - .2 Communication protocol for submittals.
 - .3 Start date on site.
- .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.

1.4 PROJECT PLANNING

- .1 Plan construction activities, submittals, and field reviews ahead of time for efficient and effective management to ensure timely completion of project.
- .2 Contractor to provide two (2) weeks look ahead schedule at every bi-weekly site meeting.

1.5 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 two (2) weeks after Pre-Construction meeting.
- .3 During progress of Work, revise and resubmit as directed by Departmental Representative.

1.6 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 and approval of minutes of previous meeting;
 - .2 Review of Work progress since previous meeting;
 - .3 Review work to be carried out until the next meeting;
 - .4 Field observations, problems, conflicts;
 - .5 Review of Health and Safety including any incidents, near misses, and WorkSafe BC visits;
 - .6 Problems which impede construction schedule;
 - .7 Review of off-site fabrication delivery schedules;
 - .8 Corrective measures and procedures to regain projected schedule;
 - .9 Revision to construction schedule;
 - .10 Progress schedule, during succeeding work period;
 - .11 Review submittal schedules: expedite as required;
 - .12 Update of Red Line As-Built Drawings;
 - .13 Maintenance of quality standards;
 - .14 Review proposed changes for effect on construction schedule and on completion date;
 - .15 Other business.

1.7 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 five (5) days of field review.

1.8 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.

1.9 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.
- .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 PARC. 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, Sub-contractor, 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, AAFC representatives.
- .3 Departmental Representative to establish time and location of pre-construction meeting, Contractor to notify parties concerned a minimum of four (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 Utilities.
 - .5 EGD Security requirements.
 - .6 Site safety in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .7 Communication Protocol for proposed changes, change orders, procedures, 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, AAFC representatives, 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 a 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 AAFC;
 - .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 Architectural,
 - .2 Mechanical,
 - .3 Electrical;
 - .4 Structural;
 - .5 Civil.
 - .10 Change order log review;
 - .11 Review submittal schedule;
 - .12 Review updated as-builts;
 - .13 Review and resolve site issues;
 - .14 New business.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

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

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 When specified in the Contract document, submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia of Canada.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

- .4 Allow 10 days for Departmental Representative's review of each submission, unless noted otherwise.
- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in shop drawings as Departmental Representative may require consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 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.
- .8 Submissions 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.
- .9 After Departmental Representative's review, distribute copies.
- .10 Submit electronic copy of shop drawings for each requirement requested in specification sections and as Departmental Representative may reasonably request.

- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies of test reports for requirements requested in specification sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of manufacturer's instructions for requirements requested in specification sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit copies of Manufacturer's Field Reports for requirements requested in specification sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative no errors or omissions are discovered or if only minor corrections are made, electronic copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of Construction and Contract Documents.

- .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of Work of sub-trades.
- .22 Shop drawings format larger than 11" x17" (275mm x 430mm) must be submitted with hardcopies together with electronic format. Submit sufficient copies such that Departmental Representative will be provided with five (5) copies plus contractor's distribution and maintenance manual.
- .23 Electronic submissions will only be reviewed and returned electronically. No hardcopies will be returned to contractor.
- .24 All electronic submissions to be uploaded to Document Control System FTP site hosted by PWGSC.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as required in respective specification sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's business address.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern, or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will be kept onsite and will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

- .1 Erect mock-ups in accordance with Section 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography in jpg format, standard resolution monthly with progress statement and as directed by Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Viewpoints and their locations as reasonably determined by Departmental Representative.
- .4 Provide photographic documentation of adjacent existing conditions prior to commencement of construction for determining and accidental damage as a result of contractor's work.

- .5 Frequency of photographic documentation: monthly as directed by Departmental Representative.
- .1 Upon completion of: demolition, framing and services before concealment of Work, and as directed by Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

- .1 Submit electronic copies of test results and inspection reports required as noted in each section of specifications.

END OF SECTION

Part 1 General

1.1 SPECIAL PROCEDURES

- .1 All procedures listed in the following section are designed as a minimum standard that the Contractor must achieve, and all work procedures submitted to the Departmental Representative will be reviewed against the following.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 RESTRICTED ACCESS

- .1 Areas of the facility are subject to access restrictions.
- .2 When access is required to such areas, coordinate with Departmental Representative and follow directions and instructions from Departmental Representative.

3.2 ARCHAEOLOGICAL / HISTORICAL FINDS

- .1 Give immediate notice to the Departmental Representative if evidence of archaeological / historical finds are encountered during excavation/construction and await Departmental Representative written instructions before proceeding with work in this area.

3.3 WASTE DISPOSAL PROCEDURE

- .1 Requirements
 - .1 All non-metal and non-glass waste will be transported and disposed of in accordance with the requirements of the Transportation of Dangerous Goods Act, the BC Ministry of Water Lands and Air Protection, and all other applicable regulations.
 - .2 Any materials stored on site will be stored in an isolated and secure area. The secure area shall be restored to the condition it was before. This area shall be adjacent to the pesticide storage area at the secondary staging area. Contractor shall provide fencing and devices to secure this area.

3.4 ALTERNATIVE PROCEDURES

- .1 General Requirements
 - .1 Procedures described in this specification are to be utilized at all times.
 - .2 If the specified procedures cannot be utilized, a request must be made in writing to the Departmental Representative providing details of the problems encountered and recommended alternatives.
 - .3 Alternative procedures shall provide equivalent or greater protection than procedures they replace.
 - .4 Any alternative procedure must be approved in writing by the Departmental Representative prior to its implementation.

3.5 SAFE WORK PROCEDURES

- .1 Refer to the enclosed Appendix for Safe Work Procedures at PARC Summerland.

END OF SECTION

Safe Working Procedures for Contractors when working at a AAFC Laboratory

*All work in the Facility is to be carried out in a safe and responsible manner as outlined in the following documentation and all work practices shall follow both the Canada Labour Code Part II and the Provincial Occupational Health and Safety Code.
* note: The more stringent code shall prevail and be adhered to.*

CONTRACTORS CREWS ARE NOT ALLOWED OUT OF THE DESIGNATED WORK AREA OR INSIDE ANY OF THE BUILDINGS WITHOUT PRIOR APPROVAL OF P.A.R.C.; SUMMERLAND STAFF.

1. Laboratory Safety:

- < *The contractor is obliged to obey all of the Laboratories safety rules (site specific and industry standard). At no time shall the activities of the contractor compromise the safety of the building occupants or the physical contents of the building. It is the contractors responsibility to post sufficient signage warning others of potential hazards from work they may be performing. Maintain all means of egress and fire exits at all times.*
- < *Site specific safety rules include the wearing of approved footwear, safety glasses, personal protective equipment, wearing of lab coats when working in laboratory area's and familiarising yourself with biological and chemical hazards that may be present in the work area.*
- < *Identify the location of the nearest eyewash / shower unit, if working in a room with one in it, for your personal protection.*

2. Contractors Responsibility:

- < *It is the contractor's responsibility to provide their employees adequate training for the duties they are performing and that they are properly supervised during such duties while on our site. If your contract and work involves subcontracting any part of the Scope of Work, a representative from the contractors' firm must accompany any sub-trades and be responsible for their actions at all times while onsite.*

3. Emergency Response / Fire:

- < *If fire occurs as a result of the work you are performing immediately activate the nearest fire alarm pull station, call for help, notify the Fire Dept. (Call 9- 911), tell them you are at the Agriculture and Agri-Food Canada, 4200 Highway 97, Summerland, B.C. then exit the building.*
- < *If the fire can be put out safely without endangering the safety of yourself or the safety of others, attempt to extinguish the fire using the nearest fire extinguisher. Report all fires.*
- < ***FIRE ALARMS;** If you hear the fire alarm, please proceed to the nearest available exit and proceed to the south parking lot where you will wait until clearance is given to enter the facility. In the case of fire drills, you will be notified that there is one scheduled and you will follow the same rules as above.*

- < *Observe the location of the nearest fire exit, if you are not sure of the location please ask for assistance.*
- < *If working with flammable materials please ensure you are aware of the nearest fire extinguisher and fire alarm pull station.*
- < *24 hours advance notice is required for taking fire alarm / sprinklers system off line.*
- 4. **First Aid:**
 - < *Is the responsibility of the contractor.*
- 5. **Laboratories Operations:**
 - < *Do not enter the laboratories unless you have been given authorization to do so from the Facility Manager or the person in charge of the Laboratory, (indicated on each room door).*
 - < *All "utility" shutdowns (hydro / gas / water / steam / heating / cooling / air / lighting / etc) must be previously arranged for and agreed to by the Facility Manager. Any valves, switches, etc that must be closed or opened from their normal position must be clearly tagged stating (position / source / contact person / date) A minimum of 72 hours written notice is required for utility shutdowns that will effect operations unless mutually agreed upon previously.*
 - < *Do not shut off any services that may effect these labs, unless you have received the proper authorization to do so. There are many different tests and projects being carried out in this Laboratory which could be affected by unscheduled power outages, waters shut offs, etc. please be careful when conducting work in or outside of the Facility, if you are not sure if something will be affected by your work, please double check with the Facility Manager*
 - < *Gas cylinders, solvents, corrosives etc. are occasionally transported in the corridors by the Laboratory staff, please be careful when transporting items in the corridors.*
- 6. **Welding / Soldering / Open flames / Fumes / Impact tools / X-Ray:**
 - < *Advise the responsible site authority when any of the above will be done so that necessary safety precautions may be taken. If inconvenience to programs are expected the work will have to be scheduled for after hours.*
 - < *When welding in the Facility please ensure there are no embers simmering in the area before you leave, the area must be watched for a minimum of 30 minutes after welding or torching is completed. A fire extinguisher is to be near by the area where welding or torching is taking place.*
 - < *No welding is to be done after 2pm on any day without prior approval from Facility Manager.*
 - < *Proper protection from welding rays must be maintained during all welding procedures.*
 - < *Gas cylinders are to transported inside the facility in a safe and secure manner.*
 - < *Hot work permit must be issued by the maintenance department prior to any welding or torching in the building.*
- 7. **Hours of Work and Facility Security:**
 - < *Locked keyed doors will be opened on request by the Facility Manager or his staff if necessary. The hours of work will be from 8:00 am to 16:00 hrs. Monday to Friday, unless specified otherwise. For the work being done on the roof, the hours will be approved by the Facility Manager.*
 - < *Submit the full name, address, Social Insurance Number (SIN) and birth date of all persons to be working on the site. Follow the "Sign-in / Sign-out" procedures daily.*
 - < *No person shall be permitted on site who has not received security clearance and has been signed "in".*

< *At no time shall contractors staff compromise the security of the building or its occupants. Doors shall not be propped open, contractors are prohibited from allowing unauthorized people access to the building. Contractors are required to remain in the immediate "work area" that they are assigned to and are not permitted to wander throughout the facility. Escorted tours can be arranged upon request.*

8. **Miscellaneous Items:**

< *Cafeteria is not for contractors use. Eating and drinking is not permitted in any area of the building except agreed designated areas.*

< *WHIMIS, The contractor must have on-site and provide to site authority manufacturers WHIMIS sheets for all materials being used on this site, before they are brought on to the property.*

< *Use of telephones, Contractors are not permitted use of any telephones, (local or long distance) with the only exception being emergency use to call 9-911*

< *All job site activities must be coordinated with the site authority and all other trades / contractors working on the site.*

< *Contractors must clean up after themselves daily, (this includes emptying any garbage cans filled by you) this will not be done by the facility staff. Disposal of flammables, corrosives, hazardous waste, etc. are to be done in strict accordance with local and Federal environmental regulations, if you are unaware of the procedure please contact the Facility Manager. Removal of debris and scrap from the hallways and lab areas needs to be done promptly, material is not to be left in the hallways for any length of time, also access to fire exits, extinguishers and safety equipment is to be kept clear at all times. Please avoid the creation of tripping hazards when working, if unavoidable please mark them so they are clearly visible. Salvage items such as fume hood removal or transportation of lab ducting must be sealed in an airtight manner and promptly relocated to an agreed storage area.*

< *Smoking: Agriculture and Agri-Food Canada strictly prohibit's smoking inside any buildings.*

< *Laboratory Hazardous Substances: Please note that some laboratories may contain the following hazardous substances, follow laboratory protocol specific to the hazard. Wash hands prior to exiting all labs using provided antibacterial hand soap.*

- *Bio Hazardous Pathogens (Level II organisms)*

- *Radioactive Substances*

- *Halogenated and Non Halogenated solvents*

- *Carcinogens*

- *Acids*

- *Compressed gases*

< *Contractors parking: Parking is available for contractors in the designated visitors parking area south of main building. There is to be no other parking on site, with the exception of the contractors work area in the east parking lot. Public access and fire routes must be maintained at all times.*

- < Shipping & Receiving: *If you have materials / tools to bring on-site notify delivery people on how to get to the contractors work/delivery area. All shipping/receiving for contractors will not be accepted through AAFC Stores.*
- < Washrooms: *Washrooms will be available on the 2nd level and shall be monitored for tidiness; subject to Facility Managers acceptance.*
- 1. **Labour Code Items:**
- < Workman's Compensation Board
- < *Prior to award of contract furnish Agriculture and Agri-Food Canada with a valid copy of your WCB certificate valid for the duration of the contract.*
- < Permits
*It is the responsibility of the contractor to obtain and pay for all necessary permits in accordance with Federal, Provincial and Municipal bylaws and regulations. *All permits must be posted on-site prior to starting work and must remain posted until completion.*
- < Contractor Safety Plan
Prior to commencing work provide a copy of your companies "safety plan" specific to the work being done on-site for review by PWGSC, and AAFC
- < Lockouts
Provide a copy of procedures to be used by your employees to de-energize any energy sources to a state of zero energy prior to working on that piece of equipment.
- < Site Locates
It is the contractors responsibility to arrange for all necessary "site locates" before excavating.
- < Competent Employees's and Subcontractors
Any workers being assigned to work at this site must be "competent" in respect to their trade discipline, having complete knowledge of health and safety regulations and acceptable industry trade practices.

- 10. **Site Authority / Facility Manager:**
- < *For the purposes of this document / contract the owners representative / site authority shall be:
Ed Helfenbein, Facility Manager. If the Facility Manager is unavailable please try his cell / 250-770-0796. Alternate contact person will be Paul Buddingh; cell/ 250-770-0832.*

Note: It is the General Contractors responsibility to ensure all their employees's that work on this site along with any Sub-Contractors and their employees that work on this site are fully aware of these documents.

11. Confidentiality agreement:

As a contractor of Agriculture and Agri-Food Canada - Pacific Agri Food Research Centre, Summerland "I agree not to disclose to any person, any confidential information or documentation through my employment or affiliation, except with prior written permission of the Director of AAFC or as required by law"

12. *I have read and understood the Safe Working Procedures for Contractors document as above for the Pacific Agri-Food Research Centre, Summerland*

Facility Manager: _____ *Date:* _____

Contractor Representative Signature: _____ *Date:* _____

Printed Name: _____ *Company/Affiliation:* _____

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 51 00 - Temporary Utilities
- .3 Section 01 56 00 - Temporary Barriers and Enclosures

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 affected by submittal shall not proceed until review is complete.
- .3 Submit the following:
 - .1 Health and Safety Plan.
 - .2 Copies of reports or directions issued by Federal and Provincial health and safety inspectors.
 - .3 Copies of incident and accident reports.
 - .4 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Material Information System (WHMIS) requirements.
 - .5 Emergency Procedures.
- .4 The Departmental Representative will review the Contractor's site-specific project Health and Safety Plan and emergency procedures, and provide comments to the Contractor within two (2) days after Receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.
- .5 Medical surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of work, and submit additional certifications for any new site personnel to Departmental Representative.
- .6 Submission of the Health and Safety Plan, and any revised version, to the Departmental Representative is for information and reference purposes only. It shall not:
 - .1 Be construed to imply approval by the Departmental Representative;
 - .2 Be interpreted as a warranty of being complete, accurate and legislatively compliant;
 - .3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

1.6 RESPONSIBILITY

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

- .2 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .3 Comply with and enforce compliance by employees with safety requirements of Contract documents, applicable Federal, Provincial, Territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.7 HEALTH AND SAFETY COORDINATOR

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

1.8 GENERAL CONDITIONS

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

1.9 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.

1.10 WORK PERMITS

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

1.11 FILING OF NOTICE

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

1.12 HEALTH AND SAFETY PLAN

- .1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.
- .2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:
 - .1 Primary requirements:
 - .1 Contractor's safety policy.
 - .2 Identification of applicable compliance obligations.
 - .3 Definition of responsibilities for project safety/organization chart for project.
 - .4 General safety rules for project.
 - .5 Job-specific safe work, procedures.
 - .6 Inspection policy and procedures.
 - .7 Incident reporting and investigation policy and procedures.
 - .8 Occupational Health and Safety Committee/Representative procedures.
 - .9 Occupational Health and Safety meetings.
 - .10 Occupational Health and Safety communications and record keeping procedures.
 - .2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.
 - .3 List hazardous materials to be brought on site as required by work.
 - .4 Indicate Engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
 - .5 Identify personal protective equipment (PPE) to be used by workers.
 - .6 Identify personnel and alternates responsible for site safety and health.
 - .7 Identify personnel training requirements and training plan, including site orientation for new workers.
- .3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.
- .4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.
- .5 Departmental Representative's review: the review of Health and Safety Plan by Public Works and Government Services Canada (PWGSC) shall not relieve the Contractor of responsibility for errors or omissions in final Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

1.13 EMERGENCY PROCEDURES

- .1 List standard operating procedures and measures to be taken in emergency situations. Include an evacuation plan and emergency contacts (i.e. names/telephone numbers) of:

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

1.14 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."
- .3 Provide adequate means of ventilation in accordance with Section 01 51 00.

1.15 ASBESTOS HAZARD

- .1 In case of discovery of any suspected asbestos containing material during demolition, inform Departmental Representative and, carry out work or demolition activities involving asbestos in accordance with applicable Provincial regulations.

1.16 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.

1.17 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.
- .2 Before undertaking any work, coordinate required energizing and de-energizing of new and existing circuits with Departmental Representative.
- .3 Maintain electrical safety procedures and take necessary precautions to ensure safety of all personnel working under this Contract, as well as safety of other personnel on site.

1.18 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.

1.19 OVERLOADING

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

1.20 CONFINED SPACES

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

1.21 POWDER-ACTUATED DEVICES

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

1.22 FIRE SAFETY AND HOT WORK

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

1.23 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.

1.24 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.

1.25 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.

1.26 POSTED DOCUMENTS

- .1 Post legible versions of the following documents on site:
 - .1 Health and Safety Plan.
 - .2 Sequence of work.
 - .3 Emergency procedures.
 - .4 Site drawing showing project layout, locations of the first-aid station, evacuation route and marshalling station, and the emergency transportation provisions.
 - .5 Notice of Project.
 - .6 Floor plans or site plans.
 - .7 Notice as to where a copy of the Workers' Compensation Act and Regulations are available on the work site for review by employees and workers.
 - .8 Workplace Hazardous Materials Information System(WHMIS) documents.

- .9 Material Safety Data Sheets (MSDS).
- .10 List of names of Joint Health and Safety Committee members, or Health and Safety Representative, as applicable.
- .2 Post all Material Safety Data Sheets (MSDS) on site, in a common area, visible to all workers and in locations accessible to tenants when work of this Contract includes construction activities adjacent to occupied areas.
- .3 Postings should be protected from the weather, and visible from the street or the exterior of the principal construction site shelter provided for workers and equipment, or as approved by the Departmental Representative.

1.27 MEETINGS

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

1.28 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 SECTION INCLUDES:

- .1 References and Codes.
- .2 Discovery of Asbestos (if any).

1.2 PRECEDENCE

- .1 Refer to General Conditions clauses.

1.3 REFERENCES AND CODES

- .1 Perform Work in accordance with National Building Code of Canada (NBC) including all amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 New construction works shall meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.
 - .3 British Columbia Building Code 2012.
 - .4 National Building Code of Canada 2010.
 - .5 National Plumbing Code of Canada 2010.
 - .6 Labour Canada Code Part II.
 - .7 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - .8 Occupational Safety and Health Standards.
 - .9 Treasury Board Guidelines.
 - .10 Health Canada Laboratory Biosafety Guidelines – 2004.
 - .11 ANSI/AIHA Z9.5-1992 – American National Standard for Laboratory Ventilation.
 - .12 NFPA 30 - 2012 – Use, handling and storage of flammable and combustible liquids.
 - .13 NFPA 45 – 2011 – Standard on Fire Protection for Laboratories Using Chemicals.

1.4 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions.

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative will order 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, Departmental Representative shall pay cost of examination and replacement.

1.2 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Departmental Representative.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and re-inspection.

1.3 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Cooperate to provide reasonable facilities for such access.

1.4 PROCEDURES

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.

- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.5 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental
- .2 Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .3 Make good other Contractor's work damaged by such removals or replacements promptly.
- .4 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

1.6 REPORTS

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

1.7 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Departmental Representative and may be authorized as recoverable.

1.8 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Departmental Representative as specified in specific Section.
- .3 Prepare mock-ups for Departmental Representative review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, Departmental Representative will assist in preparing schedule fixing dates for preparation.

- .6 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed.
- .7 Provide a mock-up (sample) of the following pre-insulated pipe components:
 - .1 A pie weld (weld left exposed) with min. 0.6 m [2 ft] of pipe on each end; minimum 0.3 m [1 ft] of pre-insulated insulation with jacket to remain at each end of the sample.
 - .2 A welded joint with jacket seal kit installed; sample will have min 1.5 m [5ft] of piping at each end of the joint.
 - .3 Sample of unfinished joint kit.
 - .4 Hand over mock-ups to Departmental Representative. Refer to Section 23.21 13.04 (Steel pre-insulated piping).

1.9 MILL TESTS

- .1 Submit mill test certificates as requested.

1.10 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical, and building equipment systems.
- .2 Refer to Divisions 21, 22, 23, 25, 26, and 27 for definitive requirements.

END OF SECTION

Part 1 General

1.1 ACCESS AND DELIVERY

- .1 Only the designated entrance may be used for personnel access to the site.
- .2 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.
- .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 is allowed to park in the designated stalls at the facility parking lot. Departmental Representative will have full discretion of the assignment of the number of stalls. Assigned stalls may not be sufficient to meet construction staff requirement.

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.

1.4 POWER

- .1 Subject to coordination with Departmental Representative, electrical power within the facility may be used at no extra cost. There is no guarantee of uninterrupted power supply. Contractor will use this power source at their own risk. Contractor will not be compensated for any incurred cost or time owing to any power failure. Contractor will be responsible for other power source as they consider to be required for completing the project. Contractor will be responsible for all the cost of connecting and disconnecting from this power source after completion of project to the satisfaction of the Departmental Representative.
- .2 Contractor to supply his own compressed air for the duration of the contract.

1.5 WATER SUPPLY

- .1 Water supply is available for use by Contractor.

1.6 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 the facility washrooms.

1.7 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.

1.8 SCAFFOLDING

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

1.9 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.

1.10 HOARDING

- .1 Prior to all demolition and construction, install dust proof hoarding or protective barrier to separate construction zone and the rest of the operating facility; 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 Make good all floor, ceiling and wall to their original condition after removal of hoarding at completion of project.

1.11 SITE OFFICE

- .1 Contractor to provide their own trailer as temporary site office. Coordinate with Departmental representative for exact location.

- .2 Contractor should clear and demolish site office at end of project according to contract requirement.

1.12 REMOVAL OF TEMPORARY FACILITIES

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

1.13 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.

1.14 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.

1.15 USE OF EXISTING UTILITIES

- .1 It is the intention of the Departmental Representative to supply temporary services where specified, however, in the event of any unforeseen occurrence, the Departmental Representative may discontinue such temporary service, without notice, and without acceptance of any liability, for damage or delay, caused by such withdrawal of temporary services.
- .2 Supply of temporary services by Department Representative is subject to the requirements of the facility and level of availability of existing services.
- .3 Contractor shall bear costs of all temporary services required for the project, subject to approval by Departmental Representative those available from existing services.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
 - .2 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-O121-M1978 (R2003, Douglas Fir Plywood.
- .3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.3 HOARDING

- .1 Refer to Section 01 51 00 - Temporary Utilities, Clause 1.10.

1.4 ACCESS TO SITE

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

1.5 FIRE ROUTES

- .1 Maintain access to property including overhead clearances for use by emergency response vehicles.
- .2 Maintain clearance for all egress routes.

1.6 PROTECTION OF OFF-SITE AND PUBLIC PROPERTY

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

1.7 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 Protect existing operating equipment within the project area
- .4 Be responsible for damage incurred due to lack of or improper protection.

1.8 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 PRODUCTS/MATERIAL AND EQUIPMENT

- .1 Use NEW products/material and equipment unless otherwise specified. The term "products" is referred to throughout the specifications.
- .2 Use products of one manufacturer for material and equipment of the 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's instructions. Departmental Representative will designate which document is to be followed.
- .5 Provide metal fastenings and accessories in the 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.
 - .3 Fastenings which cause spalling or cracking are not acceptable.
 - .4 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
 - .5 Use heavy hexagon heads, semi-finished unless otherwise specified.
 - .6 Bolts may not project more than 1 diameter beyond nuts.
 - .7 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.
 - .8 Deliver, store, and maintain packaged material and equipment with manufacturer's seals and labels intact.
 - .9 Prevent damage, adulteration and soiling of products during delivery, handling and storage. Immediately remove rejected products from site.
 - .10 Store products in accordance with suppliers' instructions.
 - .11 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 shall be new, not damaged or defective, and of the best quality (compatible with the specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of the 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 the requirements of the specifications. Produce documents when requested by the Departmental Representative.
 - .4 Should any dispute arise as to quality or fitness of products, the decision rests strictly with the Departmental Representative based upon the requirements of the Contract documents.
 - .5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the 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 the 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 the work.
- .3 In event of failure to notify Departmental Representative at the start of work and should it subsequently appear that the work may be delayed for such reason, the Departmental Representative reserves the right to substitute more readily available products of similar character, at no increase in either the Contract price or the Contract time.

1.4 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in the specifications, install or erect products in accordance with the manufacturer's instructions.
 - .1 Do not rely on labels or enclosures provided with products.
 - .2 Obtain written instructions directly from the manufacturer.
- .2 Notify Departmental Representative in writing of conflicts between the specifications and the manufacturer's instructions so that the Departmental Representative may establish the course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Departmental Representative to require removal and reinstallation at no increase in either the Contract price or the 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": select any one of the indicated manufacturers, or any other manufacturer meeting or exceeding the Prescriptive specifications and indicated Products.
- .3 Products specified by performance and referenced standard: select any product meeting or exceeding the 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 a referenced standard or by or Performance specifications, upon request of Departmental Representative obtain from manufacturer an independent laboratory report showing that the product meets or exceeds the specified requirements.

1.6 SUBSTITUTION AFTER CONTRACT AWARD

- .1 No substitutions are permitted without prior written approval of the 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 the proposed substitution.
- .3 Proposals will be considered by the 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 the attention of and considered by Departmental Representative as equivalent to the product specified, and will result in a credit to the 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 the project. Pay for design or drawing changes required as result of substitution.
 - .5 Amounts of all credits arising from approval of the substitutions will be determined by the Departmental Representative and the Contract price will be reduced accordingly.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 A set of construction drawings of existing Mechanical Room in PDF format are available for viewing and reference only upon request. The set of drawings may not be full completed set and do not necessarily represent as-built conditions. All existing conditions measurements need to be verified on site.

1.2 QUALIFICATIONS OF SURVEYOR

- .1 Qualified registered land surveyor, licensed to practice in the Province of British Columbia, acceptable to Departmental Representative.

1.3 EXISTING SERVICES

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.
- .2 Contractor is responsible to provide GPR Survey of existing services as required to verify existing underground condition prior to excavation.

1.4 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 manufacturers' 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.

1.5 RECORDS

- .1 Maintain a complete, accurate log of control and survey work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles, and elevations of Work.
- .3 Record locations of maintained, re-routed, and abandoned service lines.

1.6 SUBMITTALS

- .1 Submit name and address of Surveyor to Departmental Representative.
- .2 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.
- .3 Submit certificate signed by surveyor certifying and noting those elevations and locations of completed Work that conform and do not conform to Contract Documents.

1.7 SUBSURFACE CONDITIONS

- .1 Promptly notify Departmental Representative in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
- .2 After prompt investigation, should Departmental Representative determine that conditions do differ materially, instructions will be issued for changes in Work as provided in Changes and Change Orders.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .3 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 Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.

1.2 MATERIALS

- .1 Required for original installation.
- .2 Change in Materials: submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.

1.3 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 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

Part 2 Execution

2.1 GENERAL

- .1 Execute cutting, fitting, and patching, including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.
- .10 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00 - Firestopping, full thickness of the construction element.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.
- .14 Provide GPR scan to concrete slab prior to demolition to defect any underslab services.

2.2 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: 2020, Title: General Conditions. In Effect as Of: April 25, 2013.

1.2 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .3 Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .7 Dispose of waste materials and debris off site.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.3 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris including that caused by Owner or other Contractors.

- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, millwork floors and ceilings.
- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep gutters.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .19 Remove snow and ice from access to buildings.

1.4 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 WASTE MANAGEMENT GOALS

- .1 Prior to start of Work conduct meeting with Departmental Representative to review and discuss PWGSC's Waste Management Plan and Goals.
- .2 Accomplish maximum control of solid construction waste.
- .3 Preserve environment and prevent pollution and environment damage.

1.2 DEFINITIONS

- .1 Class III: non-hazardous waste - construction renovation and demolition waste.
- .2 Cost/Revenue Analysis Workplan (CRAW): based on information from WRW, and intended as financial tracking tool for determining economic status of waste management practices.
- .3 Demolition Waste Audit (DWA): relates to actual waste generated from project.
- .4 Inert Fill: inert waste - exclusively asphalt and concrete.
- .5 Materials Source Separation Program (MSSP): consists of series of ongoing activities to separate reusable and recyclable waste material into material categories from other types of waste at point of generation.
- .6 Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.
- .7 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.
- .8 Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- .9 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:
 - .1 Salvaging reusable materials from re-modeling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
 - .2 Returning reusable items including pallets or unused products to vendors.
- .10 Salvage: removal of structural and non-structural materials from deconstruction/dis-assembly projects for purpose of reuse or recycling.
- .11 Separate Condition: refers to waste sorted into individual types.
- .12 Source Separation: acts of keeping different types of waste materials separate beginning from first time they became waste.
- .13 Waste Audit (WA): detailed inventory of materials in building. Involves quantifying by volume/weight amounts of materials and wastes generated during construction, demolition, deconstruction, or renovation project. Indicates quantities of reuse, recycling and landfill. Refer to Schedule A.

- .14 Waste Management Coordinator (WMC): contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.
- .15 Waste Reduction Workplan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials. Refer to Schedule B. WRW is based on information acquired from WA (Schedule A).

1.3 DOCUMENTS

- .1 Maintain at job site, one copy of following documents:
 - .1 Waste Audit.
 - .2 Waste Reduction Workplan.
 - .3 Material Source Separation Plan.
 - .4 Schedules A, B, C, D, E completed for project.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare and submit following prior to project start-up:
 - .1 Submit two (2) copies of completed Waste Reduction Workplan (WRW): Schedule B.
 - .2 Submit two (2) copies of completed Demolition Waste Audit (DWA): Schedule C.
 - .3 Submit two (2) copies of Materials Source Separation Program (MSSP) description.
- .3 Submit before final payment summary of waste materials salvaged for reuse, recycling or disposal by project using deconstruction/disassembly material audit form.
 - .1 Failure to submit could result in hold back of final payment.
 - .2 Provide receipts, scale tickets, waybills, and show quantities and types of materials reused, recycled, co-mingled and separated off-site or disposed of.
 - .3 For each material reused, sold or recycled from project, include amount quantities by number, type and size of items and the destination.
 - .4 For each material land filled or incinerated from project, include amount in tonnes of material and identity of landfill, incinerator or transfer station.

1.5 WASTE AUDIT (WA)

- .1 Conduct WA prior to project start-up.
- .2 Prepare WA: Schedule A.
- .3 Record, on WA - Schedule A, extent to which materials or products used consist of recycled or reused materials or products.

1.6 WASTE REDUCTION WORKPLAN (WRW)

- .1 Prepare WRW prior to project start-up.

- .2 WRW should include but not limited to:
 - .1 Destination of materials listed.
 - .2 Deconstruction/disassembly techniques and sequencing.
 - .3 Schedule for deconstruction/disassembly.
 - .4 Location.
 - .5 Security.
 - .6 Protection.
 - .7 Clear labelling of storage areas.
 - .8 Details on materials handling and removal procedures.
 - .9 Quantities for materials to be salvaged for reuse or recycled and materials sent to landfill.
- .3 Structure WRW to prioritize actions and follow 3R's hierarchy, with Reduction as first priority, followed by Reuse, then Recycle.
- .4 Describe management of waste.
- .5 Identify opportunities for reduction, reuse, and recycling of materials. Based on information acquired from WA.
- .6 Post WRW or summary where workers at site are able to review content.
- .7 Set realistic goals for waste reduction, recognize existing barriers and develop strategies to overcome these barriers.
- .8 Monitor and report on waste reduction by documenting total volume and cost of actual waste removed from project.

1.7 DEMOLITION WASTE AUDIT (DWA)

- .1 Prepare DWA prior to project start-up.
- .2 Complete DWA: Schedule C.
- .3 Provide inventory of quantities of materials to be salvaged for reuse, recycling, or disposal.

1.8 MATERIALS SOURCE SEPARATION PROGRAM (MSSP)

- .1 Prepare MSSP and have ready for use prior to project start-up.
- .2 Implement MSSP for waste generated on project in compliance with approved methods and as reviewed by Departmental Representative.
- .3 Provide on-site facilities for collection, handling, and storage of anticipated quantities of reusable and recyclable materials.
- .4 Provide containers to deposit reusable and recyclable materials.
- .5 Locate containers in locations, to facilitate deposit of materials without hindering daily operations.
- .6 Locate separated materials in areas which minimize material damage.

- .7 Collect, handle, store on-site, and transport off-site, salvaged materials in separate condition.

- .1 Transport to approved and authorized recycling facility.

1.9 STORAGE, HANDLING AND PROTECTION

- .1 Store materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal become Contractor's property.
- .3 Protect surface drainage, mechanical and electrical from damage and blockage.
- .4 Separate and store materials produced during dismantling of structures in designated areas.
- .5 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated facilities.
 - .1 On-site source separation is recommended.
 - .2 Remove co-mingled materials to off-site processing facility for separation.
 - .3 Provide waybills for separated materials.

1.10 DISPOSAL OF WASTES

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste, volatile materials, mineral spirits, oil, paint thinner, into waterways, storm, or sanitary sewers.
- .3 Keep records of construction waste including:
 - .1 Number and size of bins.
 - .2 Waste type of each bin.
 - .3 Total tonnage generated.
 - .4 Tonnage reused or recycled.
 - .5 Reused or recycled waste destination.
- .4 Remove materials from deconstruction as deconstruction/disassembly Work progresses.
- .5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in pre-demolition material audit.

1.11 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises.
- .2 Provide temporary security measures approved by Departmental Representative.

1.12 SCHEDULING

- .1 Coordinate Work with other activities at site to ensure timely and orderly progress of Work.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 APPLICATION

- .1 Do Work in compliance with WRW.
- .2 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

3.2 CLEANING

- .1 Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.
- .3 Source separate materials to be reused/recycled into specified sort areas.

3.3 DIVERSION OF MATERIALS

- .1 From following list, separate materials from general waste stream and stockpile in separate piles or containers, as reviewed by Departmental Representative, and consistent with applicable fire regulations.
 - .1 Mark containers or stockpile areas.
 - .2 Provide instruction on disposal practices.
- .2 On-site sale of salvaged recovered reusable and/or recyclable materials is not permitted.
- .3 Demolition Waste:

Material Type	Recommended Diversion %	Actual Diversion %
Acoustical Insulation	100	
Doors and Frames	100	
Electrical Equipment	80	
Mechanical Equipment	100	
Metals	100	
Rubble	100	
Wood (uncontaminated)	100	
Other		

- .4 Construction Waste:

Material Type	Recommended Diversion %	Actual Diversion %
Cardboard	100	
Plastic Packaging	100	
Rubble	100	
Steel	100	
Wood (uncontaminated)	100	
Other		

3.4 WASTE AUDIT (WA)

The following pertains to Schedule A - Waste Audit (WA). Column-1 refers to the category of waste, and a physical description of the material (e.g. off-cuts, clean drywall, etc.). Column-2 refers to the total quantity of materials received by the Contractor. Measurement units must be specified. Column-3 refers to the estimated percentage of material that is waste. Column-4 refers to the total quantity of waste (column-2 x column-3). Column-5 refers to the areas(s) in which the waste was generated. Column-6 refers to the total percentage of recycled material from the specified total quantity of waste (column-4). Column-7 refers to the total percentage of reused material from the specified total quantity of waste (column-4).

.1 Schedule A - Waste Audit (WA):

(1) Material Category	(2) Material Quantity Unit %	(3) Estimated Waste	(4) Total Quantity of Waste (unit)	(5) Generation Point	(6) % Recycled	(7) % Reused
Wood & Plastics						
Material Description						
Off-Cuts						
Warped						
Plastic						
Cardboard						
Other						
Doors & Windows						
Material Description						
Frames						
Glass						
Wood						
Metal						
Other						

3.5 WASTE REDUCTION WORKPLAN (WRW)

The following pertains to Schedule B - Waste Reduction Workplan (WRW). Column-1 refers to the category and type of waste materials. Column-2 refers to the persons responsible for completing the WRW. Column-3 refers to Column-4 of Schedule A. Column-4 refers to the amount of reused waste predicted and realized. Column-5 refers to the amount of recycled waste predicted and realized. Column-6 refers to the approved recycling facility.

.1 Schedule B:

(1) Material Quantity Category	(2) Person Amount Responsible Waste	(3) Total of Project (units)	(4) Reused Actual (units)	(5) Recycle Actual(s) Amount	(6) Material Destination(s)
Wood & Plastics					
Material Description					
Chutes					
Warped Plastic					
Cardboard Packaging					
Other					
Doors & Windows					
Material Description					
Painted Frames					
Glass					
Wood					
Metal					
Other					

3.6 DEMOLITION WASTE AUDIT (DWA)

The following pertains to Schedule C - Demolition Waste Audit (DWA). Column-1 refers to the type of material salvaged. Column-2 refers to the material quantity shown in column-1. Several columns may be required to identify specific demolition areas. Column-3 refers to the unit of measurement used to describe Column-2. Column-4 refers to the total quantity of salvaged material. Column-5 refers to the cumulative volume of salvaged material. Column-6 refers to the total weight in kilograms. Column-7 refers to remarks and assumptions made about the specified material.

.1 Schedule C - Demolition Waste Audit (DWA):

(1) Material Description Assumptions	(2) Quantity	(3) Unity	(4) Total	(5) Volume (cum)	(6) Weight (cum)	(7) Remarks & Assumptions
Wood						
Wood						
Stud						
Plywood						
Baseboard -wood						
Door						
Trim-Wood						
Cabinet						
Doors & Windows						
Panel						
Regular						
Slab Regular						
Wood						
Laminate						
Byfold-Closet						
Glazing						

3.7 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT

.1 Schedule E - Government Chief Responsibility for the Environment:

- .1 Ministry of Environment Lands and Parks
 810 Blanshard Street, 4th Floor
 Victoria, BC, V8V 1X4
 604-387-1161 / 604-356-6464
- .2 Waste Reduction Commission Soils and Hazardous Waste
 770 South Pacific Blvd, Suite 303
 Vancouver, BC, V6B 5E7
 604-660-9550 / 604-660-9596

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .1 Administrative procedures preceding preliminary and final inspections of Work.

1.2 RELATED SECTIONS

- .1 Section 01 78 00 - Closeout Submittals.

1.3 INSPECTION AND DECLARATION

- .1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
 - .2 Request Departmental Representative's Inspection.
 - .3 Departmental Representative's Review: Departmental Representative and Contractor will perform review of Work to identify obvious defects or deficiencies. Contractor shall correct Work accordingly.
 - .4 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 Equipment and systems have been tested, adjusted, and balanced and are fully operational.
 - .4 Certificates required by authorities having jurisdiction.
 - .5 Commissioning of all systems: final commissioning reports have been submitted to the Departmental Representative.
 - .6 Operation of systems has been demonstrated to Owner's personnel.
 - .7 All Completion Submittals have been finalized.
 - .8 Work is complete and ready for Final Inspection.
- .2 Submit required forms as described in General Conditions and Standard Acquisition Contract Clause (SACC) manual.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 45 00 - Quality Control
- .2 Section 01 71 00 - Examination and Preparation
- .3 Section 01 77 00 - Closeout Procedures
- .4 Section 01 79 00 - Demonstration and Training
- .5 Section 01 91 31 - General Commissioning (Cx) Requirement

1.2 SUBMISSION

- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .2 Copy will be returned after final inspection, with Departmental Representative's comments.
- .3 Revise content of documents as required prior to final submittal.
- .4 Two weeks prior to Completion of the Work, submit to the Departmental Representative, four (4) final copies of operating and maintenance manuals in English.
- .5 An electronic copy Interactive Operating and Maintenance Manual System is required as specified under clause 1.3. Provide four (4) sets of the Electronic Interactive Operating and Maintenance Manual System to the Departmental Representative.
- .6 Hard copies of the Operating and Maintenance Manual System is required as specified under clause 1.4. Provide four (4) sets of the Hard Copy Interactive Operating and Maintenance Manual System to the Departmental Representative.
- .7 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work. Refer to individual specification sections and Appendix G of this specification for all extra parts, materials, fixtures and equipment required.
- .8 If requested, furnish evidence as to type, source and quality of products provided.
- .9 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .10 Pay costs of transportation.
- .11 Certificate of Completion.

1.3 INTERACTIVE OPERATING AND MAINTENANCE MANUAL SYSTEM

- .1 In addition to the printed copies, submit provide an Interactive Operating and Maintenance Manual System as specified herein.
- .2 System Description and Requirements

- .1 All as constructed drawings and operation and maintenance (O&M) manuals listed under the Scope of Work shall be converted, where necessary, into Portable Data File (PDF) format for viewing using the Adobe Acrobat Reader.
- .2 Documentation storage and retrieval system shall be structured based on a database framework with direct links to the appropriate PDF files. Documents retrieval and viewing shall be executed through a menu driven approach.
- .3 Program shall be capable of storing separately and independently data of multiple buildings and shall be expandable for addition of new buildings and systems.
- .4 Data of each building shall be accessible by the input of either the building name or building number as defined by the Departmental Representative.
- .5 O&M data and as constructed drawings shall be classified by their corresponding disciplines, including:
 - .1 Architectural
 - .2 Mechanical
 - .3 Electrical
 - .4 Structural
 - .5 Civil
 - .6 Data & Communication
 - .7 BSCS
 - .8 Under each discipline, data shall be grouped into the following four major categories:
 - .1 Basic Documents
 - .1 'Basic Documents' shall, according to the type of services or disciplines, include the full contents of each hard copy of the O&M manuals with the addition of Miscellaneous Maintenance Reports and Records, or as defined by the user. In general the following shall be included unless specifically excluded by the Departmental Representative:
 1. Introduction
 2. Consultant/Contractor/Suppliers List
 3. System Description
 4. Maintenance and Lubrication Schedules
 5. Testing and Commissioning (T&C) Reports
 6. Misc. Reports
 7. Specifications
 8. Equipment and/or point schedules as identified in the hard copy documents
 9. Others as stipulated by the Departmental Representative
 - .2 All Basic Documents PDF files shall be enhanced with appropriate bookmarks to facilitate searching of information

within the document or linking to other relevant documents for references.

- .2 'As-Constructed' Drawings
 - .1 'As-Constructed' drawings shall be converted from the original electronic files, such as CAD, into PDF format. If only the hard copies of the 'as constructed' drawings are available, they shall be scanned and saved in PDF format. PDF files of the 'As-Constructed' drawings shall be enhanced with the following bookmarks to zoom into legible views on the computer screen as a minimum:
 1. Drawing Number and Title
 2. Drawing Notes
 3. Major Equipment Locations
 4. Cross-links to other related drawings
 5. Revisions
- .3 System Data
 - .1 Building systems shall be identified by their services, disciplines, function, nature and specific scope. System data shall be classified into the following categories:
 1. System Description
 2. Schematic (where applicable)
 3. Equipment List
 - .2 Provide hot key buttons, where applicable, for direct access to drawings/data referenced on the schematics. The same shall be applied to listed equipment for direct links to the corresponding equipment data.
- .4 Equipment Data
 - .1 Equipment data shall be classified into the following categories:
 1. Equipment submittals
 2. T&C Report
 3. Maintenance Data
 4. Maintenance Records
 5. Photo
 - .2 Provide a summary screen to list all equipment classified under a specific system. On the summary screen, provide direct links to the corresponding equipment data under each category with addition links to the relevant 'As Constructed' drawings.
- .6 The system shall be executed by Professional Engineers with a minimum of 10 years post qualification experience in the field of Building Services Engineering.
- .7 The Contractor shall provide a minimum of three (3) past job references as proven record of similar undertakings.

- .8 The Contractor shall provide a demonstration of the system to the Departmental Representative to provide verification that the requirements of the specification are fulfilled.

1.4 FORMAT HARD COPY MANUALS

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

1.5 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 Date of submission;
 - .2 Names, addresses, and telephone and fax numbers of Contractor, Subcontractors, Suppliers with name of responsible parties;
 - .3 Schedule of products and systems, indexed to content of volume;
 - .4 Copy of hardware schedule and paint schedules, complete with the actual manufacturer, supplier and identification names and numbers;
 - .5 All extended guarantees, warranties, maintenance bonds, certificates, letters of guarantees, registration cards, as called for in the various sections of the specification;
 - .6 Complete set of all final reviewed shop drawings;
 - .7 Certificates of inspection by authorities having jurisdiction;
 - .8 Test reports and certificates as applicable;
 - .9 Complete set of as constructed drawings.
- .2 For each product or system:
 - .1 List names, addresses, and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

- .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.6 'AS CONSTRUCTED' DRAWINGS AND SAMPLES

- .1 In addition to requirements in General Conditions, maintain at the site one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to the Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturers' certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.
- .6 Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring. Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed. Use different colour waterproof ink for each service.
- .7 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings. Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .8 Arrange for and be responsible for the preparation of as-built drawings in AutoCAD computerized drafting system. Be responsible for the cost of preparation of as-built

drawings. Submit electronic copy of the as-built drawings on CD/DVD media in CAD and PDF format, as well as 2 sets of hard copies. Submit as-built drawings before requesting Substantial Completion..

1.7 RECORDING ACTUAL SITE CONDITIONS

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

1.8 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves; with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - .1 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.

- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .2 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .3 Description of plumbing specialties and accessories, giving manufacturer's name, type, model, year, capacity. List of recommended spare parts.
- .3 Performance data to include:
 - .1 Equipment performance verification test results.
 - .2 Special performance data as specified.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .15 Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: as specified in individual specifications sections.

1.10 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 location as directed by Departmental Representative.
- .4 Receive and catalogue all items.
- .5 Submit inventory listing to Departmental Representative.
- .6 Include approved listings in Maintenance Manual.
- .7 Obtain receipt for delivered products and submit prior to final payment.

1.11 MAINTENANCE MATERIALS

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

1.12 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.13 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.14 WARRANTIES AND BONDS

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Owner's permission; leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.
- .2 Owner to provide list of personnel to receive instructions, and coordinate their attendance at agreed upon times.
- .3 Preparation:
 - .1 Verify conditions for demonstration and instructions comply with requirements.
 - .2 Verify designated personnel are present.
 - .3 Ensure equipment has been inspected and put into operation in accordance with each division.
 - .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 23 05 93 – Testing, Adjusting, and Balancing Testing for HVAC.
- .4 Demonstration and Instructions:
 - .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.
 - .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
 - .3 Review contents of manual in detail to explain aspects of operation and maintenance.
 - .4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.
 - .5 Time Allocated for Instructions: ensure adequate amount of time required for instruction of each item of equipment or system: refer to Section 01 91 41 – Commissioning Training.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 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.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.
- .5 Provide electronic & hard copies (refer to Section 01 78 00 - Closeout Submittals) of completed operation and maintenance manuals for use in demonstrations and instructions.

1.3 QUALITY ASSURANCE

- .1 When specified in individual sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:
 - .1 Instruct Owner's personnel.
 - .2 Provide written report that demonstration and instructions have been completed.

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 23 05 00 – Common Work Results – Mechanical.
- .5 Section 23 05 93 – Testing, Adjusting and Balancing Testing, for HVAC.
- .6 Section 23 08 01 – Performance Verification Mechanical Piping Systems.
- .7 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.
- .8 Section 25 05 01 – EMCS General Requirements.
- .9 Section 26 05 00 – Common Work Results - Electrical.
- .10 Section 26 12 16 – Dry Type Transformers

.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 PWGSC-Commissioning Manual CP.1 - 2013.

.2 ANSI/NETA

- .1 ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.

.3 CSA

- .1 CSA Z320-11 Building Commissioning Standard.

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 This section is included for reference. The Owner has retained the services of an independent contractor as Commissioning Authority, to oversee the commissioning process, and to perform the commissioning tasks of the mechanical systems. Commissioning of the electrical systems is to be undertaken by the electrical contractor, their suppliers and appropriate sub-trades. The Contractors are required to participate and provide all required manpower and specialized services to ensure the equipment supplied by the contractor meets the contract requirements. Duties of the Commissioning Authority do not relieve the contractor from providing equipment and systems that meet the design intent and specifications. It is not intended that this work shall, in any way, replace normal factory start-up service for equipment or relieve the contractor or his sub-trades of their responsibility for providing systems and equipment in satisfactory working order.
- .3 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.
- .4 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.4 COMMISSIONING OVERVIEW

- .1 Section 01 91 31 - Commissioning (Cx) Plan.
- .2 For Cx responsibilities refer to Commissioning (Cx) Plan.
- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages 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.

- .6 Departmental Representative will issue Interim Acceptance Certificate 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 Departmental Representative, Departmental Representative 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. The above costs are to be in the 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 seven (7) days in advance of tests and confirm two (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 Contractor's Cx agent.
 - .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 Training and Attendance forms
- .9 Accepted "As-built" Plans and Specifications

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 Agent 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.
- .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: 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, General Contractor to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of General Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by General Contractor with their Commissioning Agent, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.12 STARTING AND TESTING

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

1.13 WITNESSING OF STARTING AND TESTING

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

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and 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 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative and Commissioning Authority after distinct phases have been completed and before commencing next phase.
- .4 Document required tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Commissioning Authority. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Commissioning Authority.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Commissioning Authority.

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

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Commissioning Authority for approval before commencement of commissioning.
- .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 Commissioning Authority to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

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

1.17 TEST RESULTS

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

1.18 START OF COMMISSIONING

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

1.19 INSTRUMENTS / EQUIPMENT

- .1 Submit to Commissioning Authority for review and approval:
 - .1 Complete list of instruments proposed to be used.

- .2 Listed data including, serial number, current calibration certificate, calibration date, 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 manufacturers' operating instructions.
 - .4 EMCS trending to be available as supporting documentation for performance verification.
- 1.21 WITNESSING COMMISSIONING**
 - .1 Commissioning Authority to witness activities and verify results.
- 1.22 AUTHORITIES HAVING JURISDICTION**
 - .1 Where start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
 - .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
 - .3 Provide copies to Commissioning Authority within 5 days of test and with Cx report.
- 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 EXTENT OF VERIFICATION**
 - .1 Building:
 - .1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other sections.

- .2 Number and location to be at discretion of Departmental Representative and Commissioning Authority.
- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.

1.25 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Departmental Representative and Commissioning Authority for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Departmental Representative's or Commissioning Authority's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Departmental Representative or Commissioning Authority deems Contractor's request for second verification was premature.

1.26 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.

1.27 DEFICIENCIES, FAULTS, DEFECTS

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

1.28 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.

1.29 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.

1.30 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.31 OCCUPANCY

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

1.32 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.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.33 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.

1.34 OWNER'S PERFORMANCE TESTING

- .1 Performance testing of equipment or system by 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 American Water Works Association (AWWA)
- .2 CSA
 - .1 CSA Z320-11 Building Commissioning Standard.
- .3 Underwriters' Laboratories of Canada (ULC)

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 4 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-contractors', suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .2 Cx Authority to review and submit completed Cx Plan to Departmental Representative and obtain written approval.

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 two (2) months during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .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 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:

- .1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
- .2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
- .3 Cx Authority is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Developing BMM.
 - .6 Ensuring implementation of final Cx Plan.
 - .7 Performing verification of performance of installed systems and equipment.
 - .8 Implementation of Training Plan.
- .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 with Consultant and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 Property 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 Mechanical Equipment and Acceptance Tests:

- .1 Domestic water system (including water heaters)
- .2 Cooling tower & associated pumps and condenser water system
- .3 Room air conditioner systems
- .4 BMS (controls) Operator Workstation (software)
- .5 Mechanical system in chemical storage building

.2 List of Electrical Equipment and Acceptance Tests:

- .1 Dry Type Transformer
- .2 Low Voltage lighting Control
- .3 MCC
- .4 Telecommunication System (Cabling, raceway & rack)
- .5 Certificates and/or Equipment Test Report
- .6 Equipment Spare Parts Report
- .7 Generic Acceptance Report
- .8 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 Start-up, 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 and Cx Authority;
 - .10 Training Plans;
 - .11 Cx Reports;
 - .12 Prescribed activities during warranty period.

1.10 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .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 of following witnessed by PWGSC Design Quality Review Team;
 - .10 Tests performed by Owner/User;

- .11 Training Plans;
- .12 Cx Reports;
- .13 Prescribed activities during warranty period;
- .4 Cx Authority to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.11 START-UP

- .1 Start-up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
- .3 Cx Authority to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Cx Authority.
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Cx Authority.
 - .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 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 Cx by specified Cx Agent using procedures developed by Cx Authority and approved by Departmental Representative.
- .2 Cx Authority to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Cx Authority to witness, certify reported results of, Cx activities and forward to Departmental Representative.
- .5 Cx Authority reserves the right to verify a percentage of reported results at no cost to contract.

1.13 CX INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed by specified Cx Agent using procedures developed by Cx Authority and approved by Departmental Representative.

- .2 Tests to be witnessed by Cx Authority and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Cx Authority and submitted to Departmental Representative for review.
- .4 Cx Authority reserves the right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 Integrated HVAC systems.
 - .2 Fire alarm systems.
 - .3 Emergency power generator.
 - .4 Transfer switch and controllers.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance, Cx Authority, Contractor, Project Manager, Property Manager, and Cx Manager to cooperate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.14 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.

1.15 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.

1.16 PERFORMAMNCE VERIFICATION (PV) REPORT

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

1.17 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.

1.18 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: three (3) months after award of contract.
- .5 Cx Report format: three (3) months after contract award.
- .6 Discussion of heating/cooling loads for Cx: three (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 agent, Cx Authority, and Departmental Representative will monitor progress of Cx against this schedule.

1.19 CX REPORTS

- .1 Submit reports of tests, witnessed and certified by the Cx Authority, 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.

1.20 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.
 - .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
 - .3 Full-scale emergency evacuation exercises.

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 the Cx Authority and the 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.
- .2 Related Requirements
 - .1 Section 01 91 13 - General Commissioning (Cx) Requirements
 - .2 Section 01 91 31 – Commissioning (Cx) Plan
 - .3 Section 01 91 41 – Commissioning Training
 - .4 Section 01 91 51 – Building Management Manual (BMM)

1.2 RELATED WORKS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.3 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 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. 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.

1.4 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 are 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 Departmental Representative's approval.

1.5 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 Departmental Representative's approval.

1.6 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 Departmental Representative with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing, and commissioning period.
 - .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual in accordance with Section 01 91 51 - Building Management Manual (BMM).

1.7 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 Section 01 91 13 - General Commissioning (Cx) Requirements
 - .2 Section 01 91 31 - Commissioning Plan
 - .3 Section 01 91 33 - Commissioning Forms

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, Commissioning Manager and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 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 MECHANICAL 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 (8) hours including one half hour for breaks, and one person week shall be five (5) 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.
- .6 Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.
- .7 Systems Course: allow a minimum of eight (8) hours of instruction to conduct systems training courses addressing the following topics:
 - .1 Cooling Systems:
 - .1 Review operation of system and equipment
 - .2 Review condensing unit and maintenance
 - .3 Review system maintenance.
 - .4 Cooling system site tour.
 - .5 Demonstrate start/stop.
 - .1 Auto control.
 - .2 Maintenance.
 - .2 Plumbing:
 - .1 Review system operation equipment.
 - .2 Review equipment maintenance including:
 - .1 Domestic water
 - .2 Fixtures
 - .3 Site Services:
 - .1 Sanitary/storm/domestic water.
- .8 Controls Course: Allow a minimum of 8 hours of instruction and an additional 8 hours of instructions to conduct the controls systems training courses as follows:
 - .1 Provide the services of competent instructors who will give instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements of the equipment and system specified. The training shall be specifically for the system installed rather than being a general "canned" training course. The Departmental Representative shall have the right to approve/reject the instructors based on their qualifications. All equipment and material required for classroom training shall be provided by the General Contractor.

- .2 Training Program: provide in two phases over a 6 month period, the time interval specified for each phase.
 - .1 First phase: this phase shall be for a period of 1 day prior to the 30 day test period. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. First phase training shall include the following:
 - .1 General EMCS Architectural (overview);
 - .2 System Communications (overview);
 - .3 Operation of computer and peripherals (overview);
 - .4 Operator Interface functions for control of HV AC systems (detailed);
 - .5 Control Logic (detailed for each system);
 - .6 Report Generation (overview);
 - .7 Colour graphics generation;
 - .8 Elementary preventive maintenance (detailed).
 - .2 Second Phase: this phase of training shall be conducted eight weeks after system acceptance for a period of one day. Training will be provided for three categories of personnel: operators, equipment maintenance personnel. The training shall include as a minimum, but not be limited to:
 - .1 Operator Training and Equipment Maintainer's Training include:
 1. General equipment layout.
 2. Troubleshooting of all EMCS components.
 3. Preventive maintenance of all EMCS components.
 4. Sensors and controls maintenance and calibration

1.9 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 (8) hours including one half hour for breaks, and one person week shall be five (5) 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 eight (8) hours of instruction to conduct systems training courses addressing the following topics:
 - .1 Standard Power Systems:
 - .1 Review operation of systems and equipment.
 - .2 Communications Pedestals:
 - .1 Review operation of systems and equipment.
 - .3 Fire Alarm Equipment:
 - .1 Review operation of systems and equipment.

END OF SECTION

Part 1

General

1.1 SUMMARY

- .1 Section includes:
 - .1 This section is limited to portions of the Building Management Manual (BMM) provided to Departmental Representative by Contractor.
- .2 Related Requirements
 - .1 Section 01 78 00 – Closeout Submittals
- .3 Acronyms:
 - .1 BMM Building Management Manual
 - .2 Cx Commissioning
 - .3 HVAC Heating, Ventilation, and Air Conditioning
 - .4 PI Product Information
 - .5 PV Performance Verification
 - .6 TAB Testing, Adjusting, and Balancing
 - .7 WHMIS Workplace Hazardous Materials Information System

1.2 GENERAL REQUIREMENTS

- .1 Standard letter size paper 216 mm x 279 mm.
- .2 Methodology used to facilitate updating.
- .3 Drawings, diagrams, and schematics to be professionally developed.
- .4 Electronic copy of data to be in a PDF with hyperlink from content page to individual sections.

1.3 APPROVALS

- .1 Prior to commencement, coordinate requirements for preparation, submission, and approval with Departmental Representative.

1.4 GENERAL INFORMATION

- .1 Provide Departmental Representative the following for insertion into appropriate Part and Section of BMM:
 - .1 Complete list of names, addresses, telephone and fax numbers of contractor, sub-contractors that participated in delivery of project - as indicated in Section 1.2 of BMM.
 - .2 Summary of architectural, structural, fire protection, mechanical, and electrical systems installed and commissioned - as indicated in Section 1.4 of BMM.
 - .1 Including sequence of operation as finalized after commissioning is complete as indicated in Section 2.0 of BMM.

- .3 Description of building operation under conditions of heightened security and emergencies as indicated in Section 2.0 of BMM.
- .4 System, equipment, and components Maintenance Management System (MMS) identification - Section 2.1 of BMM.
- .5 Information on operation and maintenance of architectural systems and equipment installed and commissioned - Section 2.0 of BMM.
- .6 Information on operation and maintenance of fire protection and life safety systems and equipment installed and commissioned - Section 2.0 of BMM.
- .7 Information on operation and maintenance of mechanical systems and equipment installed and commissioned - Section 2.0 of BMM.
- .8 Operating and maintenance manual - Section 3.2 of BMM.
- .9 Final commissioning plan as actually implemented.
- .10 Completed commissioning checklists.
- .11 Commissioning test procedures employed.
- .12 Completed Product Information (PI) and Performance Verification (PV) report forms, approved and accepted by Departmental Representative.
- .13 Commissioning reports.

1.5 CONTENTS OF OPERATING AND MAINTENANCE MANUAL

- .1 For detailed requirements refer to Section 01 78 00 - Closeout Submittals.
- .2 Departmental Representative to review and approve format and organization within 12 weeks of award of contract.
- .3 Include original manufacturers' brochures and written information on products and equipment installed on this project.
- .4 Record and organize for easy access and retrieval of information contained in BMM.
- .5 Include completed PI report forms, data, and information from other sources as required.
- .6 Inventory directory relating to information on installed systems, equipment, and components.
- .7 Approved project shop drawings, product and maintenance data.
- .8 Manufacturers' data and recommendations relating to: manufacturing process, installation, commissioning, start-up, O&M, shutdown, and training materials.
- .9 Inventory and location of spare parts, special tools, and maintenance materials.
- .10 Warranty information.
- .11 Inspection certificates with expiration dates, which require on-going re-certification inspections.
- .12 Controls record drawings
- .13 Maintenance program supporting information including:
 - .1 Recommended maintenance procedures and schedule;

- .2 Information to removal and replacement of equipment including, required equipment, points of lift, and means of entry and egress.

1.6 LIFE SAFETY COMPLIANCE (LSC) MANUAL

- .1 Samples of LSC Manual will be available from Departmental Representative.
- .2 Content of Manual:
 - .1 All possible emergency situations modes, including: presence of fire and smoke, power failure, loss of water or pressure, chemical spills, and refrigerant release;
 - .2 HVAC emergencies and fuel supply failures;
 - .3 Intrusion and security breach;
 - .4 Emergency provisions for natural disasters, bomb threats, and other disruptive situations;
 - .5 Dedicated emergency generators for high security projects, medical facilities, and computer systems;
 - .6 Emergency control procedures for fire, power, and major equipment failure.
 - .7 Emergency contacts and numbers;
 - .8 Manual to be readily available and comprehensible to non- technical readers.

1.7 SUPPORTING DOCUMENTATION FOR INSERTION INTO SUPPORTING APPENDICES

- .1 Provide Departmental Representative supporting documentation relating to installed equipment and system, including:
 - .1 General:
 - .1 Finalized commissioning plan;
 - .2 WHMIS information manual;
 - .3 Approved "as-built" drawings and specifications;
 - .4 Procedures used during commissioning;
 - .5 Cross-reference to specification sections.
 - .2 Architectural and Structural:
 - .1 Inspection certificates, construction permits;
 - .2 PV reports.
 - .3 Fire prevention, suppression and protection:
 - .1 Test reports;
 - .2 Smoke test reports;
 - .3 PV reports.
 - .4 Mechanical:
 - .1 Installation permits, inspection certificates;
 - .2 Piping pressure test certificates;
 - .3 TAB and PV reports;
 - .4 Charts of valves and steam traps;

- .5 Copies of posted instructions.
- .6 System description and description of system operation for each system.
- .5 Electrical:
 - .1 Installation permits, inspection certificates;
 - .2 TAB and PV reports;
 - .3 Electrical work log book;
 - .4 Charts and schedules;
 - .5 Locations of cables and components;
 - .6 Copies of posted instructions.
- .2 Provide hard copies and electronic, searchable PDF Format.
- .3 Assist Departmental Representative with preparation of BMM.
- 1.8 LANGUAGE**
 - .1 Provide documentation in English only.
- 1.9 USE OF CURRENT TECHNOLOGY**
 - .1 Use current technology for production of documentation. Emphasis on ease of accessibility at all times, maintain in up-to-date state, compatibility with user's requirements.
 - .2 Obtain Departmental Representative's approval before starting work.
- 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 SECTION INCLUDES

- .1 Supply, installation, and removal of concrete formwork and accessories.

1.2 RELATED SECTIONS

- .1 Section 07 92 00 - Joint Sealants

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-O86-09, Engineering Design in Wood, Consolidation.
 - .3 CSA O437 Series-93 (R2011), Standards for OSB and Waferboard.
 - .4 CSA S269.1-1975(R2003), Falsework for Construction Purposes.
 - .5 CAN/CSA-S269.3-M92(R2008), Concrete Formwork, National Standard of Canada.
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings for formwork and falsework.
 - .1 Submit drawings stamped and signed by Professional Engineer registered or licensed in Province of British Columbia, Canada.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .4 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CSA S269.1, for falsework drawings. Comply with CAN/CSA-S269.3 for formwork drawings.
- .5 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
- .6 Indicate sequence of erection and removal of formwork/falsework as directed by Department Representative.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 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 Place materials defined as hazardous or toxic in designated containers.

1.6 DESIGN AND CODE REQUIREMENTS

- .1 Formwork and supporting falsework shall be designed and constructed in accordance with the requirements of CSA S269.3, CSA S269.1 and CSA A23.1, as applicable to the work.
- .2 Contractor shall assume full responsibility for the design and for the adequacy and safety of all formwork and falsework.
- .3 The design and erection of formwork and related supporting works shall comply with construction safety legislation and regulations.
- .4 Engage a Professional Structural Engineer registered in the Province of British Columbia, fully qualified and experienced in the design of formwork and shoring, to be responsible for the design of formwork, falsework, scaffolding, shoring and re-shoring.

Part 2 Products

2.1 MATERIALS

- .1 Formwork materials:
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CAN/CSA-O86 and CSA O437 Series.
 - .2 Rigid insulation board: to CAN/ULC-S701.
- .2 Form ties:
 - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
 - .2 Use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
- .3 Form release agent: non-toxic, biodegradable, low VOC.
- .4 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .5 Falsework materials: to CSA-S269.1.
- .6 Sealant: to Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 FABRICATION AND ERECTION

- .1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.

- .2 Obtain Department Representative's approval for use of earth forms framing openings not indicated on drawings.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 Fabricate and erect falsework in accordance with CSA S269.1.
- .5 Do not place shores and mud sills on frozen ground.
- .6 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .7 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .8 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
- .9 Use 20 mm chamfer strips on external corners and/or 20 mm fillets at interior corners, joints, unless specified otherwise.
- .10 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .11 Build in anchors, sleeves, guides, angles, embedment and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .12 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete. Remove cuttings, shavings and debris from within the forms. Flush the completed forms with water or air jet to remove remaining foreign matter. Ensure that water and debris drain to the exterior through the cleanout ports.
- .13 Read drawings in conjunction with all other pertinent contract documents. Coordinate structural work with architectural, mechanical and electrical drawings for detailed dimensions, locations of openings, slopes, curbs, inserts, drainage, waterproofing and other items. Verify locations of mechanical openings with mechanical contractor.

3.2 REMOVAL AND RESHORING

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 Seven (7) days for footings.
- .2 Remove formwork when concrete has reached 75 % of its 28 day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring. Contractor to supply evidence of concrete strength testing.
- .3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Space reshoring in each principal direction at not more than 3000 mm apart.
- .5 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials, supply, and installation of concrete reinforcing.

1.2 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004.
 - .1 ACI 315-99, Details and Detailing of Concrete Reinforcement.
 - .2 ACI 315R-04, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.
 - .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A82/A82M-07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
 - .2 ASTM A185/A185M-07, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - .3 ASTM A497/A497M-07, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - .3 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-A23.3-04(R2010), Design of Concrete Structures.
 - .3 CAN/CSA-G30.18-09, Billet-Steel Bars for Concrete Reinforcement, A National Standard of Canada.
 - .4 CSA-G40.20/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CSA W186-M1990(R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.
 - .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315.
- .3 Submit shop drawings including placing of reinforcement and indicate:
 - .1 Bar bending details.
 - .2 Lists.

- .3 Quantities of reinforcement.
- .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Department Representative, with identifying code marks to permit correct placement without reference to structural drawings.
- .5 Indicate sizes, cover, spacings and locations of chairs, spacers and hangers.
- .4 Detail lap lengths and bar development lengths to CSA-A23.3, unless otherwise indicated.
 - .1 Provide type B tension lap splices unless otherwise indicated.
- .5 Review of the shop drawings by the Department Representative is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
- .6 Fabrication that commences prior to shop drawing review by the Department Representative is at the risk of the Contractor.

1.4 QUALITY ASSURANCE

- .1 In accordance with Section 01 45 00 - Quality Control, Section 01 45 01 – Quality Control: Construction, and as described in PART 2 - SOURCE QUALITY CONTROL.
 - .1 Mill Test Report: provide Department Representative, with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Submit in writing to Department Representative proposed source of reinforcement material to be supplied.

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 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 Place materials defined as hazardous or toxic in designated containers.

Part 2 Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by Department Representative.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CAN/CSA-G30.18.
- .4 Cold-drawn annealed steel wire ties: to ASTM A82/A82M
- .5 Deformed steel wire for concrete reinforcement: to ASTM A497/A497M.

- .6 Welded steel wire fabric: to ASTM A185/A185M.
 - .1 Provide in flat sheets only.
- .7 Welded deformed steel wire fabric: to ASTM A497/A497M.
 - .1 Provide in flat sheets only.
- .8 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .9 Plain round bars: to CSA-G40.20/G40.21.
- .10 Mechanical splices: subject to approval of Department Representative.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Department Representative's approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Department Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 SOURCE QUALITY CONTROL

- .1 Provide Department Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
- .2 Inform Department Representative of proposed source of material to be supplied.

Part 3 Execution

3.1 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Department Representative.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.2 PLACING REINFORCEMENT

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.
- .2 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.

- .3 Prior to placing concrete, obtain Department Representative's approval of reinforcing material and placement. Notify the Department Representative at least 72 hrs prior to cast of concrete to inspect the reinforcement.
- .4 Ensure cover to reinforcement is maintained during concrete pour and in accordance with CSA A23.1/A23.2 according to exposure class and conditions.
- .5 Clear distances between bars, shall be not less than the nominal diameter of the bar, or 25 mm or one and one-third the maximum size of the coarse aggregate. Bars placed in two or more layers shall have a minimum clear distance between the layers of not less than 25 mm and shall be placed directly above and below each other.
- .6 Reinforcement shall be adequately supported by metal chairs, spacers or hangers and secured against displacement within the tolerance permitted and in accordance with ACI 315, but not further than 1000 mm in either direction for slabs.

3.3 CLEANING

- .1 All materials shall be clean and free of all form oil or deleterious materials.
- .2 All deleterious material shall be removed from the surface of the reinforcing steel in a manner acceptable to the Department Representative.
- .3 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .5 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Supply and installation of cast in place concrete and accessories.

1.2 RELATED SECTIONS

- .1 Section 03 10 00 - Concrete Forming and Accessories
- .2 Section 03 20 00 - Concrete Reinforcing
- .3 Section 03 35 00 - Concrete Finishing

1.3 REFERENCES

- .1 American Concrete Institute (ACI)
 - .1 ACI 212.3R-10 Report on Chemical Admixtures for Concrete
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C39/C39M-12a, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - .2 ASTM C109/C109M-11b, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or 50 mm Cube Specimens)
 - .3 ASTM C157/C157M-8, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
 - .4 ASTM C260-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .5 ASTM C494/C494M-12, Standard Specification for Chemical Admixtures for Concrete.
 - .6 ASTM D1751-04(2008), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
 - .2 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA A283-06(R2011), Qualification Code for Concrete Testing Laboratories.
 - .3 CAN/CSA-A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004, and A3005).
 - .1 CSA-A3001-08, Cementitious Materials for Use in Concrete.

1.4 ACRONYMS AND TYPES

- .1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
 - .1 Type GU or GUB - General use cement.
 - .2 Type HS or HSb – High sulphate resistance hydraulic cement
- .2 Fly ash:
 - .1 Type F - CaO content in accordance with CAN/CSA-A3000.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .3 Submit testing and inspection results and reports for review by Department Representative and do not proceed without written approval when deviations from mix design or parameters are found.
- .4 Concrete pours: submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .5 Concrete hauling time: submit for review by Department Representative deviations exceeding maximum allowable time of 120 minutes for concrete to be delivered to site of Work and discharged after batching.
- .6 Supply pour sheets to Department Representative at least two days prior to concrete pour.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Submit to Department Representative, minimum 4 weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.
 - .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials used in concrete mix design will meet specified requirements.
- .3 Minimum four (4) weeks prior to starting concrete work, submit proposed quality control procedures for review by Department Representative on following items:

- .1 Falsework erection.
 - .2 Hot weather concrete.
 - .3 Cold weather concrete.
 - .4 Curing.
 - .5 Finishes.
 - .6 Formwork removal.
 - .7 Joints and locations of joints.
 - .8 Sequence of concrete pours.
- .4 Quality Control Plan: submit written report, as described in PART 3 - VERIFICATION, to Department Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.
- .5 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.
 - .1 Modifications to maximum time limit must be agreed to by Department Representative and concrete producer as described in CSA A23.1/A23.2.
 - .2 Deviations to be submitted for review by Department Representative.
- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .3 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 concrete materials from landfill to local facility approved by Department Representative.
- .3 Provide an appropriate area on the job site where concrete trucks can be safely washed.
- .4 Unused admixtures and additive materials must not be disposed of into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard. -
- .5 Prevent admixtures and additive materials from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

Part 2 Products

2.1 DESIGN CRITERIA

- .1 Alternative 1 - Performance: to CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

2.2 MATERIALS

- .1 Cement: to CAN/CSA-A3001, Type HS.
- .2 Supplementary cementing materials: with maximum 25% Type F fly ash, by mass of total cementitious materials to CAN/CSA-A3001.
- .3 Water: to CSA-A23.1.
- .4 Aggregates: to CAN/CSA-A23.1/A23.2.
- .5 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494. Department Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .6 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA-A23.1/A23.2.
 - .1 Compressive strength: 50 MPa at 28 days.
 - .2 Net shrinkage at 28 days: maximum 5%.
- .7 Sealing and curing compounds: to Section 03 35 00 - Concrete Finishing.
- .8 Premoulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
- .9 Polyethylene film: 0.25 mm thickness to CAN/CGSB-51.34.
- .10 Epoxy Adhesive Anchors: injectable epoxy system.

2.3 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: to meet DCC Representative performance criteria in accordance with CAN/CSA-A23.1/A23.2.
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as described in PART 3 - VERIFICATION.
 - .2 Provide concrete mix to meet following hard state requirements:

TYPE	LOCATION	28 DAY STRENGTH f'c (MPa)	CEMENT TYPE	AGGREG. MAX. (mm)	SLUMP (mm)	TOTAL AIR (%)	EXPOSURE CLASS
1.	Foundation walls	25	GU	20	80 ± 30	5 - 8	C-2
2.	Strip Footings	25	GU	20	80 ± 30	Natural	N
3.	Grade supported interior slabs	25	GU	20	80 ± 30	Natural	N
4.	Misc. exterior slabs/pads	32	MS	20	80 ± 30	5 - 8	C-2
5.	Masonry fill	20	GU	10	200 ± 50	1 - 4	N

- .3 Maximum fly ash content as a percentage of the total cementitious material:
 - .1 Concrete with exposure classes C-1 and C-2: No fly ash is allowed unless it is limited to 5% and provided that the water/cement ratio is not more than 0.4.
 - .2 Concrete with exposure classes C-3 and F-1: Maximum 15% fly ash.
 - .3 Concrete with exposure classes F-2 and N: Maximum 20% fly ash.
- .4 Provide quality management plan to ensure verification of concrete quality to specified performance.
- .5 Concrete supplier's certification.
- .2 Documentation indicating the compatibility of the water reducing admixture, the air entraining admixture, the superplasticizing admixture (if any), the silica fume (if any) and the fly ash (if any) is to be submitted upon request with the mix design for review by the Department Representative.

Part 3 Execution

3.1 PREPARATION

- .1 Obtain Department Representative's approval before placing concrete.
 - .1 Provide a minimum 72 hours' notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:

- .1 Development of cold joints not allowed.
- .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .6 Prior to placing of concrete obtain Department Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .7 Protect previous Work from staining.
- .8 Use cold weather concreting methods in accordance with CSA-A23.1, when the mean daily temperature falls below 5°C, and use hot weather methods when the mean temperature rises above 25°C.
- .9 Clean and remove stains prior to application for concrete finishes.
- .10 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .11 Do not place load upon new concrete until authorized by Department Representative.

3.2

CONSTRUCTION

- .1 Do cast-in-place concrete work in accordance with CSA-A23.1/A23.2.
- .2 Read drawings in conjunction with all other pertinent contract documents. Coordinate structural work with architectural, mechanical and electrical drawings for detailed dimensions, locations of openings, slopes, curbs, inserts, drainage, waterproofing and other items.
- .3 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through equipment pad footing except where indicated or approved by Department Representative.
 - .2 Where approved by Department Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by Department Representative.
 - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Department Representative before placing of concrete.
 - .5 Confirm locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .4 Anchor bolts:

- .1 Set anchor bolts to steel templates secured to proper supports to prevent movements, under supervision of appropriate trade prior to placing concrete.
- .2 For epoxy anchors, drill holes and fill with adhesive to manufacturers' recommendations.
- .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
- .5 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.
- .6 Finishing and curing:
 - .1 Finish concrete in accordance with CSA-A23.1/A23.2 and Section 03 35 00 - Concrete Finishing.
 - .2 Use procedures as reviewed by Department Representative or those noted in CSA-A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces except for slabs. Provide written declaration that compounds used are compatible.
 - .4 Slabs shall be wet cured for seven days minimum according to CSA-A23.1, using one of the following methods as soon as the concrete has hardened sufficiently to prevent marring:
 - .1 Surface covered with canvas or other satisfactory material and kept thoroughly wet.
 - .2 Surface sealed with polyethylene sheeting at least 6 mils (0.15mm) thick and the concrete kept thoroughly wet.
- .7 Epoxy set anchors and reinforcement dowels:
 - .1 Install in strict accordance with manufacturer's recommendations.
 - .2 Minimum anchorage requirements for reinforcement dowels and Epoxy Adhesive Anchors: as indicated.

3.3 SURFACE TOLERANCE

- .1 Concrete tolerance in accordance with CSA-A23.1/A23.2.
- .2 See Section 03 35 00 for floor finish tolerances.

3.4 FIELD QUALITY CONTROL

- .1 Site tests: conduct following test in accordance with Section 01 45 01 - Quality Control: Construction and submit report as described in PART 1 - SUBMITTALS.
 - .1 Concrete pours.
 - .2 Slump tests.
 - .3 Air content.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Contractor for review in accordance with CSA-A23.1/A23.2. Pay cost of all testing carried out under this section.

- .1 Ensure testing laboratory is certified in accordance with CSA A283.
- .3 Testing firm to take a minimum of three (3) test cylinders for a strength test and not less than one strength test for each 40 m³ of concrete, or portion thereof, for each type of concrete placed and not less than one (1) test for each type of concrete placed in any one day.
- .4 Testing firm to moist cure and test one (1) cylinder in seven (7) days and to moist cure and test the remaining two (2) cylinders in 28 days.
- .5 Testing firm to take at least one slump test and one entrained air test for each set of test cylinders taken.
- .6 Testing firm to take one additional test cylinder during cold weather concreting and cure on job site under same conditions as the concrete it represents.
- .7 Testing firm is to report results of tests immediately to the Contractor and the Department Representative. The Contractor is responsible for ensuring that the concrete meets the requirements of the specifications.
- .8 Testing firm is to submit to the Department Representative and Contractor copies of test results. Include the following information with the results:
 - .1 Name of the project.
 - .2 Date of sampling.
 - .3 Mix design, specified strength, slump and air content.
 - .4 Name of supplier, truck and ticket number.
 - .5 Time batched and time placed.
 - .6 Identification of sampling and testing technician.
 - .7 Cement type and admixtures used.
 - .8 Exact location in the structure of the concrete sampled.
 - .9 Ambient air and concrete temperatures.
 - .10 Nominal aggregate size.
 - .11 Water added and personnel authorizing additional water.
 - .12 Concrete density.
- .9 Inspection and Testing of Grout
 - .1 In accordance with ASTM C109, provide at least two (2) cube tests on all types of non-shrink grout used.
- .10 Ensure test results are distributed for discussion at pre-pouring concrete meeting between Contractor, testing laboratory and Department Representative.
- .11 Department Representative will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .12 Non-Destructive Methods for Testing Concrete: in accordance with CSA-A23.1/A23.2.
- .13 Inspection or testing by Department Representative will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

3.5 VERIFICATION

- .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established in PART 2 - PRODUCTS, by Department Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

3.6 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Divert unused concrete materials from landfill to local quarry or facility.
 - .2 Provide appropriate area on job site where concrete trucks and be safely washed.
 - .3 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site.
 - .4 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
 - .5 Prevent admixtures and additive materials from entering drinking water supplies or streams.
 - .6 Using appropriate safety precautions collect liquid or solidify liquid with inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

END OF SECTION

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Cast-In-Place Concrete Section 03 30 00

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.40-97, Anti-corrosive Structural Steel Alkyd Primer.
.2 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 CSA International
.1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .3 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
.1 SCAQMD Rule 1168-A2005, Adhesive & Sealants Applications.

1.3 QUALITY ASSURANCE

- .1 Standards: Conform to CAN/CSA-A23.1, for concrete finishes.
- .2 Installer Qualifications:
.1 Work shall be carried out by personnel who are thoroughly trained and experienced in the floor treatment. The installer to provide a list of a minimum of 3 projects performed within 3 years of equivalent complexity and scope as this contract.
- .3 Pre-installation Meeting:
.1 Prior to commencement of Work on site, convene a pre-installation conference to be attended by the Contractor, Coating Subcontractor, Manufacturer's Technical Representative, Consultant and Owner to review:
.1 Convey proper installation and placement of concrete slabs to ensure proper concrete finishing requirements in order to achieve adequate floor polishing application.
.2 Convey to Contractor Requirements for protection of concrete slabs to receive concrete floor polishing and to coordinate sequence of work and application during construction.

1.4 SUBMITTALS

- .1 Submittals to be in accordance with 01 33 00 Submittal Procedures.
- .2 Product Data:
.1 Provide manufacturer's printed product literature and data sheets for concrete finishes and include product characteristics, performance criteria, physical size, finish and limitations.
.1 Provide two copies of WHMIS MSDS in accordance with Section 01 35 33-Health & Safety Requirements. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content in g/L.
.2 Include application instructions for concrete floor treatments.
- .3 Submit maintenance instructions for insertion in operations and maintenance manuals. Instructions shall give specific warning of maintenance or cleaning practices or materials, which may damage installed work.

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 and storage requirements:
 - .1 Deliver materials to site in manufacturer's original factory packaging, labelled with manufacturer's name and address.
 - .2 Store materials in a clean dry area in accordance with manufacturer's instructions.
 - .3 Keep product from freezing.
 - .4 Avoid direct contact with this product as it may cause mild to moderate irritation of the eyes and/or skin.
 - .5 Protect materials during handling and application to prevent damage or contamination.
- .3 Dispense special concrete finish material from sealed containers.
- .4 Packaging Waste Management: Comply with requirements of Section 01 74 19 Waste Management and Disposal.
- .5 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials, and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

1.6 ENVIRONMENTAL REQUIREMENTS / PROJECT CONDITIONS

- .1 Do not apply product when air, surface, or material temperature is below 35°F (2°C) or above 135°F (57°C).
2. Do not apply to frozen concrete.
3. Do not use on highly dense or non-porous surfaces.
4. Allow concrete to cure a minimum of 45 days, or as otherwise acceptable by product manufacturer before commencement of work.
5. Do not commence with polishing until Work has been sufficiently advanced, whereby Work yet to be performed will not adversely affect polished concrete floors. Application of products shall take place a minimum of 21 days prior to fixture and trim installation and Substantial Performance of Work.
6. Limit and control dust generated by grinding and polishing procedures in order to prevent potential damage to adjacent surfaces and equipment.
7. Control the use of water. Remove standing water from completed floor surfaces.
8. Ensure that penetrating sealers are not applied to concrete floors that are to be polished.

1.7 EXTENDED WARRANTY

1. Provide two (2) year manufacturer's warranty on products and installation against fading and delamination of finished surfaces.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Concrete materials shall conform to requirements of Section 03 30 00-Cast-In-Place Concrete Short Form and CAN/CSA-A23.1.
- .2 Bonding Agent: Formulated for bonding new concrete to cured concrete. Acceptable Products:
 - .1 "Polymer Bonding Agent" by Target Products Ltd.
 - .2 "710 Flex-Con" by Else Construction Products.

- .3 "K-710 Krytobond" by Kryton International Inc.
 - .4 "Fabribond-A" by Fabrikem Manufacturing Ltd.
 - .5 Or approved alternative.
- .3 Curing and Sealing Compound: Surface Sealer: to CAN/CGSB-25.20, Water based polyurethane sealer.
- .4 Non-Shrink Grout (for patching): Acceptable Products:
- .1 "Embeco Mortar" by Master Builders Company Limited.
 - .2 Pre-mixed "Fast-Set Patching Concrete" by Target Products Ltd
 - .3 "810 Gengrout" by Elsro Construction Products.
 - .4 "K-510 Krytol Patch/Grout" by Kryton International Inc.
 - .5 Or approved alternative.

2.2 FINISHES

- .1 Trowelled finish for all new concrete floor and concrete pit (wall+ floor) and finished with polyurethane sealer.

3.0 EXECUTION

3.1 FINISHING-GENERAL

- .1 Do concrete finishing work in accordance with CAN/CSA-A23.1-M09, unless otherwise indicated.

3.2 HORIZONTAL SURFACES

- .1 Where floor drains occur, floors to be level around walls and have a minimum 1:50 uniform pitch to drains, unless indicated otherwise.
- .2 Finish horizontal concrete surfaces as follows:
 - .1 Exposed horizontal surfaces not intended to receive additional concrete: Smooth steel trowel finish or as indicated on the drawings.
 - .2 Horizontal concrete surfaces intended to receive waterproofing membrane or applied floor finishes: Smooth, steel trowel finish. Floors to be finished flat, free from defects which would telegraph through finish material.
 - .3 Horizontal concrete surfaces intended to receive additional concrete toppings, quarry tile or ceramic tile: Screeded off to true lines and levels shown, roughened to an amplitude of 3/16" (5 mm), cleaned of laitance and loose concrete and left ready to receive finish. Depress slabs to accommodate finish where indicated.
 - .4 Broom Finish: After completion of floating and when excess moisture of surface sheen has disappeared, complete surface finishing by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Consultant.

3.4 PLAIN FLOOR FINISH (TROWELLED)

- .1 Roll or tamp concrete to force coarse aggregate into concrete mix and then screed.
- .2 Float surface with wood or metal floats or with power finishing machine and bring surface to true grade.
- .3 Steel trowel to smooth and even surface.

- .4 Follow with second steel trowelling to produce smooth burnished surface to within tolerance described in CAN/CSA-A23.1-M09, Clause 22.1.2-Straight-Edge Method for Very Flat Classification Finish 1/8" (3 mm) in 10'-0" (3000 mm) to all floors receiving carpet, resilient flooring, liquid applied flooring, thin-set ceramic tile. All other floors shall be finished to Flat Classification Finish 3/16" (5 mm) in 10'-0" (3000 mm). Floors shall be true to plane as determined by a 10'-0" (3.0 meter) straight-edge placed anywhere on the surfaces in any direction. Check conformance to tolerance limits at any time after the curing period. Where this Section conflicts with other Sections in Division 3, this Section shall govern.
- .5 Sprinkling of dry cement or dry cement and sand mixture over concrete surfaces is not acceptable.
- .6 Apply curing compound in accordance with manufacturer's instructions to all areas not scheduled to receive further floor finish.
- .7 Protect surfaces which will be exposed to direct sunlight during the curing period in accordance with manufacturer's instructions.

3.5 SEALED FLOOR FINISH

- .1 Roll or tamp concrete to force coarse aggregate into concrete mix and then screed and apply non-metallic hardener to manufacturer's instructions.
- .2 Apply first shake of aggregate (one half of amount) after floating.
- .3 Float first shake and apply second shake.
- .4 Float second shake.
- .5 Flat steel trowel to produce fine texture non-slip finish.
- .6 Apply two coats of curing and sealing compound in accordance with manufacturer's directions.

3.6 BONDING AGENT

- .1 Apply bonding agent to all concrete when new concrete will be applied against it under the following conditions:
 - .1 Patching.
 - .2 Feathering.
 - .3 Construction joints.
 - .4 Bonding of topping slabs.

3.7 DEFECTIVE WORK

- .1 Repair honeycombing, rock packets, chips, spalls and other voids in exposed concrete surfaces, using patching materials as specified to provide a smooth surface. Remove fins and other protrusions in concrete surfaces. Maximum allowable depth of grinding to be 1/16".
- .2 Consult with Departmental Representative on the repair of defective concrete surfaces prior to execution of the work.
- .3 Patch form tie holes in all exposed concrete surfaces and surfaces designated to receive waterproofing unless otherwise directed.
- .4 Where in the opinion of Departmental Representative, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the consultant at no additional cost to the owner.

3.8 PROTECTION

- .1 Take every precaution to protect finished surfaces from stains and abrasions. Surfaces and edges likely to be damaged during the construction period shall be especially protected.
- .2 Protect work of other sections from damage resulting from work of this Section.
- .3 Provide suitable enclosures for collecting grit and dust from sandblasting operation.
- .4 Erect barricades to prevent traffic on newly finished surfaces.
- .5 Suggested protection in high traffic areas after the sealer has been applied is as follows:
 - .1 Place cheap colourfast carpet that is breathable (not rubber backed), fuzzy side down or Protect CP board.
 - .2 Masonite or plywood may then be applied over the carpet/cardboard for further protection.

3.9 ADJUSTING & CLEANING

- .1 Progress Cleaning: Clean during progress of the Work in accordance with Section 01 74 11- Cleaning.
- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11- Cleaning.
- .3 Repair, remove and clean all drips or smears resulting from the work of this section on exposed, finished surfaces or surfaces to be subsequently finished.
- .4 Engage a concrete finish manufacturer's authorized representative to train Owner's maintenance personnel on proper maintenance procedures

END OF SECTION 03 35 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Masonry Mortar and Grout Section 04 05 12
- .2 Masonry Anchorage and Reinforcing Section 04 05 19
- .3 Concrete Unit Masonry. Section 04 22 00

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-A165 Series-04, Standards on Concrete Masonry Units.
 - .2 CSA A179-04, Mortar and Grout for Unit Masonry.
 - .3 CSA-A371-04, Masonry Construction for Buildings.
- .2 International Masonry Industry All-Weather Council (IMIAC)
 - .1 Recommended Practices and Guide Specification for Hot and Cold Weather Masonry Construction.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation meetings: comply with Section 01 31 19 - Project Meetings. Conduct pre-installation meeting one week prior to commencing work of this Section and on-site installations to:
 - .1 Verify project requirements, including mock-up requirements.
 - .2 Verify substrate conditions.
 - .3 Co-ordinate products, installation methods and techniques.
 - .4 Sequence work of related sections.
 - .5 Co-ordinate with other building subtrades.
 - .6 Review manufacturer's installation instructions.
 - .7 Review masonry cutting operations, methods and tools and determine worker safety and protection from dust during cutting operations.
 - .8 Review warranty requirements.
- .2 Sequencing: sequence with other work in accordance with 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart. Comply with manufacturer's written recommendations for sequencing construction operations.
- .3 Scheduling: schedule with other work in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.

1.4 ACTION & 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, limitations and colours.
 - .2 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) – Material Safety Data Sheets (MSDS).

1.5 INFORMATION & SUBMITTALS

- .1 Certificates: provide manufacturer's product certificates certifying materials comply with specified requirements.

- .2 Test and Evaluation Reports:
 - .1 Provide certified test reports in accordance with Section 01 45 00 Quality Control
 - .2 Test reports to certify compliance of masonry units and mortar ingredient with specified performance characteristics and physical properties.
 - .3 Provide data for masonry units, in addition to requirements set out in referenced CSA and ASTM Standards, indicating initial rates of absorption.
- .3 Installer Instructions: provide manufacturer's installation instructions, including storage, handling, safety and cleaning.
- .4 Manufacturer's Reports: provide written reports prepared by manufacturer's on-site personnel to include:
 - .1 Verification of compliance of work with Contract.
 - .2 Site visit reports providing detailed review of installation of work, and installed work.
- .5 Submit shop drawings for temporary bracing according to Section 01 33 00 Submittal Procedures.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide manufacturer's instructions for care, cleaning and maintenance of prefaced masonry units for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Manufacturer: capable of providing field service representation during construction and approving application method.
 - .2 Ensure manufacturer has minimum 5 years experience in manufacturing components similar to or exceeding requirements of project.
 - .3 Installer: experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
 - .4 Masons: company or person specializing in masonry installations with 5 years experience with masonry work similar to this project.
 - .1 Masons employed on this project must demonstrate ability to reproduce mock-up standards.
- .2 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construction mock-up panel of exterior and interior masonry wall 2000 mm long x 1800 mm high showing masonry colours and textures, use of reinforcement, mortar, grout and workmanship.
 - .3 Mock-up used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
 - .4 Construct mock-up where directed by Departmental Representative.
 - .5 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with work.
 - .6 When accepted by Departmental Representative, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.
 - .7 Start work only upon receipt of written acceptance of mock-up by Departmental Representative.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in accordance with Section 01 61 00 - Product Requirements.

- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Storage and Handling Protection:
 - .1 Keep materials dry until use.
 - .2 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.
 - .3 Packaging Waste Management:
 - .1 Remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management And Disposal.

1.9 SITE CONDITIONS

- .1 Ambient Conditions: assemble and erect components when temperatures are above 4 degrees C.
- .2 Weather Requirements: to CSA-A371 to IMIAC - Recommended Practices and Guide Specifications for Hot and Cold Weather Masonry Construction.
- .3 Cold weather requirements:
 - .1 To CSA-A371 with following requirements.
 - .1 Maintain temperature of mortar between 5 degrees C and 50 degrees C until batch is used or becomes stable.
 - .2 Maintain ambient temperature of masonry work and it's constituent materials between 5 degrees C and 50 degrees C and protect site from windchill.
 - .3 Maintain temperature of masonry above 0 degrees C for minimum of 3 days, after mortar is installed.
 - .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10 degrees C, before applying mortar.
 - .2 Hot weather requirements:
 - .1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
 - .2 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
 - .3 Spray mortar surface at intervals and keep moist for maximum of three days after installation.

1.10 WARRANTY

- .1 For Work in this Section 04 05 00 - Common Work Results for Masonry, Provide 12 months warranty period for concrete masonry.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Masonry materials are specified elsewhere in related Sections:
 - .1 Section 04 22 00 Concrete Unit Masonry.

3.0 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 EXAMINATION

- .1 Examine conditions, substrates and work to receive work of this Section.
 - .1 Co-ordinate with Section 01 71 00 - Examination and Preparation.
- .2 Examine openings to receive masonry units. Verify opening size, location, and that opening is square and plumb, and ready to receive work of this Section.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation after unacceptable conditions have been remedied and after receipt of written approval from Departmental Representative.
- .3 Verification of Conditions:
 - .1 Verify that:
 - .1 Substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete block and glass block.
 - .2 Field conditions are acceptable and are ready to receive work.
 - .3 Built-in items are in proper location, and ready for roughing into masonry work.
 - .2 Commencing installation means acceptance of existing substrates.

3.3 PREPARATION

- .1 Surface Preparation: prepare surface in accordance with manufacturer's written recommendations and co-ordinate with Section 01 71 00 - Examination and Preparation.
- .2 Establish and protect lines, levels, and coursing.
- .3 Protect adjacent materials from damage and disfiguration.

3.4 INSTALLATION

- .1 Do masonry work in accordance with CSA-A371 except where specified otherwise.
- .2 Build masonry plumb, level, and true to line, with vertical joints in alignment, respecting construction tolerances permitted by CSA-A371.
- .3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.5 CONSTRUCTION

- .1 Exposed masonry:
 - .1 Remove chipped, cracked, and otherwise damaged units, in accordance with CSA A-165, in exposed masonry and replace with undamaged units.
- .2 Jointing:
 - .1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, joints true to line, compressed, uniformly concave joints where concave joints are indicated.
 - .2 Allow joints to set just enough to remove excess water, then rake joints uniformly to 6 mm depth and compress with square tool to provide smooth, compressed, raked joints of uniform depth where raked joints are indicated.
 - .3 Strike flush joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

- .3 Cutting:
 - .1 Cut out for electrical switches, outlet boxes, and other recessed or built-in objects.
 - .2 Make cuts straight, clean, and free from uneven edges.
- .4 Building-In:
 - .1 Build in items required to be built into masonry.
 - .2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
 - .3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.
- .5 Wetting of bricks:
 - .1 Except in cold weather, wet bricks having initial rate of absorption exceeding 1 g/minute/1000 mm²: wet to uniform degree of saturation, 3 to 24 hours before laying, and do not lay until surface dry.
 - .2 Wet tops of walls built of bricks qualifying for wetting, when recommencing work on such walls.
- .6 Support of loads:
 - .1 Use 25 MPa concrete to Section 03 30 00 - Cast-in-Place Concrete, where concrete fill is used in lieu of solid units.
- .7 Provision for movement:
 - .1 Leave space between top of non-load bearing walls and partitions and structural elements. Do not use wedges. Refer to structural drawings for details.
- .8 Interface with other work:
 - .1 Cut openings in existing work as indicated.
 - .2 Openings in walls: reviewed by Departmental Representative.
 - .3 Make good existing work. Use materials to match existing.

3.6 SITE TOLERANCES

- .1 Tolerances in notes to CSA-A371 apply.

3.7 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection:
 - .1 Perform field inspection and testing in accordance with Section 01 45 00 - Quality Control.
 - .2 Notify inspection agency minimum of 24 hours in advance of requirement for tests.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Progress Cleaning: in accordance with related masonry sections.
- .3 Final Cleaning:
 - .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
 - .2 Upon completion of installation and verification of performance of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal

- .1 Divert unused or damaged masonry units from landfill as specified in Section 01 74 19 - Waste Management and Disposal.

3.9 PROTECTION

- .1 Temporary Bracing:
 - .1 Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.
 - .2 Brace masonry walls as necessary to resist wind pressure and lateral forces during construction.
- .2 Moisture Protection:
 - .1 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until completed and protected by flashing or other permanent construction.
 - .2 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.
Air Temperature Protection: protect completed masonry as recommended in 1.9 SITE CONDITIONS.

END OF SECTION 04 05 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Common Work Results for Masonry Section 04 05 00
- .2 Concrete Unit Masonry Section 04 22 00

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA A179-04, Mortar and Grout for Unit Masonry.
 - .3 CAN/CSA A371-04, Masonry Construction for Buildings.
 - .4 CAN/CSA-A3000-08, Cementitious Materials Compendium
- .2 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
 - .1 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMAL SUBMITTALS

- .1 Product Data:
 - .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Provide manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
 - .3 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 33 - Health and Safety Requirements and 01 35 43 - Environmental Procedures. Indicate VOC's mortar, grout, parging, colour additives and admixtures. Express as grams per litre (g/L).
- .2 Samples:
 - .1 Samples: provide unit samples in accordance with Section 04 05 00 - Common Work Results for Masonry, supplemented as follows:
 - .1 Provide two size samples of mortar coloured mortar.
 - .2 Provide samples and confirmation of source or product data sheet, prior to mixing or preparation of mortars, to Departmental Representative.
 - .1 Aggregate: course aggregate and sand.
 - .2 Cement.
 - .3 Lime.
 - .4 Colour pigment samples.
- .3 Manufacturer's Instructions:
 - .1 Provide manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports including sand gradation tests in accordance with CAN/CSA A179 showing compliance with specified performance characteristics and physical properties, and in accordance with Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Submit laboratory test reports in accordance with Section 01 45 00 - Quality Control
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements,

manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Section 01 31 19 Project Meetings.

.4 Mock-ups:

- .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control and requirements of Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Construction mock-up panel of 2000mm long x 1800mm high using proposed procedures, colors, texture, finish and workmanship.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handles masonry mortar and grout materials in accordance with Section 01 61 00 - Product Requirements, supplemented as follows:
 - .1 Deliver prepackaged, dry-blended mortar mix to project site in labelled plastic-lined bags each bearing name and address of manufacturer, production codes or batch numbers, and colour or formula numbers.
 - .2 Maintain mortar, grout and packaged materials clean, dry, and protected against dampness, freezing, traffic and contamination by foreign materials.
- .2 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 SITE CONDITIONS

- .1 Weather Requirements: CAN/CSA A371 International Masonry Industry All-Weather Council (IMIAC) - Recommended Practices and Guide Specifications for Hot and Cold Weather Masonry Construction.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Use same brands of materials and source of aggregate for entire project.
- .2 Cement:
 - .1 Portland Cement: to CAN/CSA-A3000, Type GU - General use hydraulic cement Type 10 gray colour.
 - .1 Use low VOC products in compliance with SCAQMD Rule 1168.
 - .2 Masonry Cement: to CAN/CSA-A3002 and CAN/CSA A179.
 - .3 Mortar Cement: to CAN/CSA-A3002 and CAN/CSA A179.
 - .1 Use low VOC products in compliance with SCAQMD Rule 1168.
 - .4 Packaged Dry Combined Materials for mortar: to CAN/CSA A179, Type S, using gray colour cement.
- .3 Aggregate: supplied by one supplier.
 - .1 Aggregate: to CAN/CSA A179, Table 3 10mm maximum size.
- .4 Water: clean and potable.
- .5 Lime:
 - .1 Quick Lime: to CAN/CSA A179, Type S.
 - .2 Hydrated Lime: to CAN/CSA A179, Type S.
- .6 Bonding Agent: latex type.

- .7 Polymer Latex: organic polymer latex admixture of butadiene-styrene type non-emulsifiable bonding admixture.

2.2 COLOUR ADDITIVES

- .1 Use colouring admixture not exceeding 10% of cement content by mass, or integrally coloured masonry cement, to produce coloured mortar to match approved sample. Admixtures to be approved prior to use. Use in accordance with the specific manufacturer's recommendations.
- .2 White mortar: use white Portland cement, and lime to produce mortar type specified.

2.3 MORTAR MIXES

- .1 Mortar for interior masonry:
 - .1 Loadbearing: type S based on property specifications.
 - .2 Non-Loadbearing: N based on property specifications.

2.4 MORTAR MIXING

- .1 Use pre-blended, pre-coloured mortar prepackaged under controlled factory conditions. Ingredients batching limitations to be within 1% accuracy.
- .2 Mix mortar ingredients in accordance with CAN/CSA A179 in quantities needed for immediate use.
- .3 Maintain sand uniformly damp immediately before mixing process.
- .4 Add mortar colour and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and colouration.
- .5 Do not use anti-freeze compounds including calcium chloride or chloride based compounds.
- .6 Do not add air entraining admixture to mortar mix.
- .7 Use a batch type mixer in accordance with CAN/CSA A179.
- .8 Pointing mortar: prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour no more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.
- .9 Re-temper mortar only within two hours of mixing, when water is lost by evaporation.
- .10 Use mortar within 2 hours after mixing at temperatures of 32 degrees C, or 2-1/2 hours at temperatures under 10 degrees C.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Request inspection of spaces to be grouted.

3.2 PREPARATION

- .1 Apply bonding agent to existing concrete surfaces.
- .2 Plug clean-out holes with block masonry units. Brace masonry for wet grout pressure.

3.3 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.4 CONSTRUCTION

- .1 Do masonry mortar and grout work in accordance with CAN/CSA A179 except where specified otherwise.

3.5 MIXING

- .1 All pointing mortar can be mixed using a regular paddle mixer. Only electric motor mixers are permissible. Mixers run on hydrocarbons are not permitted, due to fumes, Mixing by hand must be pre-approved by the Departmental Representative.
- .2 Clean all mixing boards and mechanical mixing machine between batches.
- .3 Mortar must be weaker than the units it is binding.
- .4 Contractor to appoint one individual to mix mortar, for duration of project. In the event that this individual must be changed, mortar mixing must cease until the new individual is trained, and mortar mix is tested.

3.6 MORTAR PLACEMENT

- .1 Install mortar to manufacturer's instructions.
- .2 Remove excess mortar from grout spaces.

3.7 GROUT PLACEMENT

- .1 Install grout in accordance with manufacturer's instructions.
- .2 Install grout in accordance with CAN/CSA A179.
- .3 Work grout into masonry cores and cavities to eliminate voids.
- .4 Do not install grout in lifts greater than 400 mm, without consolidating grout by rodding.
- .5 Do not displace reinforcement while placing grout.

3.8 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Test and evaluate mortar prior to construction and during construction in accordance with CAN/CSA A179.
 - .2 Test and evaluate grout prior to construction and during construction to CAN/CSA A179; test in conjunction with masonry unit sections specified.

3.9 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .2 Remove droppings and splashings using clean sponge and water.
- .3 Clean masonry with low pressure clean water and soft natural bristle brush.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section

01 74 19 - Waste Management and Disposal

3.10 PROTECTION OF COMPLETED WORK

- .1 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.

END OF SECTION 04 05 12

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Common Work Results for Masonry Section 04 05 00
- .2 Concrete Unit Masonry Section 04 22 00

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM A 36/A 36M- 12, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A 82/A 82M- 07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - .3 ASTM A 167- 99 (2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .4 ASTM A 307- 12, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - .5 ASTM A 580/A 580M- 13a, Standard Specification for Stainless Steel Wire.
 - .6 ASTM A 641/A 641M- 09a, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .7 ASTM-A666- 10, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A23.1/A23.2- 09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA A179- 04, Mortar and Grout for Unit Masonry.
 - .3 CAN/CSA A370- 04, Connectors for Masonry.
 - .4 CAN/CSA A371- 04, Masonry Construction for Buildings.
 - .5 CAN/CSA G30.18- M92 (R2007), Billet-Steel Bars for Concrete Reinforcement.
 - .6 CSA-S304.1- 04, Design of Masonry Structures.
 - .7 CSA W186- M1990 (R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 ACTION AND INFORMAL 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 datasheets illustrating products to be incorporated into project for specified products.
 - .2 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 33 - Health and Safety Requirements.
- .3 Manufacturer's Instructions:
 - .1 Provide manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements,

manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Section 04 05 00 - Common Work Results for Masonry.

- .4 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control and requirements of Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Construct mock-ups same; s pf reinforcement installation and anchorage installation.
 - .2 Sample panel: 2000mm long x 1800mm high using proposed procedures, anchorage material, connectors, reinforcement material, and workmanship.

1.5 FIELD MEASUREMENTS

- .1 Make field measurements necessary to ensure proper fit of members.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle masonry anchorage and reinforcing materials in accordance with Section 01 61 00 - Product Requirements, supplemented as follows:
 - .1 Deliver reinforcement and connectors, identified in shop and placement drawings.
- .2 Packaging Waste Management:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Bar reinforcement: Steel to CAN/CSA A371 and CAN/CSA G30.18, Grade 400.
- .2 Connectors: to CAN/CSA A370 and CSA-S304.1.
- .3 Corrosion protection: to CSA-S304.1, galvanized to CSA-S304.1 and CAN/CSA A370.
- .4 Fasteners: installed post-construction:
 - .1 Bolts and Screws: size and type to suit application, locate where indicated.
 - .2 Nails: case-hardened cut or spiral nails, size and type to suit fastening application.
 - .3 Powder-Driven Fasteners: pin styles and lengths to suit fastening application in accordance with manufacturers use, load and hold recommendations.
 - .4 Adhesives: epoxies, mastics and contact cements for fastening applications, use in accordance with manufacturers' recommendations.
- .5 Ties: Stainless Steel conforming to ASTM A580, Type 304, 4.8mm siderods with 3mm cross ties.
 - .1 Unit ties, to CAN/CSA A370: wire stainless steel, size to suit application.
 - .2 Adjustable Unit Ties: to CAN/CSA A370: proprietary type ties, type, style and size to suit application in accordance with manufacturer's recommendations.
 - .3 Joint Reinforcement Ties: to CAN/CSA A370:
 - .1 Single Wythe Joint Reinforcement: ladder type:
 - .1 Steel wire, hot dip galvanized: to ASTM A 641, Class 3 after fabrication.
 - .2 Cold drawn steel wire conforming to ASTM A 82.
 - .3 Stainless steel conforming to ASTM A 580, Type 304, 4.8 mm side rods with 3 mm cross ties.
 - .2 Multiple Wythe Joint Reinforcement: ladder type: without moisture drip; adjustable:
 - .1 Steel wire, hot dip galvanized: to ASTM A 641 Class 3 after fabrication.

- .2 Cold drawn steel wire conforming to ASTM A 82.
- .3 Stainless steel conforming to ASTM A 580 Type 304, 4.8 mm side rods with 3 mm cross rods.
- .4 Anchors: to CAN/CSA A370:
 - .1 Conventional Anchors: type steel bolts with bent bar anchors; plate anchors; through bolts, shape, J or L, sized to suite application.
 - .2 Wedge Anchors: expansion anchors type; wedge and bolt sized to suit application.
 - .3 Sleeve Anchors: type sleeve and bolt, sized to suit application.
 - .4 Self-Contained Anchors: type double glass/plastic vial system, with epoxy resin and hardener
 - .5 Dovetail Anchors: bent steel strap, galvanized to CAN/CSA A370 Table 5.2 coated finish.
 - .6 Spiral Anchors: 8 mm stainless steel spiral anchors to Grade 304.
 - .7 Stone Anchors: series 300 stainless steel conforming to ASTM A 666. Anchors to be manufactured.
 - .8 Anchor Bolts: conventional unpatented anchors, steel, uncoated finish.
- .5 Conventional Bolts:
 - .1 Bolts: to ASTM A 36, bar stock shop threaded, straight bolts with square or hex-headed nuts; bent bar anchors, J or L shaped.
 - .2 Plate anchors: steel to ASTM A 36, weld square of circular steel plate perpendicular to axis of steel bar threaded on opposite end.
 - .3 Through bolt rods: to ASTM A 307 threaded rod or threaded ASTM A 36 bar stock.
- .6 Adhesive Anchors: proprietary systems, pre-mixed, self-contained system with double glass vial system to contain epoxy, consisting of resin, hardener and aggregate.

2.2 FABRICATION

- .1 Fabricate reinforcing in accordance with CAN/CSA-A23.1 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Fabricate connectors in accordance with CAN/CSA A370.
- .3 Obtain Departmental Representative's approval for locations of reinforcement splices other than shown on placing drawings.
- .4 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.
- .5 Ship reinforcement and connectors clearly identified in accordance with drawings.

2.3 SOURCE QUALITY CONTROL

- .1 Provide Departmental Representative certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum 2 weeks prior to commencing reinforcement work.
- .2 Inform Departmental Representative of proposed source of material to be supplied.

3.0 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PREPARATION

- .1 Direct and coordinate placement of metal anchors for masonry supplied to other Sections.

3.3 INSTALLATION

- .1 Supply and install masonry connectors and reinforcement in accordance with CAN/CSA A370, CAN/CSA A371, CAN/CSA-A23.1 and CSA-S304.1 unless indicated otherwise.
- .2 Prior to placing mortar, obtain Departmental Representative's approval of placement of reinforcement and connectors.
- .3 Supply and install additional reinforcement to masonry as indicated.

3.4 BONDING AND TYING

- .1 Bond walls of two or more wythes using metal connectors in accordance with CSA-S304.1, CAN/CSA A371 and as indicated.
- .2 Tie masonry veneer to backing in accordance with NBC, CSA-S304.1, CAN/CSA A371 and as indicated.
- .3 Install unit, adjustable, single wythe and multiple wythe joint reinforcement where indicated and in accordance with CAN/CSA A370 and CAN/CSA A371 manufacturer's instructions.
 - .1 Bond walls of two or more wythes using metal connectors in accordance with CAN/CSA A371 and as indicated.
 - .2 Install horizontal joint reinforcement 400 mm on centre.
 - .3 Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
 - .4 Place joint reinforcement continuous in first and second joint below top of walls.
 - .5 Lap joint reinforcement ends minimum 150 mm.
 - .6 Connect stack bonded unit joint corners and intersections with strap anchors 400 mm on centre.

3.5 REINFORCED LINTELS AND BOND BEAMS

- .1 Reinforce masonry beams, masonry lintels and bond beams as indicated.
- .2 Place and grout reinforcement in accordance with CSA-S304.1, CAN/CSA A371, and CAN/CSA A179.
- .3 Support and position reinforcing bars in accordance with CAN/CSA A371.

3.6 GROUTING

- .1 Grout masonry in accordance with CSA-S304.1, CAN/CSA A371 and CAN/CSA A179 and as indicated.

3.7 ANCHORS

- .1 Supply and install metal anchors in accordance with CAN/CSA A370 and CAN/CSA A371 as indicated.

3.8 LATERAL SUPPORT AND ANCHORAGE

- .1 Supply and install lateral support and anchorage in accordance with CSA-S304.1 and as indicated.

3.9 MOVEMENT JOINTS

- .1 Reinforcement will not be continuous across movement joints unless otherwise indicated.

3.10 FIELD BENDING

- .1 Do not field bend reinforcement and connectors except where indicated or authorized by

Departmental Representative.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars and connectors which develop cracks or splits.

3.11 FIELD QUALITY CONTROL

.1 Site inspections in accordance with Section 04 05 00 - Common Work Results for Masonry.

.2 Obtain Departmental Representative approval of placement of reinforcement and connectors, prior to placing mortar.

3.12 FIELD TOUCH-UP

.1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

3.13 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION 04 05 19

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Common Work Results for Masonry Section 04 05 00.
- .2 Masonry Mortar and Grout Section 04 05 12
- .3 Masonry Anchorage and Reinforcing Section 04 05 19

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A165 Series-2004, CSA Standards on Concrete Masonry Units covers: A165.1, A165.2, A165.3.
 - .2 CAN/CSA A371-04, Masonry Construction for Buildings.
 - .3 CSA S304.1-04, Design of Masonry Structures.
- .2 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
 - .1 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S101-07, Standard Methods of Fire Endurance Tests of Building Construction and Materials.

1.3 ACTION & INFORMAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Product Data: provide product data, including manufacturer's printed data sheets and catalog pages illustrating products to be incorporated into project for specified products.
- .3 Manufacturer's Written Instructions: provide in accordance with Section 04 05 00 - Common Work Results for Masonry.

1.4 QUALITY ASSURANCE SUBMITTALS

- .1 Certificates: provide in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Test and Evaluation Reports: provide certified test reports in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .3 Pre-Installation Meetings: conduct pre-installation meeting in accordance with Section 04 05 00 - Common Work Results for Masonry to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
- .4 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control and requirements of Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Construct mock-up panel of interior concrete unit masonry construction 1200 x 1800 mm.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle concrete unit masonry in accordance with Section 04 05 00 - Common Work Results for Masonry.

- .2 Packaging Waste Management:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Standard concrete block units Type : to CAN/CSA-A165.
 - .1 Classification: H/15/A/M.
 - .2 Dimensions - Nominal: 200 mm wide x200 mm high x 400 mm long or as specified.
 - .3 Special shapes: provide square units for exposed corners. Provide purpose-made shapes for lintels, beams and bond beams. Provide additional special shapes as indicated.
 - .4 Colour:
 - .1 Integrally coloured pre-finished architectural concrete block with one or more faces ground to expose variegated colours of natural aggregates; with factory-applied clear satin gloss acrylic finish.
 - .2 Unit faces filled with cementitious grout, polished with factory applied clear satin gloss acrylic finish.

2.2 REINFORCEMENT

- .1 Reinforcement in accordance with Section 04 05 19 - Masonry Anchorage Reinforcing.

2.3 CONNECTORS

- .1 Connectors in accordance with Section 04 05 19 - Masonry Anchorage Reinforcing.

2.4 MORTAR MIXES

- .1 Mortar and mortar mixes in accordance with Section 04 05 12 - Masonry Mortar and Grout.

2.5 GROUT MIXES

- .1 Grout and grout mixes in accordance with Section 04 05 12 - Masonry Mortar and Grout.

2.6 CLEANING COMPOUNDS

- .1 Use low VOC products in compliance with SCAQMD Rule 1168.
- .2 Compatible with substrate and acceptable to masonry manufacturer for use on products.
- .3 Cleaning compounds compatible with concrete unit masonry and in accordance with manufacturer's written recommendations and instructions.

2.7 TOLERANCES

- .1 Tolerances for standard concrete unit masonry tolerances in accordance with CAN/CSA A165.1, supplemented as follows:
 - .1 Maximum variation between units within specific job not to exceed 2 mm.
 - .2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.
 - .3 Out of square tolerance not to exceed 2 mm.

3.0 EXECUTION

- .1 Verify surfaces and conditions are ready to accept work of this Section.
- .2 Commencing installation means acceptance of existing substrates.

3.2 PREPARATION

- .1 Protect adjacent finished materials from damage due to masonry work.

3.3 INSTALLATION

- .1 Concrete block units:
 - .1 Bond: running.
 - .2 Coursing height: 200mm for one block and one joint.
 - .3 Jointing: concave where exposed or where paint or other finish coating is specified.
- .2 Special Shapes:
 - .1 Install special units to form corners, returns, offsets, reveals and indents without cut ends being exposed and without losing bond or module.
 - .2 Install reinforced concrete block lintels over openings in masonry where steel or reinforced concrete lintels are not indicated.
 - .3 End bearing: not less than 200 mm.
 - .4 Install special site cut shaped units.

3.4 REINFORCEMENT

- .1 Install reinforcing in accordance with Section 04 05 19 - Masonry Anchorage Reinforcing.

3.5 CONNECTORS

- .1 Install connectors in accordance with Section 04 05 19 - Masonry Anchorage Reinforcing.

3.6 MORTAR PLACEMENT

- .1 Place mortar in accordance with Section 04 05 12 - Masonry Mortar and Grout.

3.7 GROUT PLACEMENT

- .1 Place grout in accordance with Section 04 05 12 - Masonry Mortar and Grout.

3.8 CONSTRUCTION

- .1 Cull out masonry units, in accordance with CAN/CSA A165 and reviewed range of colour samples, with chips, cracks, broken corners, excessive colour and texture variation.
- .2 Build in miscellaneous items such as bearing plates, steel angles, bolts, anchors, inserts, sleeves and conduits.
- .3 Construct masonry walls using running bond unless otherwise noted.
- .4 Build around frames previously set and braced. Fill behind hollow frames within masonry walls with mortar or grout and embed anchors.
- .5 Fit masonry closely against electrical and plumbing outlets so collars, plates and covers overlap and conceal cuts.
- .6 Install movement joints and keep free of mortar where indicated.
- .7 Hollow Units: spread mortar setting bed from outside edge of face shells. Gauge amount of mortar on top and end of unit to create full joints, equivalent to shell thickness. Avoid excess mortar.
- .8 Ensure compacted head joints. Use full or face-shell joint as indicated.
- .9 Tamp units firmly into place.

- .10 Do not adjust masonry units after mortar has set. Where resetting of masonry is required, remove, clean and reset units in new mortar.
- .11 Tool exposed joints concave raked for interior work; strike concealed joints flush.
- .12 After mortar has achieved initial set up, tool joints.
- .13 Do not interrupt bond below or above openings.

3.10 REPAIR/RESTORATION

- .1 Upon completion of masonry, fill holes and cracks, remove loose mortar and repair defective work.

3.11 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 04 05 00 - Common Work Results for Masonry supplemented as follows:
 - .1 Concrete masonry units will be sampled and tested by independent testing agency appointed and paid by Departmental Representative in accordance with CSA S304.1.

3.12 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning, supplemented as follows.
 - .1 Progress Cleaning:
 - .1 Standard Concrete Unit Masonry:
 - .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.
 - .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

3.13 PROTECTION

- .1 Brace and protect concrete unit masonry in accordance with Section 04 05 00 - Common Work Results for Masonry.

END OF SECTION 04 22 00

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Related Requirements Section 01 33 00 – Submittal Procedures

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A36/A36M-08, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A193/A193M-11, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications.
 - .3 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .4 ASTM A325-10, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - .5 ASTM A325M-09, Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength[Metric].
 - .6 ASTM A490M-10, Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints Metric.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-85.10-99, Protective Coatings for Metals.
- .3 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA).
 - .1 Handbook of the Canadian Institute of Steel Construction.
 - .2 CISC/CPMA Standard 2-75, Quick-Drying Primer for use on Structural Steel.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CAN/CSA-S16-09, Limit States Design of Steel Structures.
 - .4 CAN/CSA-S136-07, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .5 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel.
 - .6 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .7 CSA W55.3-08, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .8 CSA W59-03(R2008), Welded Steel Construction (Metal Arc Welding).

- .5 Master Painters Institute
 - .1 MPI-INT 5.1-08, Structural Steel and Metal Fabrications.
 - .2 MPI-EXT 5.1-08, Structural Steel and Metal Fabrications.
- .6 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International
 - .1 NACE No. 3/SSPC SP-6-06, Commercial Blast Cleaning.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
- .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
 - .1 Description of methods.
 - .2 Sequence of erection.
 - .3 Temporary bracings.
- .4 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, components and connections are stamped and signed by qualified professional engineer licensed in the Province of British Columbia, Canada.
- .5 Source Quality Control Submittals:
 - .1 Submit 3 copies of mill test reports 4 weeks prior to fabrication of structural steel.
 - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.
 - .2 Provide mill test reports certified by metallurgists qualified to practice in Province of British Columbia, Canada.
- .6 Fabricator Reports:
 - .1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

- .2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.
- .3 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 DESIGN REQUIREMENTS

- .1 Design details and connections in accordance with requirements of CAN/CSA-S16 and CAN/CSA-S136 with CSA-S136.1 to resist forces, moments, shears and allow for movements indicated.
- .2 Shear connections:
 - .1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.
 - .2 Select or design connections to support reaction from maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.
- .3 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of British Columbia, Canada for non-standard connections.

2.2 MATERIALS

- .1 Structural steel: to CSA-G40.20/G40.21 350W Grade for rolled and HSS (class C) sections and Grade 300W for plates, bars, angles, and channels.
- .2 High strength anchor bolts: to ASTM A193/A193M, Grade A.
- .3 Bolts, nuts and washers: to ASTM A325M.
- .4 Welding materials: to CSA W59 and certified by Canadian Welding Bureau.
- .5 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, grey.
- .6 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 700 g/m².

2.3 FABRICATION

- .1 Fabricate structural steel in accordance with CAN/CSA-S16 and in accordance with reviewed shop drawings.
- .2 Continuously seal members by continuous welds where indicated. Grind smooth.

- .3 Provide 10mm diameter weep holes in tops and bottoms of HSS columns and in bottoms of HSS girts.

Part 3 - Execution

3.1 APPLICATION

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

3.2 GENERAL

- .1 Structural steel work: in accordance with CAN/CSA-S16.
- .2 Welding: in accordance with CSA W59.
- .3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.3 CONNECTION TO EXISTING WORK

- .1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to Engineer for direction before commencing fabrication.

3.4 MARKING

- .1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.
- .2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.5 ERECTION

- .1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16 and in accordance with reviewed erection drawings.
- .2 Field cutting or altering structural members: to approval of Departmental Representative.
- .3 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.
- .4 Continuously seal members by continuous welds where indicated. Grind smooth.

3.6 FIELD QUALITY CONTROL

- .1 Inspection and testing of materials and workmanship will be carried out by testing laboratory designated by Department Representative.

- .2 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by Department Representative.
- .3 Submit test reports to Department Representative within 2 weeks of completion of inspection.

3.7 FIELD PAINTING

- .1 Paint in accordance with Section 09 91 23 - Interior Painting.
 - .1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise. Apply in accordance: MPI Architectural Painting Specification Manual.
 - .2 Repair damaged galvanizing with Galvacon in accordance to Manufacturer's specifications.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Rough Carpentry for Minor Works Section 06 08 99
- .2 Interior Painting Section 09 91 23

1.2 REFERENCES

- 1 ASTM International
 - .1 ASTM A 53/A 53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A 269 08, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .3 ASTM A 307-07v, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .4 ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .5 ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
- .2 CSA International
 - .1 CSA G40.20/G40.21-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA S16-09, Design of Steel Structures.
 - .4 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
 - .5 CSA W59-M03(R2008), Welded Steel Construction (Metal Arc Welding) [Metric].
 - .1 GS-11-2008, 2nd Edition], Paints and Coatings.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
- .5 Green Seal Environmental Standard GS 03 (anti-corrosive primer).

1.3 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 sections, plates, pipe, tubing, bolts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements
 - .1 For finishes, coatings, primers, and paints applied on site: indicate VOC concentration in g/L.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada. Submit BCBC 2012 Schedule B and C-B and Federal letter of Assurance Schedule B1, B2 and C-B as per Appendix L.

- .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.4 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE & 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 off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 19 Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Steel sections and plates: to CSA G40.20/G40.21, Grade 350W.
- .2 Exterior Steel, pipe barrier: to ASTM A 53/A 53M standard weight galvanized finish.
- .3 Welding materials: to CSA W59.
- .4 Welding electrodes: to CSA W48 Series.
- .5 Bolts and anchor bolts: to ASTM A 307.
- .6 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.
- .7 Aluminum: to ASTM B209, clear anodized finish.
- .8 Grout: non-shrink, non-metallic flowable, 15MPC at 24 hours.
- .9 Security fasteners: screws and bolts with spanner type heads to prevent removal except with special tools; non-corrosive type.
- .10 Shop coat primer: to CAN/CGSB-1.40M.

- .11 Galvanize touch-up primer: zinc rich, read mix to CGSB-1-GP-181M.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof flat headed screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

- .1 Exterior pipe barrier: Galvanizing: hot dipped galvanizing with zinc coating 610 g/m² to CAN/CSA-G164.
- .2 Interior Columns: Shop coat primer: CGSB 1GP 40M in accordance with chemical component limits and restrictions requirements and VOC limits of GC-03. Prepare surface to an abrasive blast specification SSPC-SP10.
- .3 Zinc primer: To CGSB 1GP 48, CISC/CPMA 1-73A, CISC/CPMA 2-75 in accordance with chemical component limits and restrictions requirements and VOC limits of GC-03. Prepare surface to an abrasive blast SSPC-SP10.

2.4 ISOLATION COATING

- .1 Isolate 2 different metals from following components, by means of bituminous paint:
- .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

2.5 SHOP PAINTING

- .1 Primer: VOC limit 250 g/L maximum to GC-03.
- .2 Apply one shop coat of primer to metal items, with exception of aluminum, galvanized or concrete encased items.
- .3 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.
- .4 Clean surfaces to be field welded; do not paint.

2.6 PIPE BARRIER

- .1 Steel fabrications: formed to shapes and sizes as indicated.
- .2 Galvanize exterior pipe barrier after fabrication. Shop coat prime all interior steel work after fabrication.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for metal fabrications 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.
- .4 Contractor shall verify field measurements are as shown on shop drawings prior to fabrication.

3.2 ERECTION

- .1 Do welding work in accordance with CSA W59 unless specified otherwise.
- .2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .5 Supply components for work by other trades in accordance with shop drawings and schedule.
- .6 Weld field connection.
- .7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.
- .8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion of:
 - .1 Primer: maximum VOC limit 250 g/L to GC-03.
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.
 - .1 Primer: maximum VOC limit 250 g/L to GC-03.

3.3 PIPE BARRIER

- .1 Install Pipe barrier at locations as indicated.

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 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

3.5 PROTECTION

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

END OF SECTION 05 50 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Finish Carpentry Section 06 20 00
- .2 Non-Structural Metal Framing Section 09 22 16

1.2 REFERENCES

- .1 CSA International
 - .1 CSA B111- 1974 (R2003), Wire Nails, Spikes and Staples.
 - .2 CSA O121- 08, Douglas Fir Plywood.
 - .3 CAN/CSA-O141- 05, Softwood Lumber.
 - .4 CSA O151- 09, Canadian Softwood Plywood.
 - .5 CAN/CSA-O325.0- 07, Construction Sheathing.
- .2 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001- 2004, FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002- 2004, Structure and Content of Forest Stewardship Standards V2-1.
 - .3 FSC Accredited Certified Bodies.
- .3 Green Seal Environmental Standards (GS)
 - .1 GS-11- 2008, 2nd Edition, Paints and Coatings.
- .4 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 2000.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113- A2007, Architectural Coatings.

1.3 ACTION & 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 rough carpentry work and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Wood Certification: submit vendor's Chain-of-Custody Certificate number for FSC certified wood.
- .4 Low-Emitting Materials:
 - .1 Submit listing of paints and coatings used in building, comply with VOC and chemical component limits or restriction requirements.
 - .2 Submit listing of composite wood products used in building, stating that they contain no added urea-formaldehyde resins, and laminate adhesives used in building, stating that they contain no urea-formaldehyde.

1.4 QUALITY ASSURANCE

- .1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: by grade mark in accordance with applicable CSA standards.

- .3 Plywood, OSB and wood based composite panel construction sheathing identification: by grademark in accordance with applicable CSA standards.
- .4 Sustainable Standards Certification:
 - .1 Certified Wood: submit listing of wood products and materials used in accordance with FSC-STD-01-001.

1.5 DELIVERY, STORAGE & 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wood from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 19 Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CAN/CSA-O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
 - .3 FSC certified.
- .2 Furring, blocking, nailing strips, grounds, rough bucks, curbs, fascia backing and sleepers:
 - .1 Board sizes: "Standard" or better grade.
 - .2 Dimension sizes: "Standard" light framing or better grade.
 - .3 Post and timbers sizes: "Standard" or better grade.
- .3 Panel Materials:
 - .1 Douglas fir plywood (DFP): to CSA O121, standard construction.
 - .1 Urea-formaldehyde free.
 - .2 Canadian softwood plywood (CSP): to CSA O151, standard construction.
 - .1 Urea-formaldehyde free.
 - .3 Plywood, OSB and wood based composite panels: to CAN/CSA-O325.
 - .1 Urea-formaldehyde free.
- .4 Wood Preservative:
 - .1 Surface-applied wood preservative: clear coloured, or 5% pentachlorophenol solution, water repellent preservative.

- .2 Pentachlorophenol use is restricted to building components that are in ground contact and subject to decay or insect attack only. Where used, pentachlorophenol-treated wood must be covered with two coats of an appropriate sealer.
- .3 Structures built with wood treated with pentachlorophenol and inorganic arsenicals must not be used for storing food nor should the wood come in contact with drinking water.
- .5 Primers: in accordance with manufacturer's recommendations for surface conditions:
 - .1 Interior Flat coating or Primer, Green Seal GS-11, VOC limit 50 g/l.
 - .2 Interior Non-Flat Coating or Primer, Green Seal GS-11, VOC limit 150 g/l.
 - .3 Sealers and undercoaters, SCAQMD Rule 1113, VOC limit 200 g/l.

2.2 ACCESSORIES

- .1 Fasteners: hot dipped galvanized to CAN/CSA-G164, for interior highly humid areas, pressure-preservative, fire-retardant treated lumber.
- .2 Nails, spikes and staples: to CSA B111.
- .3 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .4 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs recommended for purpose by manufacturer.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for rough carpentry 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 PREPARATION

- .1 Treat surfaces of all exterior use timber or wood in contact with concrete, metal and masonry with wood preservative before installation.
- .2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and 1 minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.

3.3 INSTALLATION

- .1 Comply with requirements of NBC 2010, and BCBC 2012, supplemented by the following paragraphs.
- .2 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.

- .4 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .5 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .6 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.
- .7 Install sleepers as indicated.
- .8 Use caution when working with particle board. Use dust collectors and high quality respirator masks.
- .9 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .10 Countersink bolts where necessary to provide clearance for other work.

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 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Waste Management and Disposal.

END OF SECTION 06 08 99

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Rough Carpentry for Minor Works Section 06 08 99
- .2 Door Hardware Section 08 71 00

1.2 REFERENCES

- .1 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
 - .1 Architectural Woodwork Quality Standards, 1st edition, 2009 (AWS).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-11.3-M87, Hardboard.
- .3 CSA International
 - .1 CSA B111-74 (R2003), Wire Nails, Spikes and Staples.
 - .2 CAN/CSA G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA O121-08, Douglas Fir Plywood.
 - .4 CSA O141-05, Softwood Lumber.
 - .5 CSA O151-09, Canadian Softwood Plywood.
 - .6 CSA O153-13 Poplar Plywood.
- .4 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001-2004, FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002-2004, Structure and Content of Forest Stewardship Standards V2-1.
 - .3 FSC Accredited Certified Bodies.
- .5 National Lumber Grades Authority (NLGA)
 - .1 NLGA Standard Grading Rules for Canadian Lumber 2008.
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168 2005, Adhesives and Sealants Applications.
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN4-S104-10 Standard Method for Fire Tests of Door Assemblies.
 - .2 CAN/ULC-S105-09, Standard Specification for Fire Door Frames.

1.3 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 plywood MDF and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit drawings in accordance with Section 01 33 00 Submittal Procedures.
 - .2 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .3 Indicate materials, thicknesses, finishes and hardware.

- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
- .5 Certifications: submit certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.
- .6 Test and Evaluation Reports: submit certified test reports for composite wood from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

- .1 Lumber by grade stamp of agency certified by Canadian Lumber Standards Accreditation Board (CLSAB).
- .2 Plywood, particleboard, OSB and wood based composite panels to CSA and ANSI standards.
- .3 Wood fire rated frames and panels: listed and labelled by an organization accredited by Standards Council of Canada to CAN4-S104 and CAN/ULC-S105.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - 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 off ground and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wood products from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan Waste Reduction Workplan related to Work of this Section
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

2.0 PRODUCTS

2.1 MATERIALS

- .1 Softwood lumber: S4S, moisture content 19% or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber
 - .3 AWMAC custom or premium grade, where noted, moisture content as specified.
 - .4 Machine stress-rated lumber is acceptable.
- .2 Hardwood lumber: moisture content 10% or less in accordance:
 - .1 AWMAC custom grade, moisture content as specified.
- .3 Panel Material: Urea-formaldehyde free

- .1 Recycled content: provide information indicating recycled content on a % (Post-Consumer + ½ Post-Industrial)
- .2 FSC certified.
- .3 Douglas fir plywood (DFP): to CSA O121, standard construction. 6.1.5 and 6.2.5 where both sides exposed to view.
- .4 Hardwood plywood: to ANSI/HPVA HP-1.
- .5 Medium density fibreboard (MDF): to ANSI A208.2, density 640-800 kg/m³.
- .6 Decorative overlaid composite panels.
 - .1 Decorative overlay, heat and pressure laminated with suitable resin to thickness indicated MDF urea-formaldehyde free core.
 - .2 Overlay bonded to both faces where exposed two sides, and when panel material require surface on one side only, reverse side to be overlaid with a plain (buff) balancing sheet.
 - .3 Furniture finish: stain wood grain pattern selected by Departmental Representative.
 - .4 Edge finishing: edges dadoed or saw kerfed to take plastic "T" moulding in width and colour to match melamine finish.

3.2 ACCESSORIES

- .1 Nails and staples: to CSA B111; galvanized to CAN/CSA-G164 for exterior work, interior humid areas and for treated lumber; plain finish elsewhere.
- .2 Wood screws: plain, type and size to suit application.
- .3 Splines: wood
- .4 Adhesive and Sealants: in accordance with Section 07 92 00 - Joint Sealants.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for wood products 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 Do finish carpentry to AWS Custom Grade.
- .2 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate piping, columns, fixtures, outlets, or other projecting, intersecting or penetrating objects.
- .3 Form joints to conceal shrinkage.

3.3 CONSTRUCTION

- .1 Fastening:
 - .1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.

- .2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
- .3 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round smooth cut hole and plug with wood plug to match material being secured.
- .4 Replace items of finish carpentry with damage to wood surfaces including hammer and other bruises.

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 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal

3.5 PROTECTION

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

END OF SECTION 06 20 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Rough Carpentry Section 06 10 11
- .2 Joint Sealants Section 07 92 00
- .3 Interior Painting Section 09 91 23

1.2 REFERENCES

- .1 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
 - .1 Architectural Woodwork Quality Standards Illustrated, 8th edition, Version 1.0 2009.
- .2 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For Commercial Interiors.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-71.20-M88, Adhesive, Contact, Brushable.
- .4 CSA International
 - .1 CSA B111-74 (R2003), Wire Nails, Spikes and Staples.
 - .2 CSA O112.4 SERIES-M1977 (R2006), Standards for Wood Adhesives.
 - .3 CSA O121-08, Douglas Fir Plywood.
 - .4 CSA O141-05, Softwood Lumber.
 - .5 CSA O151-09, Canadian Softwood Plywood.
 - .6 CSA O153-M1980 (R2008), Poplar Plywood.
- .5 American National Standards Institute (ANSI)
 - .1 ANSI/NPA A208.1-09, Particleboard.
 - .2 ANSI/NPA A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.
 - .3 ANSI/HPVA HP-1 04, Standard for Hardwood and Decorative Plywood.
- .6 ASTM International
 - .1 ASTM E 1333-96 (2002), Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates From Wood Products Using A Large Chamber.
 - .2 ASTM D 2832-92 (R2005), Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
- .7 ASTM D 5116-06, Standard Guide For Small-Scale Environmental Chamber Determinations of Organic Emissions From Indoor Materials/Products.
- .8 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001-2004, FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002-2004, Structure and Content of Forest Stewardship Standards V2-1.
- .9 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
 - .2 GS-36-00, Commercial Adhesives.
- .10 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .11 National Electrical Manufacturers Association (NEMA)
 - .1 ANSI/NEMA LD-3-05, High-Pressure Decorative Laminates (HPDL).

- .12 National Hardwood Lumber Association (NHLA)
 - .1 Rules for the Measurement and Inspection of Hardwood and Cypress 1998.
- .13 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 2003(R2007).
- .14 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 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 architectural woodwork and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .1 Scales: profiles half-full sized, details quarter-full sized.
 - .2 Indicate materials, thicknesses, finishes and hardware.
 - .3 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.
- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Submit duplicate samples of laminated plastic, acrylic sheets, engineered resin, quartz surface and vinyl faced plexigraphic.
 - .4 Submit duplicate samples of laminated plastic joints, edging, cutouts and post formed profiles.
 - .5 Submit 300 mm long sample of wood handrail.
- .5 Certifications: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating amount of construction wastes that are recycled or salvaged.
 - .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .3 Regional Materials: submit evidence that project incorporates required percentage 20% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.
 - .4 Certified Wood:
 - .1 Submit listing of wood products and materials used, produced from wood obtained

- from forests certified by FSC Accredited Certification Body in accordance with FSC-STD-01-001.
- .2 Submit manufacturer's FSC Chain-of-Custody Certificate number.
- .5 Low-Emitting Materials:
 - .1 Submit listing of adhesives and sealants and paints and coatings used in building, comply with VOC and chemical component limits or restrictions requirements.
 - .2 Submit listing of composite wood products used in building, stating that they contain no added urea-formaldehyde resins, and laminate adhesives used in building, stating that they contain no urea-formaldehyde.

1.4 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB and wood based composite panels to CSA and ANSI standards.
- .3 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .1 Shop prepare one base cabinet unit, wall cabinet, counter top and shelving unit complete with hardware and shop applied finishes, and install where directed by Departmental Representative.
 - .2 Allow 72 hours for inspection of mock-up by Departmental Representative before proceeding with Work.
 - .3 When accepted, mock-up will demonstrate minimum standard for Work.
 - .4 Do not proceed with work prior to receipt of written acceptance of mock-up by Departmental Representative.
 - .5 Mock-up may remain as part of finished work.

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.
 - .1 Protect millwork against dampness and damage during and after delivery.
 - .2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect architectural woodwork from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 COORDINATION & VERIFICATION

- .1 Verify all dimensions & existing conditions on job site prior to all shop fabrication and work on site. Where major discrepancies occur, alert Departmental Representative.
- .2 Coordinate work of this section with that of wall, electrical and mechanical sections where millwork interfaces with drywall partitions, plumbing, electrical outlets, etc.

- .3 It shall be the responsibility of this section to verify the dimensions and installation details for all Departmental Representative supplied equipment and furnishings requiring cut-outs, adaptations and interfacing with millwork items.

1.7 INSPECTION

- .1 Architectural woodwork shall be manufactured and/or installed to AWMAC Quality Standards (Custom Grade) and shall be subject to an inspection at the plant and/or site, by an appointed inspector approved by the M.M.A.B.C. (the BC Chapter of AWMAC). Such inspection costs shall be included in the tender price for this project. Shop drawings shall be submitted for review or approval before any work is commenced. Where it is deemed necessary by the Departmental Representative, a sample cabinet (consisting of a minimum of 1 drawer, 1 door, showing precisely the materials, hardware and the type of construction the manufacturer intends to use), shall be submitted for inspection.
- .2 Any work which does not meet AWMAC Quality Standards as specified, shall be replaced by this Section at no additional cost to the Department Representative and to the satisfaction of the Departmental Representative and the inspector.

1.8 GUARANTEE

- .1 This section shall furnish the Departmental Representative with a two (2) year M.M.A.B.C. (The BC Chapter of AWMAC) Guarantee Certificate or an equivalent maintenance bond, to the full value of the architectural woodwork sub-contract, certifying that the architectural woodwork supplied will be in accordance with the Standards incorporated in the AWMAC Quality Standards manual, latest edition.
- .2 The Guarantee shall cover replacing and refinishing to make good any defects in architectural woodwork due to faulty workmanship or defective materials supplied by this Section, which appear during a two (2) year period following the substantial completion of the Project.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Softwood lumber: unless specified otherwise, S4S, moisture content 15% or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
 - .3 AWMAC custom grade, moisture content as specified.
 - .4 Forestry Stewardship Council (FSC) certified.
- .2 Machine stress-rated lumber is acceptable for all purposes.
- .3 Hardwood lumber: moisture content 15% or less in accordance with following standards:
 - .1 National Hardwood Lumber Association (NHLA).
 - .2 AWMAC custom grade, moisture content as specified.
- .4 Douglas fir plywood (DFP): to CSA O121, standard construction, FSC certified.
 - .1 Plywood resin to contain no added urea-formaldehyde.
- .5 Canadian softwood plywood (CSP): to CSA O151, standard construction, FSC certified.
 - .1 Plywood resin to contain no added urea-formaldehyde.
- .6 Hardwood plywood: to ANSI/HPVA HP-1, FSC certified.
 - .1 Plywood resin to contain no added urea-formaldehyde.
- .7 Poplar plywood (PP): to CSA 0153, standard construction, FSC certified.
 - .1 Plywood resin to contain no added urea-formaldehyde.
- .8 Hardboard:

- .1 To CAN/CGSB-11.3, FSC certified.
- .2 Hardboard resin to contain no added urea-formaldehyde.

- .9 MDF (medium density fibreboard) core: to ANSI/NPA A208.2, Grade Custom, density 769 kg/m², FSC certified.
 - .1 Medium density fibreboard performance requirements to: ANSI/NPA A208.2.
 - .2 MDF resin to contain no added urea-formaldehyde.

- .10 Laminated plastic for flatwork: to NEMA LD3, Type: General Purpose. Colours, pattern and finish, refer to schedule.
 - .1 For Cabinet tops, rigid plastic bases, countertops, backsplashes: Grade HGS, Size 1.27mm thick.
 - .2 For exposed vertical surfaces including front of doors, drawers and outside of gables: Grade VGS, Size 0.76m thick.

- .11 Laminated plastic for post forming work: to NEMA LD3, Type: Postforming, Grade HGP, size 1mm thick. Colours, pattern and finish, refer to schedule.

- .12 Laminated plastic backing sheet: Grade BK, Type S minimum of 0.5 mm thick or same thickness as face laminate, colour same as face laminate.

- .13 Laminated plastic liner sheet: Grade GP, Type S, size 0.5mm thick, white colour U.N.O.

- .14 Thermofused Melamine: to NEMA LD3 Grade VGL.
 - .1 High wear resistant thermofused melamine: equal or exceed 400 cycles (Minimum standard for HPL abrasion test).

- .15 Nails and staples: to CSA B111.

- .16 Wood screws: stainless steel, type and size to suit application.

- .17 Splines: metal.

- .18 Sealant: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

- .19 Laminated plastic adhesive:
 - .1 Adhesive: contact adhesive to CAN/CGSB-71.20.
 - .2 Adhesives: VOC limit 30 g/L maximum to SCAQMD Rule 1168 GS-36.
 - .3 Clear Wood Finishes: VOC limit 250 g/L maximum to GS-11
 - .4 Paints: VOC limit 50 g/L maximum to GS-11.

- .20 Stainless: Grade 316, 18 gauge.

2.2 MANUFACTURED UNITS

- .1 Casework with Plastic Laminate Finish:
 - .1 AWMAC Quality Grade: Custom. Locations as noted on the drawings.
 - .2 Construction: Conform to Section 400 of the manual for Flush Overlay Casework. Close voids and cavities at inside corners and behind end fillers of upper cabinets.
 - .3 Exposed Parts: Plastic laminate on plywood, U.N.O.
 - .4 Semi-Exposed Parts: Plastic Laminate on plywood core. Color, pattern and finish to match exposed parts, U.N.O.
 - .5 Interior Shelving, U.N.O: 19mm melamine with finished edges. All interior gables and interior backing to be melamine on closed units. All doors, drawers would be plastic laminate on both sides; on open units al interior to be plastic laminate.
 - .6 Edge Banding, U.N.O.: matching laminate face material finish in colour, pattern, and

- finish as per AWMAC Standard.
- .7 Concealed Parts: backer to manufacturer's option.
- .8 Plastic laminate to be selected by Departmental Representative from manufacturer's full range of solid color

2.3 CASEWORK HARDWARE

- .1 Hinges: fully concealed, all metal construction, 3-way adjustment, one (1) hinge in each pair to be spring activated, 170 degree opening.
- .2 Door and Drawer pulls: Stainless Steel Finish, 191mm c/c, 248mm length, 1 3/8" (35mm) projection.
- .3 Drawer Slides: Full extension with 25mm over travel, side mounting, telescopic action on ball bearings, 100 lb class, chrome finish, lift or lever disconnect for drawer removal, non-handed. Acceptable products: Accuride, Knappe & Vogt, Roll-it or equivalent.
- .4 Shelf Supports: Metal Supports and socket, support 6mm dia hole, socket 8mm dia hole, Nickel Finish.
- .5 Finish to all cabinet hardware-Satin chrome finish unless otherwise specified.
- .6 Provide colour-coordinated plastic screw caps on ctsk screws.
- .7 All millwork hardware as required to complete work.

2.4 COUNTERTOP

- .1 Stainless Sink countertop with edge drip, backsplash and apron – 18 gauge, grade 316 stainless steel, 250mm deep, customer fabrication to size as per drawing. Stainless steel strainer, drain opening and stub out for connection to drain pipe.
- .2 Core Materials: 19mm plywood generally, and non-telegraphing plywood at countertops with sink or other plumbing cut-outs. 25mm thick for longer span as per AWMAC requirement.
- .3 No exposed core material on any exposed surface.

2.5 FABRICATION

- .1 Fabricate material in accordance with manufacturer's Fabrication Guide.
- .2 Fabricate countertops, sinks, and splash of 19mm thick material unless otherwise indicated.
- .3 Cut and finish component edges with clean, sharp returns. Finished edges shall have a 1.6 mm radius.
- .4 Stainless steel coves at backsplash and ends where against walls or other vertical surfaces, with 9.5 mm radius between top and splash.
- .5 Stainless Sinks steel shall be formed integrally with countertops.
- .6 Cutouts for sinks shall be smooth and uniform without saw marks. The top and bottom of openings shall be finished smooth. Maintain minimum 6 mm radius for sink cutouts.
- .7 Cutouts for accessories shall be smooth and uniform without saw marks. The top and bottom of openings shall be finished smooth.
- .8 Set nails and countersink screws apply stained wood filler to indentations, sand smooth and leave

ready to receive finish.

- .9 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .10 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.
- .11 Apply laminate backing sheet to reverse side of core of plastic laminate work.
- .12 Provide sufficient clearance between backsplash and faucet for operation of lever handle.

3.0 EXECUTION

3.1 EXAMINATION

- .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 Do architectural woodwork to Quality Standards of AWMAC.
- .2 Install vanity in accordance with manufacturer's instructions installation guidelines and recommendations.
- .3 Install prefinished millwork at locations shown on drawings.
 - .1 Position accurately, level, plumb straight.
- .4 Form joints using manufacturer's approved adhesive, with joints inconspicuous in finished work.
- .5 Cure countertops for 24 hours, minimum, before exposure to moisture or pressure.
- .6 Corner joints: Form 3 mm-wide joints, sealed with manufacturer's color-matching silicone sealant.
- .7 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.
- .8 Provide integral backsplashes and end splashes as shown on the Drawings.
- .9 Field joints shall be hard seamed unless otherwise specified.
- .10 Attach solid surfaces material to leveled supports on frame with dabs of silicone every 18 to 24 inches.
- .11 Fasten solid surface material to frame by anchoring screws to supports at all corner blocks.
- .12 Screws should not come in contact with solid surface material, as this may cause cracking of countertop.
- .13 Apply water resistant building paper over wood framing members in contact with masonry or cementitious construction.

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.
 - .1 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.
 - .2 Remove excess glue from surfaces.
 - .3 Solid surface to be cleaned as per manufacturer's instructions.

- .3 Waste Management: separate waste materials for reuse and 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.

3.4 PROTECTION

- .1 Protect millwork from damage until final inspection.

- .2 Protect installed products and components from damage during construction.

- .3 Repair damage to adjacent materials caused by architectural woodwork installation.

END OF SECTION 06 40 00

1.0 GENERAL

1.1 SECTION INCLUDES

- .1 Dampproofing to backfilled sides of poured-in-place concrete foundation walls and footings under the main floor where the main floor is above grade.

1.2 RELATED REQUIREMENTS

- .1 Cast-In-Place Concrete Section 03 30 00

1.3 SUBMITALS

- .1 Product Data: Submit Manufacturers Product Data and Recommended Installation Methods in accordance with Section 01 33 00 Submittal Procedures.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Deliver and store materials undamaged and, where applicable, in their original wrappings or containers with manufacturer's labels and seals intact. Store materials on a dry floor in a weatherproof enclosure.

2.0 PRODUCTS

2.1 MATERIALS

- .1 General: All materials used in this contract shall be of the highest quality as manufactured by nationally recognized manufacturers and of the type indicated on the drawings and in this specification.
- .2 Dampproofing Material: fluid applied, VOC compliant, one part moisture curing elastomeric modified polyurethane waterproofing membrane.
- .3 Primer shall conform to requirements of CGSB-37-GP-9.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Examine all surfaces to which the work of this Section is to be applied and ensure that all conditions are suitable to provide a complete and satisfactory installation. Conform to manufacturer's requirements for minimum application temperatures and humidity.
- .2 Commencement of work will indicate acceptance of surfaces and conditions.
- .3 Report any unsatisfactory surfaces or conditions to Departmental Representative.

3.2 WORKMANSHIP AND APPLICATION

- .1 Surfaces receiving treatment shall be smooth, hard, free from projections and fins, loose particles, holes, grease, oil or dirt.
- .2 Dampproofing:
 - .1 Dampproofing shall conform to standards of manufacturer's recommended methods of surface application of asphalt emulsions by. The rate of application shall be 1.0 to 1.5 l/m² or as otherwise recommended by manufacturer.
 - .2 Dampproofing shall be applied in two coats from 100 mm below finished grade down the wall and to the top of the footing. Application shall be by spray or brush.
 - .3 Fill all visible porous surfaces or air pockets with specified asphalt mastic after first coat of dampproofing application.

- .4 Special applicator will be required for application of dampproofing to confined spaces.

3.3 PROTECTION AND CLEAN-UP

- .1 Protect the work of other sections from damage resulting from the work of this section.
- .2 At the completion of the work, remove all accumulated containers, brushes, and debris, and leave the work in a neat and tidy condition. Deposit rubbish in containers provided.

END OF SECTION 07 11 00

1.0 GENERAL

1.1 SECTION INCLUDED

- .1 Furnishing of all labor, materials, services and equipment necessary for the supply and installation of crystalline waterproofing additive to concrete structures of sump pit. The crystalline waterproofing material shall be added to concrete during the mixing cycle, and shall be used in below-grade walls and slabs.

1.2 RELATED REQUIREMENTS

- .1 Section 03 10 00 – Concrete Forming and Accessories.
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 30 00 – Cast-in-Place Concrete
- .4 Section 07 92 00 – Joint Sealants

1.3 REFERENCES

- .1 Applicable Standards. The following standards are referenced herein.
 - .1 American Society for Testing and Materials (ASTM)
 - .2 Army Corps of Engineers (CRD)
 - .3 American Concrete Institute (ACI)
 - .4 NSF International (NSF)

1.4 SYSTEM DESCRIPTION

- .1 Crystalline Waterproofing Additive: Concrete waterproofing system shall be of the crystalline type, defined by the ACI 212.3R – 10 Report on Chemical Admixtures for Concrete as a "PRAH" type hydrophilic admixture. It shall react such that it chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. The system shall cause the concrete to become sealed against the penetration of liquids from any direction, and shall protect the concrete from deterioration due to harsh environmental conditions.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

- .1 Testing Requirements: Crystalline waterproofing system shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein. Independent tests verifying these results shall be submitted prior to approval.
- .2 Independent Laboratory: Testing shall be performed by an independent laboratory meeting the requirements of the recognized specifying body of the country in which the testing is performed. Testing laboratory shall obtain all concrete samples and waterproofing product samples.
- .3 Crystalline Formation: Crystallizing capability of waterproofing system shall be evidenced by independent SEM (Scanning Electron Microscope) photographs showing crystalline formations within the concrete matrix at a magnification no greater than 2000 times.
- .4 Permeability: Independent testing shall be performed according to U.S. Army Corps of Engineers CRD-C48 - Mod "Permeability of Concrete". Under CRD-C48 treated concrete samples shall be pressure tested to 150 psi (350 foot head of water) or 1.05 MPa (106 m head of water). The treated samples shall exhibit no measurable leakage against control samples which shall exhibit full saturation and measurable leakage.

- .5 Acid Resistance: Independent testing shall be performed to determine "Sulfuric Acid Resistance of Concrete Specimens". Treated concrete samples (dosage rates of 3%, 5% and 7%) shall be tested against untreated control samples. All samples shall be immersed in 7% sulfuric acid and weighed daily until a control sample reaches a weight loss of 50%. On final weighing the percentage weight loss of the 3% treated samples shall be 20% or lower than the control samples.
- .6 Sulfate Resistance: Testing for weight loss and length change when samples exposed to Ammonium Sulfate solution for 25 weeks shall show a weight loss of at least 25% less than the control concrete and a length change of - 0.01% or less than the control.
- .7 Compressive Strength: Independent testing shall be performed according to ASTM C39 "Compressive Strength of Cylindrical Concrete Specimens". Concrete samples containing the crystalline waterproofing additive shall be tested against untreated control sample. At 28 days, the treated samples shall exhibit a minimum of 10% increase in compressive strength over the control sample.
- .8 Portable Water Approval: Independent testing shall be performed according to NSF Standard 61, and approval for use of waterproofing material on structures holding potable water shall be evidenced by NSF certification.

1.6 SUBMITTALS

- .1 General: Submit listed submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit product data, including manufacturer's specifications, installation instructions, and general recommendations for waterproofing applications. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract Documents.
- .3 Test Reports: Submit, for acceptance, complete test reports from approved independent testing laboratories certifying that waterproofing system conforms to performance characteristics and testing requirements specified herein.
- .4 Manufacturer's Certification: Provide certificate signed by manufacturer or manufacturer's representative certifying that the materials to be installed comply in all respects with the requirements of this specification.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Manufacturer to have no less than 3 years experience in manufacturing the crystalline waterproofing additive for the required work, and be capable of providing field service representation during construction phase. Manufacturers that cannot provide the performance test data specified herein will not be considered for the project.
- .2 Applicator: Installer of crystalline waterproofing additive shall be approved by the manufacturer or manufacturer's representative in writing.
- .3 Pre-Installation Conference: Prior to installation of waterproofing, conduct meeting with departmental, owner's representative, applicator (concrete supplier), concrete placer and waterproofing manufacturer's representative to verify and review the following:
 - .1 Project requirements for waterproofing as set out in Contract Document.
 - .2 Manufacturer's product data including application instructions.
- .4 Technical Consultation: The waterproofing manufacturer's representative shall provide technical consultation on waterproofing application.

CRYSTALLINE WATERPROOFING

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- .2 Delivery: Deliver packaged waterproofing materials to project site in original undamaged containers, with manufacturer's labels and seals intact.
- .3 Storage: Store waterproofing materials in dry, enclosed location, at temperature and humidity conditions recommended by manufacturer.

1.9 WARRANTY

- .1 Project Warranty: Refer to conditions of the Contract for project warranty provisions.
- .2 Manufacturer's Warranty: Manufacturer shall provide standard product warranty executed by authorized company official. Term of warranty shall be ten(10) years from Date of Substantial Completion.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Source Quality: Obtain proprietary crystalline waterproofing products from a single manufacturer.

2.2 DOSAGE AND MIXING

- .1 General: Crystalline Admix must be added to concrete mix at time of batching.
- .2 Dosage Rate: Under normal conditions, the crystalline waterproofing powder shall be added to the concrete mix at a rate of 2% - 3% by weight of Portland cement content. For enhanced chemical protection or meeting specific project requirements, consult with manufacturer or its authorized representative to determine appropriate dosage rates.
- .3 Waterproofing Construction Joints and Cold Joints Between Pours: Crystalline Waterproofing Powder, single coat crystalline waterproofing; proprietary compound of Portland cement, silica sand and active chemicals, mixed with water at 3 parts powder to 1 part water or in proportions recommended by manufacturer to achieve full coverage with application method used. Application rate: 2.0 lb/sq yd (1.09 kg/sq m).
- .4 Dry Pack Joint Compound: Dry pack consistency mixture of Crystalline Waterproofing Powder; proprietary compound of Portland cement, silica sand and active chemicals; and water at 6 parts powder to 1 part water or in proportions recommended by manufacturer.

3.0 EXECUTION

3.1 MANUFACTURERS INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's product data regarding installation, including technical bulletins, product catalogue, installation instructions and product packaging labels.

3.2 PRODUCT CONDITIONS

- .1 Reinforcement: All reinforcement shall be rib deformed bar in accordance with applicable standards. Exposed concrete decks (joint free) shall contain sufficient reinforcement to minimize thermal movement and control cracking.
- .2 Setting Time and Strength: Some retardation of set may occur when using admix product. The amount of retardation will depend upon the concrete mix design, the particular Admix product

used, dosage rate of the Admix, temperature of the concrete and climatic conditions. Concrete containing a admix product may develop higher ultimate strengths than plain concrete. Conduct trial mixes under project conditions to determine setting time and strength of concrete. Consult with manufacturer or manufacturer's representative regarding concrete mix design, project conditions and proper dosage rate.

- .3 Weather Conditions: For mixing, transporting and placing concrete under conditions of high temperature or low temperature follow concrete practices as referred to in ACI 305R-77 (Hot Weather Concreting) and ACI 306R-78 (Cold Weather Concreting). For flatwork being placed in either hot, dry or windy conditions use of monomolecular film (evaporation retardant) is recommended to control loss of bleed water.

3.3 APPLICATION

- .1 General: Crystalline Admix shall be added to the concrete mix at time of batching. Thorough blending of the Crystalline Admix throughout the concrete mix is essential for correct performance of the product and, therefore, care should be taken to ensure that a homogeneous mixture is obtained.
- .2 Concrete Batching & Mixing: Procedures for mixing will vary according to type of batch plant operation and equipment.
 - .1 Ready Mix Plant-Dry Batching Operation: Add Crystalline Admix powder to drum of ready-mix truck, then add 60% - 70% of required water along with 300 - 500 lb. (136- 227 kg) of aggregate. Mix the materials for 2 - 3 minutes to ensure that the Admix is distributed evenly throughout the mix water. Add balance of materials to the ready-mix truck and mix in accordance with standard batch practices.
 - .2 Ready Mix Plant Central Mix Operation: Mix Crystalline Admix with water to form a very thin slurry (e.g. 15 - 20 lb. or 6.75 - 9 kg of powder mixed with 3 gal. or 13.6 liters of water). Pour the required amount of material in drum of ready-mix truck. The aggregate, cement and water should be batched and mixed in the plant in accordance with standard practices (taking into account the quantity of water that has already been placed in the ready-mix truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of the Crystalline Admix throughout the concrete.
 - .3 Precast Batch Plant- Pan Type Mixer: Add Crystalline Admix to the rock and sand, then mix thoroughly for 2 - 3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.
- .3 Construction and Cold Joints: One coat of Crystalline Waterproofing Powder slurry at a rate of 2 lb/sq yard is to be applied to the entire concrete substrate surface where the existing and new concrete will interface. Allow slurry to set or dry. No curing is required.
- .4 For hydrostatic conditions also apply sealing strips at each construction joint by filling grooves coinciding with construction joint.
 - .1 If grooves have not been preformed, at least 3/4 inch (19 mm) wide and minimum 1 inch (25 mm) deep, saw cut and chip grooves to that dimension.
 - .2 Apply specified slurry coat to slot at rate recommended by manufacturer.
 - .3 Fill and form surfaces using specified dry pack repair compound while slurry coat is still green, but after slurry coat has reached initial set.
 - .4 Compact tightly using pneumatic packer or hammer and block.

3.4 CURING

- .1 General: Concrete containing Crystalline Admix shall be moist cured in accordance with ACI Reference 308, "Standard Practice for Curing Concrete".
- .2 Curing Compounds: Curing compounds may be used in the event that project requirements or conditions prevent moist curing. Curing compounds shall comply with ASTM C-309.

3.5 PROTECTION

- .1 Protection: Protect installed product and finished surfaces from damage during construction.

3.6 FIELD QUALITY CONTROL

- .1 Examination for Defects : Do not conceal Crystalline Admix treated concrete before it has been observed by Departmental Representative, waterproofing manufacturer's representative and other designated entities. Concrete shall be examined for structural defects such as honeycombing, rock pockets, tie holes, faulty construction joints, cold joints and cracks. Such defects to be repaired in accordance with manufacturer's repair procedures.
- .2 Flood Testing for Suspended Slabs:
 - .1 Perform flood test on completed waterproofing installation before placement of other construction.
 - .2 Plug or dam drains and fill area with water to a depth of two inches (50 mm) or to within 0.5 inch (12.5 mm) of top of waterproofing treatment.
 - .3 Let water stand for 24 hours.
 - .4 If leaks are discovered, make repairs and repeat test until no leaks are observed.

3.7 INTERACTION WITH OTHER MATERIALS

- .1 Backfilling: Normal backfilling procedures may be used after concrete has been cured for at least seven days. If backfill takes place within seven days after concrete placement, then backfill material shall be moist so as not to draw moisture from the concrete. In no event shall backfilling take place before concrete has gained sufficient strength to withstand the applied load.
- .2 Grout, Cement Parge Coat, Plaster or Stucco: Because concrete containing Crystalline Admix forms a relatively smooth surface and the resulting crystalline formation fills the concrete pores thereby reducing suction characteristics of the concrete, it may be necessary to use a suitable bonding agent for proper bonding of cementitious systems.
- .3 Responsibility to Ensure Compatability: The manufacturer makes no representations or warranties regarding compatibility of Crystalline treated concrete with coatings, plasters, stuccos, tiles or other surface-applied materials. It shall be the responsibility of the installer of the surface-applied material that is to be applied over the Crystalline treated concrete, to take whatever measures are necessary, including testing, to ensure acceptance by or adhesion to the waterproofing treatment.

1.0 GENERAL

1.1 SECTION INCLUDES

- .1 Insulation as indicated on the drawings and specified herein.

1.2 RELATED SECTIONS

- | | | |
|----|------------------------------------------|---------------------|
| .1 | Rough Carpentry Minor Works | Section 06 08 99 |
| .2 | Finish Carpentry | Section 06 20 00 |
| .3 | Air Barriers- Descriptive or Proprietary | Section 07 27 00.01 |
| .4 | Metal Wall Panels | Section 07 42 13 |
| .5 | Gypsum Board Assemblies | Section 09 21 16 |

1.3 PRODUCT DELIVERY, STORAGE & HANDLING

- .1 Materials shall be stored in a dry and protected area, off the ground, in original undamaged, sealed container with manufacturer's labels and seals in tact. Avoid freezing.

1.4 PROJECT CONDITIONS

- .1 Review manufacturer's recommendations for ambient temperatures during and after application.
- .2 Report to general contractor in writing, defects of work prepared by other trades and unsatisfactory site or environmental conditions.
- .3 Examine surfaces to ensure they are dry, clean, free of oil, grease, dirt, paint, mull scale or other deleterious material that would impair bonding.
- .4 Commencement of work shall imply acceptance of surfaces and conditions.

2.0 PRODUCTS

- .1 Roof Insulation Polyisocyanurate: Thermal Resistance of R28 minimum of any point of the roof. Shall conform to CAN/CGSB-51.26-M86 factory finished both sides with a nominal 2 lb./ft³ density, compressive strength of 140 Kpa (20 psi) minimum and meet ULC S704. Facers must not have organic matter.
- .2 Wall Cladding Exterior Insulation: Mineral Wool Insulation, non-combustible to ULC CAN 4-S114, zero flame spread and smoke development to ULC S102, 75 mm thick thermal resistance of R14 minimum.
- .3 Spandrel Panel Insulation: Mineral Wool Insulation, non-combustible to ULC CAN 4-S114, zero flame spread and smoke development to ULC S102, Full depth of curtain wall mullion.
- .4 Exterior insulation to foundations: below grade shall be concrete faced closed cell Type 4 polystyrene insulation, or concrete faced polystyrene insulation.
- .5 Exterior Insulation to underslab: below grade to be closed cell Type 4 polystyrene insulation extend 610mm around full perimeter of building

3.0 EXECUTION

3.1 INSPECTION

- .1 Ensure that surfaces to receive insulation are clean and free of obstructions.
- .2 Do not install insulation in framing until roofing is complete and the building is enclosed.

3.2 WORKMANSHIP

- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .2 Install batt and rigid insulation to all other areas indicated on drawings to thickness shown.
- .3 Fit closely around electrical boxes, pipes, ducts, frames, joists, and other objects in or passing through insulation.

3.3 INSTALLATION

- .1 Perimeter footing rigid installation
 - .1 Install insulation boards by mechanical fasteners to concrete footing.
 - .2 Fasteners: Impale type, non-corrosive, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, fused to membrane, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self locking type.
 - .3 Extend insulation under floor slab for a minimum of 610 mm wide.
- .2 Semi-Rigid insulation installation for exterior wall
 - .1 Apply semi-rigid insulation at all other areas indicated on drawings to thickness shown. Fasteners: mechanical fastened.
 - .2 Fasteners: Impale type, non-corrosive, perforated 50 X 50 mm cold rolled carbon steel 0.8 mm thick, fused to membrane, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25mm diameter washers of self locking type.
 - .3 Butt joints tightly, offset vertical joints. Use insulation boards free from chipped or broken edges.
 - .4 Install material in accordance with manufacturer's instructions.

3.5 CLEANING

- .1 Remove waste and excess material off site at completion of application. Repair and make good any defects to this application or any defects caused by this application.

END OF SECTION 07 21 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Concrete Unit Masonry Section 04 22 00
- .2 Air Barrier – Descriptive or Proprietary Section 07 27 00.01

1.2 REFERENCES

- .1 Canadian Urethane Foam Contractors' Association Inc. (CUFCA)
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S101-07, Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S102-07, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC-S705.1-01, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.
 - .4 CAN/ULC-S705.2-05, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

1.3 SUBMITTALS

- .1 Submit product data 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 35 33 Health and Safety Requirements.
- .3 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: submit certified test reports for insulation from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Submit test reports in accordance with CAN/ULC-S101 for fire endurance and CAN/ULC-S102 for surface burning characteristics.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.4 QUALITY ASSURANCE

- .1 Applicators to conform to CUFCA Quality Assurance Program.
- .2 Qualifications:
 - .1 Installer: person specializing in sprayed insulation installations with 5 years documented experience approved by manufacturer.
 - .2 Manufacturer: company with minimum 5 years' experience in producing of material used for work required for this project, with sufficient production capacity to produce and deliver required units without causing delay in work.
- .3 Health and Safety Requirements: worker protection:
 - .1 Protect workers as recommended by CAN/ULC-S705.2 and manufacturer's recommendations:

- .2 Workers must wear gloves, respirators, dust masks, long sleeved clothing, eye protection, protective clothing when applying foam insulation.
- .3 Workers must not eat, drink or smoke while applying foam insulation.

1.5 DELIVERY, STORAGE & HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.
- .3 Upon completion of Work, after cleaning is carried out.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .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 19 – Waste Management and Disposal.

1.7 SITE CONDITIONS

- .1 Ventilate area in accordance with Section 01 51 00 - Temporary Facilities.
- .2 Ventilate area to receive insulation by introducing fresh air and exhausting air continuously during and 24 hour after application to maintain non-toxic, unpolluted, safe working conditions.
- .3 Provide temporary enclosures to prevent spray and noxious vapours from contaminating air beyond application area.
- .4 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- .5 Apply insulation only when surfaces and ambient temperatures are within manufacturers' prescribed limits.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Insulation: closed cell medium density spray applied rigid polyurethane foam to CAN/ULC-S705.1. (in checking amendments 1 and 2), Type 1.
 - .1 Long-term thermal resistance (LTTR) for 50mm is RSI 1.83.
- .2 Primers: in accordance with manufacturer's recommendations for surface conditions.

.3 Physical and chemical properties:

Molecular Weight	NA
pH	7.5 - 8.5
Boiling Point	NE
Melting/Freezing Point	NE
Flash Point	No flashpoint was detected. Flame extinguished @ 85°F during test
Solubility in Water	Slight
Specific Gravity	1.23
Bulk Density	10.3 lb/gal
% Volatile by Volume (Water)	NE
Vapour Pressure	NE
Vapour Density	NE

.4 Compliance

- .1 ICC ESR-2003,CCMC 13555-L
- .2 Class 1-ASTM E-84 (Flame <25, smoke <450)
- .3 AC 377 (NFPA 286) Appendix X-passed without ignition barrier.
- .4 CAN/ULC S102
- .5 UL-723, NFPA 255

3.0 EXECUTION

3.1 MANUFACTURER'S INSTRUCTION

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

3.2 APPLICATION

- .1 Apply insulation to clean surfaces in accordance with CAN/ULC-S705.2 and manufacturer's printed instructions.
- .2 Use primer where recommended by manufacturer.
- .3 Apply sprayed foam insulation to fill up interstitial space, as indicated.

3.3 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 07 21 29.03

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Thermal Insulation Section 07 21 00
- .2 Sheet Metal Flashing & Trim Section 07 62 00
- .3 Glazed Aluminum Curtain Wall Section 08 44 13
- .4 Gypsum Board Assemblies Section 09 21 16

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-19.13M-M87, Sealing Compound, One Component, Elastomeric Chemical Curing.
 - .2 CAN/CGSB-19.24M-M90, Multi-Component, Chemical Curing Sealing Compound.
 - .3 CGSB 19-GP-14M-84, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.
- .2 Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification.

1.3 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 WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 33 – Health Safety Requirements.
- .3 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Existing Substrate Condition: report deviations, as described in PART 3 -EXAMINATION in writing to Departmental Representative.
 - .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, and cleaning procedures.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Applicator: company specializing in performing work of this section with minimum 5 years documented experience with installation of air/vapour barrier systems.
- .2 Mock-Up:
 - .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct typical exterior wall panel, incorporating louvre and door frame, insulation, illustrating materials interface and seals.
 - .3 Locate in location as agreed to with Departmental Representative.
 - .4 Mock-up may remain as part of finished work.
 - .5 Allow 72hours for inspection of mock-up by Departmental Representative before proceeding with air/vapour barrier Work.

- .3 Schedule site visits with Departmental Representative, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.
 - .2 Minimum twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out, prior to cover up by other building component.

1.5 DELIVERY STORAGE AND HANDLING

- .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.
- .3 Avoid spillage: immediately notify Departmental Representative if spillage occurs and start clean up procedures.
- .4 Clean spills and leave area as it was prior to spill.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.7 AMBIENT CONDITIONS

- .1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.
- .2 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.
- .3 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

1.8 SEQUENCING

- .1 Sequence work in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Charts.
- .2 Sequence work to permit installation of materials in conjunction with related materials and seals.

1.9 WARRANTY

- .1 For sealant and sheet materials the 12 months warranty period is extended to 24 months.

2.0 PRODUCTS

2.1 SELF ADHESIVE MEMBRANE

- .1 Membrane composed of high temperature grade SBS modified bitumen and a Tri-laminate woven polyethylene face on the top surface. The self-adhesive bottom surface is protected by a silicone release sheet.
 - .1 Water Vapour transmission 202 g/m² /24 hours/ASTM E96/B (Dessicant).
 - .2 Dry Tensile Strength 41 lbf/182N MD, 29 lbf/129N CD, ASTM D 828.
 - .3 Average Dry Breaking Force 127 lbf/565N MD, 91 lbf/405N CD, ASTM D 5034.

- .4 Accelerated Aging, Pass, ICC-ES AC 48, 25 cycles.
- .5 Cycling and Elongation, Pass, ICC-ES AC48, 100 cycles at -29°C (20°F).
- .6 Application Temperature Minimum 5°C (41°F).
- .7 Flame Spread Index 0, Class A, ASTM E-84.
- .8 Smoke Developed 105, Class A, ASTM E-84.
- .9 Membrane thickness, Minimum 40 mil.
- .10 Air Permeance, Pass, ASTM E 2178 (Maximum 0.02 L/m²s @ 75Pa or 0.004 cfm/ft² @ 1.57pcf) ASTM E 2357 – assembly, Pass.
- .11 Criteria for Water Resistive Barriers, Pass, ICC-ES AV 38.
- .12 Low Temp Flexibility, Pass, ICC-AC308/3.3.4.
- .13 Peel-adhesion to Unprimed Plywood, PASS, ICC-ES AC48, Control 62 lbf/ft-905N/m, After 7 day water immersion 54 lbf/ft-788N/m, After accelerated aging 72 lbf/ft-1051N/m, After UV exposure 77 lbf/ft-1124N/m
- .14 Water Penetration Resistance around Nails, PASS, AAMA 711-05 and ASTM D 1970 modified.

2.2 SEALANTS

- .1 Sealants in accordance with Section 07 92 10 - Joint Sealing.
- .2 Sealant compatible with membrane as recommended by the manufacturer:
 - .1 Silicone Sealant specifically for use with self-adhered membrane.
- .3 Primer: recommended by sealant manufacturer as appropriate to application.
- .4 Substrate Cleaner: non-corrosive type recommended by sealant manufacturer and compatible with adjacent materials.

2.3 PRIMER

- .1 Apply primer to substrate according to manufacturer's specification. Ensure proper adhesion and compatibility to the membrane.

2.4 ACCESSORIES

- .1 Provide mechanically fastened stainless steel termination bar with gumlip edge.

3.0 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 GENERAL

- .1 Perform Work in accordance with Sealant and Waterproofers Institute - Sealant and Caulking Guide Specification requirements for materials.

3.3 EXAMINATION

- .1 Verify that surfaces and conditions are ready to accept work of this section.
- .2 Ensure surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer's requirements.
- .3 Report unsatisfactory conditions to Departmental Representative in writing.
- .4 Do not start work until deficiencies have been corrected.

- .1 Beginning of Work implies acceptance of conditions.

3.4 PREPARATION

- .1 All surfaces to receive the membrane must be thoroughly cleaned so as to have removed all concrete spatter, job dirt, laitance, from release agents, curing compounds, or any other substance which could inhibit the adhesion, and long term performance of the membrane.
- .2 All honeycombing in concrete shall be grouted flush prior to application of primer.
- .3 Apply primer as per manufacturer's recommendation to all surfaces to receive the membrane. Use a 2 coat application on gypsum board or plywood substrate.
- .4 Prepare in accordance with manufacturer's instructions.
- .5 Apply a horizontal membrane strip over vertical leg and fasteners of all horizontal cladding supports. Seal top with mastic regular.
- .6 Fill all joints or gaps wider than ¼" with galvanized steel sheet steel or wood backing and apply 12" strip of membrane over joints prior to application of the field membrane. Seal all side laps without factory bitumen self-adhering edge and all top laps with mastic.

3.5 APPLICATIONS

- .1 Apply in accordance with manufacturer's instructions.
- .2 All joints within and between back up walls and window frames shall be sealed according to detail drawings.
- .3 Ensure continuity of air barrier. Co-ordinate construction of roof/wall junction to maintain continuity of air barrier from wall to roof. Co-ordinate with construction of exterior walls to maintain continuity of air barrier between various exterior wall construction types.
- .4 Shingle laps to drain. Minimum side and end laps as per manufacturer's recommendation with a minimum of 75mm.
- .5 Membrane should be adhered onto window frame section as per detail drawings.
- .6 Lap and seal air barrier membrane over through-wall flashing at base of wall and at all horizontal wall flashings.
- .7 Lap roof membrane flashing over air/vapour barrier membrane at parapets and seal.
- .8 Seal all through-wall equipment flanges with air barrier membrane flashing strips; apply mastic to edges.
- .9 Seal all metal fabrication flanges with air/vapour barrier membrane flashing strips; apply

mastic to
edges.

- .10 Seal all horizontal drip flashings to air/vapour barrier membrane with minimum 150 mm strips of membrane flashing applied horizontally; apply mastic to edges of flashing membrane.

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.

3.7 PROTECTION OF WORK

- .1 Protect finished work in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Do not permit adjacent work to damage work of this section.
- .3 Ensure finished work is protected from climatic conditions.

END OF SECTION 07 27 00.01

1.0 GENERAL

1.1 SECTION INCLUDES

- .1 Supply and install preformed metal cladding panels, including all necessary supporting structure, girts, clips, flashings, sealants, gaskets, caulking and accessories to full extent shown on drawings and as specified herein.

1.2 RELATED REQUIREMENTS

- .1 Rough Carpentry for Minor Works Section 06 08 99
- .2 Thermal Insulation Section 07 21 00
- .3 Air Barriers- Descriptive or Proprietary Section 07 27 00.01
- .4 Sheet Metal Flashing and Trims Section 07 62 00
- .5 Joint Sealants Section 07 92 00
- .6 Glazed Aluminum Curtain Wall Section 08 44 13
- .7 Gypsum Board Assemblies Section 09 21 16
- .8 Non-Structural Metal Framing Section 09 22 16

1.4 SUBMITTALS

- .1 Submit 300 x 300 mm size sample of wall cladding material, of color and profile specified, in accordance with Section 01 33 00 Submittal Procedures.
- .2 Submit product data or shop drawings in accordance with Section 01 33 00 showing the profiles of preformed metal cladding units, and the detail of forming, jointing (gaskets if any), internal supports, anchorages, trim, flashing and accessories. Show details of weatherproofing at edges, terminations and penetrations of the metal cladding work. Show small scale layout and elevations of entire work.
- .3 Shop drawings to be designed and prepared under the supervision of a registered Professional Engineer registered in British Columbia. All submitted shop drawings shall be sealed and signed by the said Professional Engineer. The same Professional Engineer shall provide Letter of Assurance Model Schedule B + C-B confirming the work is designed and installed in conformance with the structural design criteria.

1.5 EXISTING CONDITIONS

- .1 Before commencing erection, examine the structure carefully. Notify the Consultant of any defects and have the base surfaces corrected as required. Do not work until corrective measures are taken.
- .2 Commencement of work signifies acceptance of all base surfaces.

1.6 WARRANTY

- .1 The metal cladding installation and material shall be warranted against the penetration of rain, snow, ice or environmental elements, to be rigid and safely able to withstand all wind and snow loads, not to deflect, buckle, twist or pull away from fastenings over a period of two (2) years from the date of Substantial Performance. Defects occurring within the two year warranty period shall be rectified at no cost to the Owner.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Exterior Cladding and Trim Materials
 - .1 Minimum 0.759mm (22ga) sheet steel.
 - .2 Minimum 0.912mm (20ga) for flat stock sheet metal installed behind fixtuers or wall penetration.
 - .3 All exposed sheet metal or cladding material to be galvalume Plus finish to match adjoining profile metal cladding.
- .2 Profile:
 - .1 305mm wide flat panel completed with 25mm high standing seam or snap lock, Galvalume Plus AZ180.
- .3 Assembly and Installation Accessories: Provide manufacturer's standard fasteners, brackets, clips, anchoring devices, furring strips, spacers, flashings, closures, adhesives, joint sealers, expansion joints and other components needed for a complete permanently weather proof installation. Use materials which are non-corrosive, non-deteriorating, and compatible with the panel faces. All exposed fasteners shall be painted to match siding panels.
- .4 Trims and Custom Break Shapes: Provide trim components as part of the preformed metal cladding work, including all flashing and collars, capping, seam covers, end stops and filler pieces, etc. Match the material and finish of the exterior panels, thickness minimum 0.61 mm (22 ga).
- .5 Flashings: shall be of the same material and finish as metal cladding, thickness minimum 0.759 mm.
- .6 Closure Strips: shall be of same material and finish as metal cladding, thickness minimum 0.759 mm.
- .7 Sealant: for metal cladding system with the colour to match adjoining surfaces, field applied around all openings, and to side of all cladding. Sealant shall comply with Section 07 92 00.
- .8 Z-Girt: Stainless steel, Thermally broken, adjustable with PVC spacers, composed of inner short sections of angle and a continuous angle to the outside, tie together with a screw fastener.

2.2 PANEL FABRICATION

- .1 Determine the section properties of the metal cladding panel systems in strict accordance with the requirements of the National Building Code, BC Building Code; Canadian Structural Design Manual including CSA S136, Design of Light Gauge Steel Structured Members.
- .2 Metal cladding panel systems shall withstand all live loads resulting from wind or a combination of wind and temperature as defined in the National Building Code, BC Building Code without exceeding the maximum working stress of 20,000 psi for steel members or the maximum deflection of 1/180th of the span.
- .3 Form sections square, true and accurate to size, free of distortion and other defects detrimental to appearance or performance.
- .4 Provide resilient gaskets or spacers between metal components of panel assemblies, and between panels, as required to eliminate metal-to-metal contact and movement noises in the completed work, which might result from thermal or structural movements.

3.0 EXECUTION

3.1 PREPARATION

- .1 Wherever possible, take field measurements prior to completion of shop fabrication and finishing of preformed metal cladding. Do not delay job progress; allow for trimming where final dimensions cannot be established before fabrication.

3.2 INSTALLATION

- .1 Comply with panel manufacturer's instructions and approved Engineered shop drawing for assembly, installation and erection of preformed metal cladding.
- .2 Apply a coat of bituminous paint, concealed, on one or both surfaces wherever dissimilar metals would otherwise be in contact. Use gasket fasteners where needed to eliminate the possibility of corrosive or electrolytic action between metals.
- .3 Anchor component parts of the preformed metal cladding securely in place, providing for necessary thermal and structural movement as recommended by manufacturer and as indicated on Engineered Shop Drawings. Make corners square, surfaces true and straight in all planes and lines accurate to profiles.
- .4 Tolerances: Erect the Work plumb, level and true to line with tolerances not exceeding 6 mm in runs of 6 m.
- .5 Install exterior corners, fillers and closure strips with individually formed and profiled work using concealed fasteners.
- .6 Install sealants for the preformed metal cladding work as indicated and as required for performance. Comply with sealant manufacturer's instructions for installation and curing.
- .7 Install starter strips, backer plates, drip caps, outside custom corners and other trims and flashings, as indicated on the drawings and as required to provide a complete and finished product.
- .8 All flashing in contact with steel preformed metal cladding as herein described shall be steel and by this trade, except as noted otherwise.
- .9 Isolate all dissimilar materials.
- .10 Apply waterproof membrane between all members/supports for metal cladding connecting to back-up structure and weather barrier. Ensure membrane projects 25 mm beyond all sides of every member to provide a complete seal around fastenings.
- .11 Do not install cladding in direct contact with lead or copper or in areas where run off from these metals on to the cladding surface may occur.

3.3 CLEANING

- .1 Clean exposed surfaces of preformed metal cladding work promptly after completion of installation. Comply with recommendations of both the panel and coating manufacturers.
- .2 Clean up and remove from the site all surplus materials and rubbish resulting from the Work of this Section.

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1	Thermal Insulation	Section 07 21 00
.2	Air Barriers – Descriptive or Proprietary	Section 07 27 00.01
.3	Metal Wall Panel	Section 07 42 13
.4	Sheet Metal Flashing and Trim	Section 07 62 00

1.2 REFERENCES

- .1 Aluminum Association (AA).
 - .1 AA DAF-45-R03, Designation System for Aluminum Finishes - 9th Edition.
 - .2 AA ASM-35-October 2000, Specifications for Aluminum Sheet Metal Work in Building Construction, Section 5.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 167-99, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM A 240/A 240M-02a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .3 ASTM A 653/A 653M-02a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM A 792/A 792M-02, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot Dip Process.
 - .5 ASTM B 32-00e1, Standard Specification for Solder Metal.
 - .6 ASTM B 370-98, Standard Specification for Copper Sheet and Strip for Building Construction.
 - .7 ASTM D 523-89(1999), Standard Test Method for Specular Gloss.
 - .8 ASTM D 822-01, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .3 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-37.5-M89, Cutback Asphalt Plastic Cement.
 - .2 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.
 - .3 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
 - .4 CAN/CGSB-93.1-M85, Sheet Aluminum Alloy, Prefinished, Residential.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA A123.3-98, Asphalt Saturated Organic Roofing Felt.
- .5 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .7 National Research Council Canada (NRC)/Institute for Research in Construction (IRC) - Canadian Construction Materials Centre (CCMC).
 - .1 CCMC-2002, Registry of Product Evaluations.

- .8 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992.

1.3 SUBMITTALS

- .1 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, and cleaning procedures.
- .2 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .4 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures. Shop drawings to be signed and sealed by Professional Engineer registered in Province of British Columbia. The said engineer to provide NBCC 2010 Schedule B1, B2 and C-B as per appendix in this specification.
- .5 Indicate arrangements of sheets and joints, types and locations of fasteners and special shapes and relationship of panels to structural frame.
- .6 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .7 Submit duplicate 300 x 300mm samples of each sheet metal material.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.
- .7 Ensure emptied containers are sealed and stored safely.
- .8 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .9 Unused paint, caulking, and sealing compound materials must be disposed of at an official hazardous material collections site as approved by Departmental Representative.
- .10 Unused paint, caulking, and sealing compound materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

- .11 Fold up metal banding, flatten and place in designated area for recycling.

1.5 GUARANTEE

- .1 Provide the RCABC ten (10) year guarantee for new roofing systems and flashings specified in this Section and twenty (20) year Manufacturer Warranty. Guarantee shall cover all materials, installation and workmanship from the date of Substantial Performance of the Project.

2.0 PRODUCTS

2.1 SHEET METAL MATERIALS

- .1 minimum base metal thickness- 0.701mm(24 gauge).
Acceptable Product: 305mm wide flat panel completed with 25mm high snap lock, Galvalume Plus AZ180

2.2 ACCESSORIES

- .1 Assembly and Installation Accessories: Provide manufacturer's standard fasteners, brackets, clips, anchoring devices, furring strips, spacers, flashings, closures, adhesives, joint sealers, expansion joints and other components needed for a complete permanently weater proof installation. Use materials which are non-corrosive, non-deteriorating, and compatible with the panel faces. All exposed fasteners shall be painted to match siding panels.
- .2 Trims and Custom Break Shapes: Provide trim components as part of the preformed metal cladding work, including all flashing and collars, capping, seam covers, end stop and filler pieces, etc. Match the material and finish of the exterior panels, thickness minimum 0.61mm (24ga).
- .3 Flashings: shall be of the same material and finish as metal cladding, thickness minimum 0.61mm(24ga)
- .4 Closure Strips: shall be of same material and finish as metal cladding, thickness minimum 0.61mm(24ga)
- .5 Sealant: for metal cladding system shall be gummable non-skinning butyl, with the colour to match adjoining surfaces, field applied around all openings, and to side of all cladding. Sealant shall complex with Section 07 92 00.
- .6 Z-Girt: Thermally broken, adjustable with PVC spacers, composed of inner short sections of angle and a continuous angle to the outside, tie together with a screw fastener.

2.3 FABRICATION

- .1 Fabricate aluminum sheet metal in accordance with AA ASM-35.
- .2 Determine the section properties of the metal cladding panel systems in strict accordance with the requirements of the National Building Code; Canadian Structural Design Manual including CSA S136, Design of Light Gauge Steel Structured Members.
- .3 Metal cladding panel systems shall withstand all live loads resulting from wind or a combination of wind and temperature as defined in the BC Building Code without exceeding the maximum working stress of 20,000 psi for steel members or the maximum deflection of 1/180th of the span.
- .4 Form individual pieces in 2400 mm maximum lengths. Make allowances for expansion at joints.
- .5 Hem exposed edges on underside 12 mm, mitre and seal.

- .6 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .7 Apply minimum 0.2 mm dry film thickness coat of plastic cement to both faces of dissimilar metals in contact.
- .8 Protect dissimilar metals against oxidization by backpainting with isolation coating where indicated.

2.4 AIR/WATER/VAPOUR BARRIER MEMBRANE (ROOF UNDERLAYMENT)

- .1 SBS modified self-adhesive membrane composed of SBS modified bitumen and a tri-laminated woven polyethylene facer. The underface is covered with a silicone release film.
- .2 Primer
 - .1 All substrates must be primed according to manufacturer's recommendations. Substrate to be sound & clean, free of loose materials or contaminants.
- .3 Properties:
 - .1 Thickness: 0.8 mm (31 mil)
 - .2 Dimensions: 40.8 x 1.14 m (134 x 3.7 ft.)
 - .3 Gross / Net coverage per roll: 46.5 / 43.5 m² (500 / 468 ft²)
 - .4 Weight: 0.77 kg/m² (0.16 lb/ft²)
 - .5 Selvedge width: 75 mm (3 in)
 - .6 Top face: Tri-laminate woven polyethylene
 - .7 Underface: Silicone release film
 - .8 Rolls per skid: 25
 - .9 Tensile strength, MD/XD: ASTM D5147 9.5 / 13 KN/m (54 / 74 lbf/in)
 - .10 Ultimate elongation, MD/XD: ASTM D5147 33 / 25%
 - .11 Cold bending: ASTM D5147 -50 °C (-58 °F)
 - .12 Static puncture: ASTM D5602 400 N (90 lbf)
 - .13 Tear resistance, MD/XD: ASTM D1970 423 / 458 N (95 / 103 lbf)
 - .14 Lap adhesion: ASTM D1876 1000 N/m (68 lbf/ft)
 - .15 Water absorption: ASTM D5147 0.1 % max.
 - .16 Peel resistance on steel: ASTM D903 950 N/m (5.4 lbf/in)
 - .17 Water vapour permeance: ASTM E96 (Procedure B) 1.7 ng/Pa.s.m² (0.03 perm)
 - .18 Air permeability: ASTM E2853 (75 Pa) < 0.0002 L/sec • m²
- .4 Ice and Water Shield
 - .1 Provide ice dam protection membrane of self-adhesive SBS modified bitumen membrane extend upslope for a minimum of 915mm.

2.5 SLIP SHEET

- .1 Provide slip sheet on top of insulation as per manufacturer's recommendation.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Examine and obtain all necessary measurements of previously executed work which may affect the work of this Section.
- .2 Report any discovered discrepancies to the Contractor so that instructions may be give for the

necessary remedial work.

3.2 PREPARATION

- .1 Wherever possible, take field measurements prior to completion of shop fabrication and finishing of preformed metal cladding. Do not delay job progress; allow for trimming where final dimensions cannot be established before fabrication.

3.3 STORAGE AND HANDLING

- .1 Exercise care in storing, handling and placing the roof panels to prevent damage likely to impair the adequacy or appearance of the material in the finished structure.
- .2 Damaged material shall be replaced or corrected to the satisfaction of the Consultant and any costs incurred shall be borne by the parties responsible for the damage.

3.4 AIR/WATER/VAPOUR BARRIER

- .1 Install air/water/vapour barrier according to RCABC specifications or to manufacturer's recommendations for cold adhesive application as applicable.

3.5 PRIMER

- .1 Prime gypsum wall board and metal surfaces to be directly adhered with bituminous membrane and allow to dry.

3.6 MEMBRANE APPLICATION

- .1 Align membrane and remove 600mm (24") of release paper. Apply to surface keeping the roll in line. Adhere the remainder of the membrane roll by removing the silicone paper as the membrane is unrolled, pass a broom over the surface to remove any air trapped under the membrane.
- .2 Install subsequent rolls in similar fashion and align with preceding rolls with a side lap of minimum 75 mm (3"). End laps must overlap a minimum of 150mm (6").
- .3 Field membrane shall extend up curb section a minimum of 76mm (3"). Curb membrane shall extend down the wall and back onto the field membrane and minimum of 150mm (6"). This application shall produce a 'shingle lap' over the field membrane resulting in an inside corner which consists of two (2) plies of waterproofing membrane.
- .4 Roll a linoleum roller over the deck membrane application to improve initial adhesion to the substrate.
- .5 Apply a trowelled bead of SBS bitumen mastic to top terminations of curb membrane at the end of each days work.

3.7 METAL STANDING SEAM ROOFING

- .1 Erect Standing Seam Roofing to manufacturer's instructions and in accordance with the drawings and details over roofing membrane and Plywood Sheathing.
- .2 All erection work shall be the responsibility of the manufacturer and such erection work shall be carried out by the manufacturer's trained erection crews or manufacturer's approved erector in strict accordance with manufacturer's directions and reviewed shop drawings.
- .3 Metal roofing shall be installed to the slope as indicated on the drawings.
- .4 Anchor component parts of the preformed metal cladding securely in place, providing for

necessary thermal and structural movement as recommended by manufacturer. Make corners square, surfaces true and straight in all planes and lines accurate to profiles.

- .5 Tolerances: Erect the work plumb, level and true to line with tolerances not exceeding 6 mm in runs of 6 m.
- .6 Install exterior corners, fillers and closure strips with individually formed and profiled work using concealed fasteners.

3.8 FLASHING INSTALLATION

- .1 Use concealed fasteners where appropriate. Exposed fasteners to be of same color as sheet.
- .2 Lock end joints and caulk to provide weather-tight seal. Use standing seam joints in flashings to RCABC Standards. Seal all joints in flashings.
- .3 Provide all flashings to make metal roofing watertight.
- .4 Install matching cap flashing at ridges, eaves, skylights, walls and other locations as indicated.
- .5 Flashing color to match metal cladding colors where exposed to view.
- .6 Flashing details shown on the drawings indicate the general type and appearance required. Carry out all work in a proper workmanlike manner to RCABC Standards and details. Form proper returns to stop ends and work to and around all features as necessary.
- .7 Make all roof areas watertight as required. Flash openings and items projecting through roofing. Bend up flashing as required; fold and clip neatly and secure in straight lines free from wrinkles and undulations. Fastening to be concealed and watertight. Carefully place, form and trim breaks. Bond and neutralize soldering.
- .8 Turn back edges of all exposed flashing to form ¼" (6mm) stiffeners.
- .9 Form all flashings on a bending brake. Execute all hand trimming, shaping and soldering with appropriate tools. Install with hold down clips.
- .10 Allow for expansion and contraction to finished work without deformation.
- .11 Install starter strips, backer plates, drip caps, outside custom corners and other trims and flashings, as indicated on the drawings and as required to provide a complete and finished product. Cladding manufacture to supply cap flashings for forming and installation by roofing contractor.
- .12 All Flashing in contact with steel preformed metal cladding as herein described shall be steel and by this trade.

3.9 SEALANT

- .1 Provide sealant and joint packing to perimeter joints at metal roofing and at all penetrations through roofing and as required for performance. Comply with sealant manufacturer's instructions for installation and curing.

3.10 CLEANUP

- .1 Before removing scaffolding, clean off any marks on metal roofing. Repair any defects to any

other work caused by this work; leave panels free of oil, grease and dirt.

- .2 This subcontractor shall leave all metal roofing panels clean and free of all grime and dirt.
- .3 At the completion of the work of this Section, remove any excess materials, debris and equipment, pertaining to the work of this Section from the site.

END OF SECTION 07 61 13

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Air Barriers Descriptive or Proprietary Section 07 27 00.01.
- .2 Metal Wall Panels Section 07 42 13
- .3 Standing Seam Sheet Metal Roofing Section 07 61 13

1.2 REFERENCES

- .1 The Aluminum Association Inc. (AAI)
 - .1 AAI-Aluminum Sheet Metal Work in Building Construction-2002.
 - .2 AAI DAF45-03, Designation System for Aluminum Finishes.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 653/A 653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A 792/A 792M-10, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .3 Roofing Contractors Association of B.C. (RCABC)
 - .1 RGC Roofing Practice Manual.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
- .7 Green Seal Environmental Standards
 - .1 Standard GS-03-93, Anti-Corrosive Paints.
 - .2 Standard GS-11-97, Architectural Paints.
 - .3 Standard GS-36-00, Commercial Adhesives.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .9 British Columbia Sheet Metal Association (SMACNA-BC)
 - .1 Architectural Sheet Metal Manual- 6th Edition 2003.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature for sheet metal flashing systems materials, 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 35 33- - Health and Safety Requirements.
- .3 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

- .4 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.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings: convene pre-installation meeting [one] week prior to beginning work of this Section and, with contractor's representative, Departmental Representative in accordance with Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Chart to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building sub trades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Upon completion of work, this Contractor shall furnish Owners with a 10 year R.C.A.B.C. guarantee work of this section.
- .3 Provide for inspection in accordance with specifications and Consultant's Standards. Include inspection fees in this contract. Inspection agency to be selected from R.C.A.B.C. approved list of roofing inspectors.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 PRE-FINISHED SHEET METAL

- .1 0.8534mm (22ga) thickness, Galvalume Plus AZ180

2.2 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Plastic cement: to CAN/CGSB 37.5.
 - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.
- .3 Underlay for metal flashing: asphalt laminated 3.6 to 4.5 kg kraft paper.
- .4 Sealants.
 - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.
- .5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
- .6 Fasteners: stainless steel, flat head roofing nails of length and thickness suitable for metal flashing application.
- .7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

- .8 Touch-up paint: as recommended by prefinished material manufacturer.
 - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1113.

2.3 FABRICATION

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable RCABC and SMACNA Standards. Guarantee standard as specified in 1.4 Quality Assurance.
- .2 Form pieces in 2400 mm maximum lengths.
 - .1 Make allowance for expansion at joints.
- .3 Hem exposed edges on underside 12 mm.
 - .1 Mitre and seal corners with sealant.
- .4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

2.4 METAL FLASHINGS

- .1 Form flashings, copings and fascias to profiles indicated of galvanized steel as indicated on drawings.
- .2 Caulk perimeter flashings with specified sealant where necessary to make a proper seal.
- .3 'S' Lock and caulk end joints in flashing. Provide standing seams with concealed clips at corners. Hem exposed edges of flashing a minimum of 12.5 mm for rigidity.
- .4 Provide flashings with edges turned to form a drip. Make proper allowance for expansion and contraction. Face clip flashings with concealed clips (600 mm) on centres.
- .5 Provide flashings at vents, chimneys and control joints.
- .6 Carry face metal down exterior face a minimum of 100 mm or as indicated on drawings.
- .7 Provide metal base and cap flashings to extend to within 25 mm of roof surface.
- .8 At vent stacks, install aluminum vent stacks and include for aluminum metal caps.

3.0 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install sheet metal work in accordance with R.C.A.B.C standards. Guarantee standard as per 1.4 Quality Assurance.
- .2 Use concealed fastenings except where approved before installation.
- .3 Provide underlay under sheet metal.
 - .1 Secure in place and lap joints 100 mm.

- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
 - .1 Flash joints using S-lock forming tight fit over hook strips.
- .5 Lock end joints and caulk with sealant.
- .6 Install pans, where shown around items projecting through roof membrane.

3.3 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.
- .3 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION 07 62 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Concrete Unit Masonry Section 04 22 00
- .2 Mechanical Divisions 21-23
- .5 Electrical Communications/Electronics/Security Divisions 25-28

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Underwriter's Laboratories of Canada (CAN/ULC)
 - .1 CAN/ULC-S101 Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S102 Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC-S115-07, Fire Tests of Fire stop Systems.

1.3 DEFINITIONS

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted; (ref: NBC 2010): penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
 - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

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 of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 33 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings and method of installation for each type of firestop condition.
 - .2 Construction details should accurately reflect actual job conditions.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with CAN/ULC-S101 and CAN/ULC-S102.
 - .1 Submit certified test reports from approved independent testing laboratories,

- indicating compliance of applied fire stopping 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.
- .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
- .4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company specializing in fire stopping installations with 5 years documented experience and certified by manufacturer of firestop system.
- .2 Pre-Installation Meetings: convene pre-installation meeting two weeks prior to beginning work of this Section, with contractor's representative and Departmental Representative in accordance with Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Chart to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building sub trades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .3 Site Meetings: as part of Manufacturer's 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.

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.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.
- .2 Storage and Protection:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against

- flame, smoke and gases in compliance with requirements of CAN- ULC-S115 and not to exceed opening sizes for which they are intended and conforming to specified special requirements described in PART 3.
- .2 Fire stop system rating: 1 hour FRR, F rating.
 - .2 Service penetration assemblies: systems tested to CAN-ULC-S115.
 - .3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
 - .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC and BCBC 2012.
 - .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
 - .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
 - .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
 - .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
 - .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
 - .10 Sealants for vertical joints: non-sagging.

3.0 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 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

3.4 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by Departmental Representative.
- .2 Install floor fire stopping before interior partition erections.
- .3 Mechanical pipe insulation: fire stop system component.
 - .1 Ensure pipe insulation installation precedes fire stopping.

3.5 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- .2 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.

3.6 FIRE STOP LABEL

- .1 All fire stop penetrations shall be labeled. Labels shall be secured to surface directly on both sides of fire stop penetration. Fire stop penetration labels shall include the following information.
 - .1 Name of installer.
 - .2 Date of installation.
 - .3 Type of sealing system.
 - .4 Time duration of sealant.

3.7 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.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.8 SCHEDULE

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Top of fire-resistance rated masonry and gypsum board partitions.
 - .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
 - .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.

- .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
- .6 Openings and sleeves installed for future use through fire separations.
- .7 Around mechanical and electrical assemblies penetrating fire separations.
- .8 Rigid ducts: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

END OF SECTION 07 84 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- | | | |
|----|------------------------------------------------|------------------|
| .1 | Finish Carpentry | Section 06 20 00 |
| .2 | Metal Wall Panels | Section 07 42 13 |
| .3 | Sheet Metal Flashing and Trim | Section 07 62 00 |
| .4 | Glazed Aluminum Curtain Wall | Section 08 44 13 |
| .5 | Glazing | Section 08 80 50 |
| .6 | Gypsum Board Assemblies | Section 09 21 16 |
| .7 | Interior Painting | Section 09 91 13 |
| .8 | Mechanical | Divisions 21-23 |
| .9 | Electrical Communications/Electronics/Security | Divisions 25-28 |

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C 919- 12, Standard Practice for Use of Sealants in Acoustical Applications.
- .2 ASTM C920-11 Standard Specification for Elastomeric Joint Sealants
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's product to describe.
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- .3 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Submit duplicate samples of each type of material and colour.
- .5 Cured samples of exposed sealants for each color where required to match adjacent material.
- .6 Submit manufacturer's instructions in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions to include installation instructions for each product used.

1.4 QUALITY ASSURANCE / MOCK-UPS

- .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
- .2 Construct mock-up to show location, size, shape and depth of joints complete with back-up

- . material, primer, caulking and sealant.
- .3 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
- .4 Location to be decided with Departmental Representative.
- .5 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with sealant work.
- .6 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.5 DELIVERY, STORAGE & HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.
- .3 Upon completion of Work, after cleaning is carried out.

1.6 ENVIRONMENTAL REQUIREMENTS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - .2 When joint substrates are wet.
- .2 Joint-Width Conditions:
 - .1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.
- .4 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.
- .5 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .6 Ventilate area of work as directed by Departmental Representative by use of approved portable supply and exhaust fans.

2.0 PRODUCTS

2.1 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.

- .2 When low toxicity caulks are not possible, confine usage to areas which offgas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize offgas time.
- .3 Where sealants are qualified with primers use only these primers.
- .4 Standard: For interior and exterior work unless otherwise specified, ensure compatibility of sealants being used and other materials in contact with them, meet VOC level of 250 g/L for architectural sealant.

2.2 SEALANT TYPE

- .1 S-1:
 - .1 ASTM C920, polyurethane or polysulfide.
 - .2 Type M.
 - .3 Class 25.
 - .4 Grade NS.
 - .5 Shore A hardness of 20-40.
- .2 S-2:
 - .1 ASTM C920, polyurethane or polysulfide.
 - .2 Type M.
 - .3 Class 25.
 - .4 Grade P.
 - .5 Shore A hardness of 25-40.
- .3 S-3:
 - .1 ASTM C920, polyurethane or polysulfide.
 - .2 Type S.
 - .3 Class 25, joint movement range of plus or minus 50 percent.
 - .4 Grade NS.
 - .5 Shore A hardness of 15-25.
 - .6 Minimum elongation of 700 percent.
- .4 S-4:
 - .1 ASTM C920, polyurethane or polysulfide.
 - .2 Type M.
 - .3 Class 25,
 - .4 Grade NS.
 - .5 Shore A hardness of 25-40.
- .5 S-5:
 - .1 ASTM C920, polyurethane or polysulfide.
 - .2 Type M.
 - .3 Class 25.
 - .4 Grade P.
 - .5 Shore A hardness of 25-40.
- .6 S-6:
 - .1 ASTM C920, silicone, neutral cure.
 - .2 Type S.
 - .3 Class: Joint movement range of plus 100 percent to minus 50 percent.
 - .4 Grade NS.

- .5 Shore A hardness of 15-20.
- .6 Minimum elongation of 1200 percent.

- .7 S-7:
 - .1 ASTM C920, silicone, neutral cure.
 - .2 Type S.
 - .3 Class 25.
 - .4 Grade NS.
 - .5 Shore A hardness of 25-30.
 - .6 Structural glazing application.

- .8 S-8:
 - .1 ASTM C920, silicone, acetoxy cure.
 - .2 Type S.
 - .3 Class 25.
 - .4 Grade NS.
 - .5 Shore A hardness of 25-30.
 - .6 Structural glazing application.

- .9 S-9:
 - .1 ASTM C920, silicone.
 - .2 Type S.
 - .3 Class 25.
 - .4 Grade NS.
 - .5 Shore A hardness of 25-30.
 - .6 Non-yellowing, mildew resistant.

- .10 S-10:
 - .1 ASTM C920, coal tar extended fuel resistance polyurethane.
 - .2 Type M/S.
 - .3 Class 25.
 - .4 Grade P/NS.
 - .5 Shore A hardness of 15-20.

- .11 S-11:
 - .1 ASTM C920, polyurethane.
 - .2 Type M/S.
 - .3 Class 25.
 - .4 Grade P/NS.
 - .5 Shore A hardness of 35-50.
 - .6 Structural glazing application.

- .12 S-12:
 - .1 ASTM C920, polyurethane.
 - .2 Type M/S.
 - .3 Class 25, joint movement range of plus or minus 50 percent.
 - .4 Grade P/NS.
 - .5 Shore A hardness of 25-50.

2.3 CAULKING COMPOUND

- .1 C-1: ASTM C834, acrylic latex.
- .2 C-2: One component acoustical caulking, non-drying, non hardening, synthetic rubber.

2.4 JOINT CLEANER

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.
- .2 Primer: as recommended by manufacturer.

3.0 EXECUTION

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant.
 - .1 Apply sealant in accordance with manufacturer's written instructions and ASTM C919.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.

- .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
- .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
- .8 Remove excess compound promptly as work progresses and upon completion.

- .2 Curing.
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.

- .3 Cleanup.
 - .1 Clean adjacent surfaces immediately and leave Work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.
 - .3 Remove masking tape after initial set of sealant.

3.7 CLEANING

- .1 Clean adjacent surfaces immediately and leave work clean and neat. Remove excess sealant and droppings using recommended cleaners as work progresses. Remove masking after tooling of joints.

3.8 LOCATIONS

- .1 Exterior Building Joints, Horizontal and Vertical:
 - .1 Metal to Metal: Type S-1, S-2.
 - .2 Metal to Masonry or Stone: Type S-1.
 - .3 Masonry to Masonry or Stone: Type S-1.
 - .4 Threshold Setting Bed: Type S-1, S-3, S-4.
 - .5 Masonry Expansion and Control Joints: Type S-6

- .2 Metal Reglets and Flashings:
 - .1 Flashings to Wall: Type S-6.
 - .2 Metal to Metal: Type S-6.

- .3 Sanitary Joints:
 - .1 Pipe Penetrations: Type S-12.

- .4 Interior Caulking:
 - .1 Typical Narrow Joint 6mm, (1/4 inch) or less at Walls and Adjacent Components: Type C-1 and C-2.
 - .2 Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Exterior Walls: Types C-1 and C-2.
 - .3 Joints at Masonry Walls and Columns, Piers, Concrete Walls or Exterior Walls: Types C-1 and C-2.
 - .4 Expose Isolation Joints at Top of Full Height Walls: Types C-1 and C-2.
 - .5 Exposed Acoustical Joint at Sound Rated Partitions Type C-2.
 - .6 Concealed Acoustic Sealant Types S-4, C-1 and C-2.

END OF SECTION 07 92 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Joint Sealants Section 07 92 00
- .2 Glazed Aluminum Curtain Walls Section 08 44 13
- .3 Door Hardware Section 08 71 00
- .4 Glazing Section 08 80 50

1.2 REFERENCES

- .1 American Architectural Manufacturers Association (AAMA)
 - .1 AAMA 609/610-09, Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
- .2 ASTM International
 - .1 ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .3 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-CI 1.0 2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For Commercial Interiors.
- .4 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.40-97, Anticorrosive Structural Steel Alkyd Primer.
 - .2 CAN/CGSB-12.1-M90, Tempered or Laminated Safety Glass.
 - .3 CAN/CGSB-12.20-M89, Structural Design of Glass for Buildings.
- .5 CSA International
 - .1 CSA G40.20/G40.21-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .6 Environmental Choice Program (ECP)
 - .1 CCD-045-95, Sealants and Caulking Compounds.
- .7 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .8 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 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 doors and frames and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada. Submit Model Schedule B and C-B.

- .2 Indicate materials and profiles and provide full-size, scaled details of components for each type of door and frame. Indicate:
 - .1 Interior trim and exterior junctions with adjacent construction.
 - .2 Junctions between combination units.
 - .3 Elevations of units.
 - .4 Core thicknesses of components.
 - .5 Type and location of exposed finishes, method of anchorage, number of anchors, supports, reinforcement, and accessories.
 - .6 Location of caulking.
 - .7 Each type of door system including location.
 - .8 Arrangement of reinforcing for hardware and joints.
 - .9 Arrangement of hardware and required clearances.

- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Submit one 300 x 300 mm corner sample of each type door and frame.
 - .3 Submit sample showing glazing detail, reinforcement, finish and location of manufacturer's nameplates.
 - .4 Frame sample to show glazing stop, door stop, jointing detail, finish.

- .5 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.
 - .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .3 Low-Emitting Materials:
 - .1 Submit listing of adhesives and sealants paints and coatings used in building, showing compliance with VOC and chemical component limits or restriction 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 cleaning and maintenance of aluminum finishes for incorporation into manual.

1.5 QUALITY ASSURANCE

- .1 Certifications: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labeled with manufacturer's name and address.

- .3 Storage and Handling Requirements:

- .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect aluminum doors and frames from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

2.0 PRODUCTS

2.1 DESIGN CRITERIA

- .1 Size glass thickness and glass unit dimensions to limits in accordance with CAN/CGSB-12.20.
- .2 Air infiltration to ASTM E283 – 0.06ctm/ft² at a static differential of 6.24 psf
- .3 No leakage to ASTM E331- no leakage at 8 psf static differential as AAMA 501.
- .4 Uniform Load: A static air design load of 20 psf shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of 1/175 of the span of any framing member. At a structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

2.2 MATERIALS

- .1 Aluminum extrusions: to Aluminum Association alloy AA 6063-T5 anodizing quality.
- .2 Fasteners: aluminum finished to match adjacent material.
- .3 Door bumpers: black neoprene.
- .4 Isolation coating: bituminous paint.
- .5 Glazing materials: double glazed unit, refer to section 08 80 50 Glazing.
- .6 Sealants: colour selected by Departmental Representative in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Maximum VOC limit: 250 g/L 5% by weight to SCAQMD Rule 1168.

2.3 EXTERIOR ALUMINUM DOORS

- .1 Construct doors with minimum wall thickness of 1.6 mm, door thickness to be 44 mm deep flush with door.
- .2 Door stiles nominal 61.9 mm wide plus or minus 6 mm.
- .3 Top rail nominal 58.7 mm wide plus or minus 6 mm.
- .4 Bottom rail nominal 58.7 mm wide plus or minus 6 mm.
- .5 Reinforce mechanically-joined corners of doors to produce sturdy door unit.
- .6 Polyurethane core minimum 5 lb/sf, meet GEI indoor quality certification standard.

.7 Finishing: Plain (no pattern), clear anodized.

.8 Other hardware: Refer to 08 71 00

2.4 ALUMINUM FRAMES

.1 Construct frames of aluminum extrusions with minimum wall thickness to meet specified performance requirements.

.2 Frame members 114.3 x 44.5 mm nominal size, installed as sub-frame to curtain wall section type window.

2.5 ALUMINUM FINISHES

.1 Clear anodic finish: to designation AA- M12C22A41.

2.6 FABRICATION

.1 Doors and framing to be by same manufacturer.

.2 Fabricate doors and frames to profiles and maximum face sizes as indicated.

.3 Provide structural steel reinforcement as required.

.4 Fit joints tightly and secure mechanically.

.5 Conceal fastenings.

.6 Mortise, reinforce, drill and tap doors, frames and reinforcements to receive hardware using templates provided under Section 08 71 00 - Door Hardware.

.7 Isolate aluminum from direct contact with dissimilar metals, concrete and masonry.

3.0 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for aluminum doors and frames 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 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Set frames plumb, square, level at correct elevation in alignment with adjacent work.

.3 Anchor securely.

.4 Install doors and hardware in accordance with hardware templates and manufacturer's instructions.

.5 Adjust door components to ensure smooth operation.

.6 Make allowances for deflection of structure to ensure that structural loads are not transmitted to

frames.

- .7 Glaze aluminum doors and frames in accordance with Section 08 80 50 - Glazing.
- .8 Seal joints to provide weathertight seal at outside and air, vapour seal at inside.
- .9 Apply sealant in accordance with Section 07 92 00 - Joint Sealants. Conceal sealant within the aluminum work except where exposed use is permitted by Departmental Representative.

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 Perform cleaning of aluminum components in accordance with AAMA 609.1 - Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum.
 - .3 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
 - .4 Clean aluminum with damp rag and approved non-abrasive cleaner.
 - .5 Remove traces of primer, caulking, epoxy and filler materials; clean doors and frames.
 - .6 Clean glass and glazing materials with approved non-abrasive cleaner.
- .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 for 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.

3.4 PROTECTION

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

END OF SECTION 08 11 16

1.0 GENERAL

1.1 DOCUMENTS

- .1 This Section of the Specifications forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SECTIONS INCLUDED

- .1 Provide electrically operated, sectional steel, insulated overhead door, complete with lift hardware, tracks, door guides, electrical operator and controls.

1.3 RELATED REQUIREMENTS

- .1 Metal Fabrication: Section 05 50 00

1.4 DESIGN

- .1 Wind load: Design exterior door assembly to withstand a wind load calculated in accordance with the Building Code.

1.5 SUBMITTALS

Shop Drawings

- .1 Submit shop drawings in accordance with Section 01 33 00.
.2 Indicate materials, operating mechanisms, required clearances, and electrical connections.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver and store door to prevent damage.
.2 Made good or replace damaged units to the consultant's acceptance.

1.7 MAINTENANCE DATA

- .1 Provide operation and maintenance data for overhead door hardware for incorporation into operation and maintenance manual.

1.8 GUARANTEE

- .1 A written warranty will be required, guaranteeing the work from all defects from the use of materials, deficiencies of design strength, or by reason of poor workmanship which may appear within one (1) year from the date of Substantial Performance.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Steel: Door sections, stiles, back panels and tracks, ASTM A526/ A526-90 galvanized sheet steel; coating weight 380g/sq.m (1.25 oz./sq.ft.).
- .2 Sections: Insulated sections fabricated from pre-painted, hot dip galvanized, steel sheet; with rigid polyurethane insulation core, CFC-11 free, face sheet stucco embossed and rib reinforced. Sections thermally broken, steel-polyurethane-steel sandwich formed by continuous process. Sections formed with shiplapped joint. 16mm (16ga.) galvanized steel endcaps.
- Face sheet thickness: 0.48mm (0.019")
- Section thickness: 45mm (1-3/4")
- Thermal values of sections: R= 16.4
- .3 Reinforcement: Continuous internal reinforcement for hardware mounting.

- .4 Weatherstripping: Neoprene bulb weatherstrip with continuous retainer full width of bottom of door. Steel/ vinyl jamb and head seals on standard lift doors.
- .5 Finish: Two coat, baked-on paint system on exterior side, primer and polyester finish coat, Color – to match ICI Paint 70 BG 10/214 A1358 Soft Azure.

2.2 HARDWARE

- .1 Finish: All door face hardware, tracks and mounting hardware, and torsion assembly mounting brackets. Hot-dipped with 380g./sq.m. (1.25 oz/sq.ft.) zinc coating to – ASTM A525 – 9lb
- .2 Track: 2.75mm (12ga.) commercial galvanized track, formed track 80mm (3-1/8") overall outside dimension. Vertical tracks sloped for weather tight closing, 400mm (16") radius.
- .3 Track Brackets: 3.1mm (11ga.) thick commercially galvanized steel, rib reinforced. Continuous track angle - bolted adjustable type, fabricated from 2.4mm (13ga.) commercially galvanized steel full height of the opening fully adjustable for weather tight seal. Continuous angle for continuous track support full opening height.
- .4 Track Hangers: Min. 32 x 32mm (1-1/4" x 1-1/4") x 2.0mm (14ga.) minimum commercially galvanized perforated steel angles.
- .5 Rollers: Steel rollers 73mm (2-7/8") diameter with ten 8mm (5/16") diameter ball bearings, 11mm (7/16") diameter roller axles and inner and outer ball races of hardened steel.
- .6 Roller Brackets: Fabricated from 3.1mm (11/13/14ga.) commercially galvanized steel.
- .7 Counter Balance: Helically wound torsion springs, manufactured from oil tempered spring wire, stress relieved, minimum 10,000 cycles. Aluminum die-cast grooved drums and flexible, galvanized aircraft cables, 7 x 19 construction, mounted on 25mm 1" tubular steel, 2.0mm (14ga.) minimum.
- .8 Locking: Interior slide bolt.
- .9 Bumper Springs: For 4' (verify opening dimensions) hi-lift.
- .10 Operations: Manual control by chain operator with locking mechanism.

3.0 EXECUTION

3.1 FABRICATION

- .1 Fabricate the work true to dimensions and square. Fabricate finished work free from distortion and defects detrimental to appearance and performance.
- .2 Use shop and field connections complying with CAN/CSA S16. 1-M89.
- .3 Accurately fit joints and intersecting members with adequate fastenings.

3.2 INSTALLATION

- .1 Examine supports provided by others, at time of bidding and before installation. Report deficiencies to Consultant. Commencement of installation will signify acceptance of work by others.

- .2 Install guides and door hardware plumb, true and square, in accordance with drawings and manufacturer's instructions.
- .3 Install counter balance assembly as shown, electrical operator complete with controls.
- .4 Provide all necessary accessories for the complete installation of doors, guides, and operator to achieve a weather tight installation.
- .5 Install doors and align to ensure smooth operation and to provide correct closure.
- .6 Install manual chain hoist. The door subcontractor is responsible for wiring mechanical safety edges, and control station to electric operator.
- .7 Total installation of electrically operating door to be complete one month prior to completion of project. Notify Consultant for inspection and acceptance.
- .8 Check and adjust as required and deliver to Owner complete and functional overhead door system.
- .9 Touch up door with primer where galvanized finish damaged during fabrications.
- .10 Adjust weather stripping to form a weather tight seal.
- .11 On completion, adjust and lubricate sectional overhead doors. Check and adjust controls. Ensure that equipment and mechanisms are operating smoothly. Demonstrate the operation, control and safety features.

END OF SECTION 08 36 19

1.0 GENERAL1.1 RELATED REQUIREMENTS

.1	Rough Carpentry	Section 06 10 11
.2	Air Barriers – Descriptive or Proprietary	Section 07 27 00.01
.3	Sheet Metal Flashing Trim	Section 07 62 00
.4	Joint Sealants	Section 07 91 00
.5	Aluminum Doors and Frames	Section 08 11 16
.6	Glazing	Section 08 80 50

1.2 REFERENCES

- .1 Aluminum Association (AA)
 - .1 AA DAF 45-03 (R2009), Designation System for Aluminum Finishes.
- .2 American Architectural Manufacturers Association (AAMA)
 - .1 AAMA CW-10-04, Care and Handling of Architectural Aluminum From Shop to Site.
 - .2 AAMA CW-11-85, Design Wind Loads and Boundary Layer Wind Tunnel Testing.
 - .3 AAMA T1R-A1-04, Sound Control for Fenestration Products.
 - .4 AAMA 501-05, Methods of Test for Exterior Walls.
 - .5 AAMA 611-98, Voluntary Specifications for Anodized Finishes Architectural Aluminum.
 - .6 AAMA 612-02, Voluntary Specifications, Performance Requirements, and Test Procedures for Combined Coatings of Anode Oxide and Transparent Organic Coatings on Architectural Aluminum.
 - .7 AAMA 2603-02, Voluntary Specification Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
 - .8 AAMA 2605-05, Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
 - .9 AAMA 501.1-05 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors using Dynamic Pressure.
- .3 ASTM International
 - .1 ASTM A 36/A 36M-08, Specification for Carbon Structural Steel.
 - .2 ASTM A 123/A 123M-09, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A 167-99 (2009), Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .4 ASTM A 653/A 653M-09a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM B 209-07, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .6 ASTM B 221-08, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .7 ASTM E 283-04, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .8 ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls, by Uniform Static Air Pressure Difference.
 - .9 ASTM E 331-00 (2009), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.

- .10 ASTM E 413-04, Classification for Rating Sound Insulation.
- .11 ASTM E 1105-00 (2008), Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- .12 ASTM E783-02 (2010), Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors.
- .13 ASTM E1186-03 (2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

- .4 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System and Reference Guide For Commercial Interiors.

- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.108-M89, Bituminous Solvent Type Paint.
 - .2 CAN/CGSB-12.20-M89, Structural Design of Glass for Buildings.

- .6 CSA International
 - .1 CSA G40.20/G40.21-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA S136-07, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .3 CAN/CSA-S157/S157.1-05, Strength Design in Aluminum/Commentary on CAN/CSA-S157, Strength Design in Aluminum.
 - .4 CSA W59.2-M1991 (R2008), Welded Aluminum Construction.

- .7 Environmental Choice Program (ECP)
 - .1 CCD-045-95 (R2005), Sealants and Caulking Compounds.
 - .2 CCD-047-98 (R2005), Architectural Surface Coatings.
 - .3 CCD-048-98 (R2006), Surface Coatings - Recycled Water-borne.

- .8 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.

- .9 Society for Protective Coatings (SSPC)
 - .1 SSPC - Paint 20-02 (R2004), Zinc Rich Coating, Type I - Inorganic and Type II - Organic.
 - .2 SSPC - Paint 25 - 97 (R2004) BCS, Zinc Oxide, Alkyd, Linseed Oil and Primer for Use Over Hand Cleaned Steel Type 1 and Type 2.

- .10 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

- .11 American Society of Heating, Refrigeration, and Air Conditioning Engineers Inc. (ASHRAE)
 - .1 ASHRAE 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings

- .12 BC Energy Efficiency Act
 - .1 Regulations for Windows, Glazing, Doors and Skylights.

- .13 National Fenestration Rating Council (NFRC)
 - .1 All rating of Glazing system to be NFRC certified.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Co-ordination: co-ordinate work of this Section with installation of air barrier placement, vapour retarder placement, flashing placement, components or materials.

1.4 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 curtain wall components, anchorage and fasteners, glass and infill, and internal drainage details and include product characteristics, performance criteria, physical size, finish and limitations and water flow diagrams.
 - .2 Report showing system meets performance requirements.
 - .3 Thermal model report showing compliance with effective U-value requirement.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada. Submit Letter of Assurance Model Schedule B + C-B.
 - .2 Indicate system dimensions, framed opening requirements and tolerances, adjacent construction, anchor details anticipated deflection under load, affected related Work, weep drainage network, expansion and contraction joint location and details, and field welding required.
- .4 Sample:
 - .1 Submit for review and acceptance each color and finish.
 - .2 Submit one 300 x 300 corner sample.
 - .3 Submit sample showing glazing detail, reinforcement, and finish.
- .5 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.
 - .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .3 Regional Materials: submit evidence that project incorporates required percentage 10% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.
 - .4 Low-Emitting Materials:
 - .1 Submit listing of adhesives and sealants and paints and coatings used in building, showing compliance with VOC and chemical component limits or restriction requirements.

1.5 CLOSEOUT SUBMITTALS

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

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Handle work of this Section in accordance with AAMA CW-10.
 - .2 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .3 Store and protect aluminum glazed curtain wall components from nicks, scratches, and blemishes.
 - .4 Protect prefinished aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.
 - .5 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

1.7 AMBIENT CONDITIONS

- .1 Install sealants when ambient and surface temperature is above 5 degrees C minimum.
- .2 Maintain this minimum temperature during and for 48 hours minimum after installation of sealants.

1.8 WARRANTY

- .1 Refer Section 01 77 00- Closeout Procedures:

2.0 PRODUCTS

2.1 SYSTEMS

- .1 Description:
 - .1 Vertical and horizontal, four-sided capture, stick built glazed aluminum curtain wall system includes thermally broken tubular aluminum sections with self-supporting framing, shop fabricated, factory prefinished, vision glass; related flashings, anchorage and attachment devices.
 - .2 Assembled system to permit re-glazing of individual glass (and infill panel) units from exterior without requiring removal of structural mullion sections.
- .2 Performance Requirements:
 - .1 Design and size components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of system as calculated in accordance with NBC
 - .2 Design and size components to withstand seismic loads and sway displacement as calculated in accordance with applicable codes.
 - .3 Limit mullion deflection to L/240 with full recovery of glazing materials.
 - .4 Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
 - .5 Ensure system is designed to accommodate the following without damage to components or deterioration of seals:
 - .1 Movement within system.
 - .2 Movement between system and perimeter framing components.

- .3 Dynamic loading and release of loads.
- .4 Deflection of structural support framing.
- .5 Shortening of building concrete structural columns.
- .6 Creep of concrete structural members.
- .6 Limit air infiltration through assembly to 0.0003 m³ /s/m² of wall area, measured at a reference differential pressure across assembly of 300 Pa as measured in accordance with ASTM E 283.
- .7 Vapour seal with interior atmospheric pressure of 25 mm sp, 22 degrees C, 40% RH: no failure.
- .8 Water leakage: none at minimum differential pressure of 700pa, when measured to ASTM E 331.
- .9 Ensure system allows for expansion and contraction within system components when temperature range is 95 degrees C over 12 hour period without causing detrimental affect to system components.
- .10 Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior by weep drainage network.
- .11 Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound.
 - .1 Position thermal insulation on exterior surface of air barrier and vapour retarder.
- .12 Ensure no vibration harmonics, wind whistles, noises caused by thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system occur.
- .13 Reinforce curtain wall system to accommodate window washing guide rails.
 - .1 Supply sufficiently rigid anchors to resist loads caused by equipment platform, without damage to wall system.
- .14 Air infiltration to CSA-A 440 A3 fixed, A3 operable
- .15 Water Leakage to CSA-A 440: B7 fixed , B5 operable.
- .16 Wind load to CSA-A440 C5.

2.2 MATERIALS

- .1 Extruded aluminum: to ASTM B 221.
- .2 Sheet aluminum: to ASTM B 209.
- .3 Anchors: 3-way adjustable hot-dip galvanized cast iron.
- .4 Fasteners: stainless or aluminum, finish to match curtain wall.
- .5 Bituminous paint: CAN/CGSB 1.108, Type 1 2, without thinner.
- .6 Vertical and horizontal glass units:
 - .1 Glass in exterior lights: Refer to Section 08 80 50.
- .7 Fire Safety Materials: see Section 07 84 00 - Fire Stopping.
- .8 Sealant:
 - .1 Perimeter sealant: as per Section 07 92 00
 - .2 Sealant used within system (not used for Glazing).
 - .1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.

2.3 COMPONENTS

- .1 Mullion profile:
 - .1 Vertical members: 50.8 x 153.9 mm nominal minimum dimension.
 - .2 Horizontal members: 50.8 x 153.9 mm nominal minimum dimension.
 - .3 Thermally broken with interior tubular section insulated from exterior pressure plate.
 - .4 Matching stops and pressure plate of sufficient size and strength to ensure adequate bite on glass.
 - .5 Drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system.
 - .6 Internal mullion baffles to eliminate "stack effect" air movement within internal spaces.
- .2 Flashings: aluminum, finish to match curtain wall mullion sections where exposed, secured with concealed fastening method.
- .3 Air barrier: specified in Section 07 27 00.01 - Air Barriers - Descriptive or Proprietary.
- .4 Entrance Door: Aluminum Clear Anodized Finish, refer section 08 11 16
- .5 Openable window
 - .1 Thermally broken double glazed, Same material and finishes as curtain wall framing.
 - .2 Profile and section to suit curtain wall system.
 - .3 Complete weather seal and water tightness.
- .6 Anti-rotation block
 - .1 Anti-rotation block to be rigid PVC (or acceptable alternative) noting that Styrofoam will not be accepted
- .7 Insulated Aluminum Sandwich Panel
 - .1 25mm thick clear Anodized Aluminum Sheet Panel (20ga) on both sides with rigid Polystyrene insulation in between.

2.4 FABRICATION

- .1 Fabricate system components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- .2 Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof
- .3 Prepare components to receive anchor devices. Install anchors.
- .4 Arrange fasteners and attachments to ensure concealment from view.
- .5 Prepare system components to receive exterior doors, in Section 08 11 16.
- .6 Reinforce interior horizontal head rail to receive window covering track brackets and attachments.
- .7 Reinforce framing members for external imposed loads.
- .8 Visible manufacturer's identification labels not permitted.
- .9 Finishes:
 - .1 Clear anodic finish: to designation AA-M12 CZZA41

2.5 SOURCE QUALITY CONTROL

- .1 Perform work in accordance with AAMA GSM-1
- .2 Manufacturer qualifications: company specializing in manufacturing the products specified in this section with minimum 3 years documented experience.
- .3 Perform welding Work in accordance with CSA W59.2.
- .4 Ensure compatibility between components.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for aluminum curtain wall installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Verify dimensions, tolerances, and method of attachment with other work.
 - .3 Verify wall openings and adjoining air barrier and vapour retarder materials are ready to receive work of this Section.
 - .4 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .5 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 Install curtain wall system in accordance with manufacturer's instructions.
- .2 Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- .3 Use alignment attachments and shims to permanently fasten system to building structure. Clean weld surfaces; apply protective primer to field welds and adjacent surfaces.
- .4 Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.
- .5 Use thermal isolation where components penetrate or disrupt building insulation.
- .6 Install sill flashings.
- .7 Install eave edge flashings at sloped glazing system.
- .8 Co-ordinate attachment and seal of perimeter air barrier and vapour retarder materials.
- .9 Provide spray-applied polyurethane thermal insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- .10 Install fire-safing in areas as indicated.
- .11 Install operating sash in accordance with Section 08 80 50 - Glazing, to glazing method required to achieve performance criteria.
- .12 Install glass in accordance with Section 08 80 50 - Glazing, to glazing method required to achieve

performance criteria Cover caps to conceal screws and ensure continuous sightline.

3.3 SITE TOLERANCES

- .1 Maximum variation from plumb: 1.5 mm/m non-cumulative or 12 mm/30 m, whichever is less.
- .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
- .3 Maximum sealant space between curtain wall and adjacent construction: 13 mm.

3.4 ADJUSTING

- .1 Adjust operating sash for smooth operation.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Remove protective material from prefinished aluminum surfaces.
 - .3 Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
 - .4 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
 - .5 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for 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.

3.6 PROTECTION

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

END OF SECTION 08 44 13

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Finish Carpentry Section 06 20 00
- .2 Aluminum Doors & Frames Section 08 11 16

1.2 REFERENCES

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/BHMA A156.1- 2000, American National Standard for Butts and Hinges.
 - .2 ANSI/BHMA A156.2- 2003, Bored and Preassembled Locks and Latches.
 - .3 ANSI/BHMA A156.3- 2001, Exit Devices.
 - .4 ANSI/BHMA A156.4- 2000, Door Controls - Closers.
 - .5 ANSI/BHMA A156.5- 2001, Auxiliary Locks and Associated Products.
 - .6 ANSI/BHMA A156.6- 2005, Architectural Door Trim.
 - .7 ANSI/BHMA A156.8- 2005, Door Controls - Overhead Stops and Holders.
 - .8 ANSI/BHMA A156.12- 2005, Interconnected Locks and Latches.
 - .9 ANSI/BHMA A156.13- 2002, Mortise Locks and Latches Series 1000.
 - .10 ANSI/BHMA A156.15- 2006, Release Devices - Closer Holder, Electromagnetic and Electromechanical.
 - .11 ANSI/BHMA A156.16- 2002, Auxiliary Hardware.
 - .12 ANSI/BHMA A156.17- 2004, Self-closing Hinges and Pivots.
 - .13 ANSI/BHMA A156.18- 2006, Materials and Finishes.
 - .14 ANSI/BHMA A156.20- 2006, Strap and Tee Hinges and Hasps.
- .2 Canadian Steel Door and Frame Manufacturers' Association (CSDMA)
 - .1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.

1.3 HARDWARE/SECURITY COORDINATION

- .1 Prior to preparation and submittal of hardware list, door hardware supplier's hardware consultant shall arrange a coordination meeting with the following attendees:
 - .1 Hardware supplier's hardware consultant.
 - .2 Facility's Building Maintenance Manager.
 - .3 Departmental Representative.
 - .4 General Contractor.
- .2 The final door hardware lists shall reflect all decisions made at said coordination meeting.

1.4 ACTION & INFORMAL 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 door hardware and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.

- .4 After approval samples will be returned for incorporation in Work.
- .4 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
- .5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIALS SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Supply maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Tools:
 - .1 Supply 2 sets of wrenches for door closers, locksets, and fire exit hardware.

1.7 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.8 DELIVERY, STORAGE & 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 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .4 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect door hardware from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping strippable coating.
 - .4 Replace defective or damaged materials with new.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

1.9 REDUNDANT LOCKSETS

- .1 Where existing and other lock-bearing devices are to be removed and disposed of: turn-over to Departmental Representative and obtain receipt. In order to maintain building keying security, no existing locksets are to be removed from building.

2.0 PRODUCTS

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Locks and latches:
 - .1 Mortise locks and latches: to ANSI/BHMA A156.13, series 1000 mortise lock, grade 1, designed for function and keyed as stated in Hardware Schedule.
 - .2 Lever handles: plain 64mm x 114mm x 51mm design.
 - .3 Roses: round
 - .4 Normal strikes: box type, lip projection not beyond jamb.
 - .5 Cylinders: key into keying system as noted as directed.
 - .6 Finished to 652, 626 & 630.
 - .7 6 pin (or7) tumbler keying to Maintenance's Master System.
- .2 Butts and hinges:
 - .1 Butts and hinges: to ANSI/BHMA A156.1, designated by letter A and numeral identifiers, followed by size and finish, listed in Hardware Schedule.
- .3 Exit devices: to ANSI/BHMA A156.3, type & function as listed, grade (1)
 - .1 Auxiliary items: door coordinator.
- .4 Door Closers and Accessories:
 - .1 Door controls (closers): to ANSI/BHMA A156.4, listed in Hardware Schedule, multi-sized sized 1 to though 6 in accordance with ANSI/BHMA A156.4, table A1, finished to 689.
 - .2 Door controls - overhead holders: to ANSI/BHMA A156.8, designated by letter C and numeral identifiers listed in Hardware Schedule, finished to 626.
 - .3 Closer/holder release devices: to ANSI/BHMA listed in hardware schedule, finished to 689.
 - .4 Door co-ordinator: surface for pairs of doors with overlapping astragal.
 - .5 Magnetic holder floor or wall mounted release on fire alarm: finished to 689.
- .5 Auxiliary locks and associated products: to ANSI/BHMA A156.5, numeral identifiers listed in Hardware Schedule, finished to 626.
 - .1 Cylinders: type as listed, finished to 626, for installation in deadlocks provided with special doors as listed in Hardware Schedule. Key into keying system [as noted] [as directed].
- .6 Architectural door trim: to ANSI/BHMA A156.6, designated by letter J and numeral identifiers listed in Hardware Schedule as listed below, finished to 626 or 630.
 - .1 Architectural door trim: to ANSI/BHMA A156.6, listed in Hardware Schedule as listed below, finished to 626 or 630
 - .2 Door protection plates: kick plate type as listed, 1.27 mm thick stainless steel 1 edges, finished to 630.
 - .3 Push plates: type as listed, 1.27 mm thick stainless steel 1 edge, as listed, finished to 630.
 - .4 Push/Pull units: type as listed, finished to 630.
- .7 Auxiliary hardware: to ANSI/BHMA A156.16, listed in Hardware Schedule finished to 626 or 630.

- .8 Door bottom seal: heavy duty, door seal of extruded aluminum frame and solid closed cell neoprene weather seal, recessed in door bottom surface mounted recessed in door face, closed ends, adjustable automatic retract mechanism when door is open, clear anodized finish.
- .9 Thresholds: 127mm wide x full width of door opening, extruded aluminum mill finish, serrated surface, with lip and vinyl door seal insert.
- .10 Weatherstripping:
 - .1 Head and jamb seal:
 - .1 Adhesive backed neoprene vinyl covered foam material.
 - .2 Door bottom seal:
 - .1 Extruded aluminum frame and [closed cell neoprene vinyl sweep, clear anodized finish.
- .11 Astragal: overlapping, Primed steel meeting stiles Pile.
- .12 Electric Strikes
 - .1 Weatherproof type includes all accessories, transformer and housing. Conduit by Division 26, connection by Division 28.

2.3 MISCELLANEOUS HARDWARE

- .1 Indexed key control system: to ANSI/BHMA A156.5, designated by letter E and numeral identifiers, wall mounted, type 50% expandable colour enamel paint finish.

2.4 FASTENINGS

- .1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.
- .2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .3 Exposed fastening devices to match finish of hardware.
- .4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.
- .5 Use fasteners compatible with material through which they pass.

2.5 KEYING

- .1 Doors, padlocks and cabinet locks to be keyed to grand master keyed as directed and as noted in Hardware Schedule. Prepare detailed keying schedule in conjunction with Departmental Representative.
- .2 Supply (five) 5 master keys for each master key or grand master key group.
- .3 Supply 5 keys for each lock.
- .4 Stamp keying code numbers on keys and cylinders.
- .5 Supply construction cores.
- .6 Hand over permanent cores and keys to Departmental Representative.

2.6 KEYS

- .1 Use standard construction cylinders for locks for Contractor's use during the construction period.
- .2 Issue instructions to employees and sub-trades, as necessary, to ensure safe custody of the construction set of keys.
- .3 Upon completion of construction, Departmental Representative will, in conjunction with the lock manager:
 - .1 Prepare an operational keying schedule.
 - .2 Accept the operational keys and cylinders directly from the lock manufacturer.
 - .3 Arrange for removal and return of the construction cores.

3.0 EXECUTION

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Supply metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Supply manufacturers' instructions for proper installation of each hardware component.
- .4 Install hardware to standard hardware location dimensions in accordance with CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction).
- .5 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .6 Use only manufacturer's supplied fasteners.
 - .1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- .7 Remove construction cores locks when directed by Departmental Representative.
 - .1 Install permanent cores and ensure locks operate correctly.

3.2 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .2 Lubricate hardware, operating equipment and other moving parts.
- .3 Adjust door hardware to ensure tight fit at contact points with frames.

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 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
 - .3 Remove protective material from hardware items where present.
 - .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section

01 74 19 - Waste Management and Disposal.

3.4 DEMONSTRATION

- .1 Keying System Setup and Cabinet:
 - .1 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.
 - .2 Place file keys and duplicate keys in key cabinet on their respective hooks and turn over to Departmental Representative.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
 - .3 Use, application and storage of wrenches for door closers locksets.
- .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.5 PROTECTION

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

3.6 FINISH HARDWARE SCHEDULE

- 1 Typical Aluminum Exterior Door:
 - .1 3 Ea. Hinges, stainless steel
 - .2 1 Ea. Lock Set
 - .3 1 Ea. Cylinder
 - .4 1 Ea. Closer, installed on inside of building
 - .5 1 Ea. Threshold
 - .6 1 Ea. Kick Plate
 - .7 1 Ea. Door Bottom

3.7 DOOR HARDWARE TYPE

- .1 HINGES:
Hinge 5 Knuckle-.134 gauge-114mm x 101mm x Non Removable Pin x 652
- .2 LOCKS:

Cylinder	Type x length x cam to suit	626
Lock set	ANSI F04	626
- .3 CLOSERS:
Note: Include thru-bolts and grommet nuts fasteners.
Closer Institutional, non-sized, rigid parallel arm x delayed action x 689
- .4 ARCHITECTURAL DOOR TRIM:
Kick Plate 254mm x width less 38mm x 630, stainless steel
- .5 THRESHOLDS; DOOR BOTTOM, DOOR STOP
 - .1 Threshold Thermal Barrier -free latching panic exit Saddle 127mm x 6.4mm x 6.4 stop strip x ThermoSeal with non skid finish set in solid mastic and secured with counter sunk SS screws and metal shields every 300 mm, size door to make continuous contact with door.

.2 Door Sweep, surface mount.

END OF SECTION 08 71 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Glazed Aluminum Curtain Wall Section 08 44 13

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C 542-05 (2011), Standard Specification for Lock-Strip Gaskets.
 - .2 ASTM D 2240-05 (2010), Standard Test Method for Rubber Property - Duromete Hardness.
 - .3 ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-12.1-M90, Tempered or Laminated Safety Glass.
 - .2 CAN/CGSB-12.2-M91, Flat, Clear Sheet Glass.
 - .3 CAN/CGSB-12.3-M91, Flat, Clear Float Glass.
 - .4 CAN/CGSB-12.8-97, Insulating Glass Units.
 - .5 CAN/CGSB-12.8-97, (Amendment), Insulating Glass Units.
 - .6 CAN/CGSB-12.10-M76, Glass, Light and Heat Reflecting.
 - .7 CAN/CGSB-12.11-M90, Wired Safety Glass.
- .3 Glass Association of North American (GANA) ¹
 - .1 GANA Glazing Manual – 50th Anniversary Edition.
 - .2 GANA Laminated Glazing Reference Manual - 2009.
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 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 glass, sealants, and glazing accessories and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Low-Emitting Materials:
 - .1 Submit listing of adhesives and sealants used in building, showing compliance with VOC and chemical component limits or restrictions requirements.
- .4 Samples: Provide 2 glazed units samples, 300 x 300, in accordance with Section 01 33 00- Submittal Procedures.
- .5 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00- Submittal Procedures:
 - .1 Shop drawing consist of aluminum framing installation details. Indicate sizes, spacing, location and quantities.

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 glazing for incorporation into manual.

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, labeled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect glazing and frames from nicks, scratches, and blemishes.
 - .3 Protect prefinished aluminum surfaces with wrapping.
 - .4 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal

1.6 AMBIENT CONDITIONS

- .1 Ambient Requirements:
 - .1 Install glazing when ambient temperature is 10 degrees C minimum. Maintain ventilated environment for 24 hours after application.
 - .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.7 WARRANTY

- .1 Provide manufacturer's warranty in writing for insulating glass units against failure of seal of enclosed air space and deposits on inner faces of glass detrimental to vision for a period of 2 years from date of Substantial Performance of Work.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Design Criteria:
 - .1 Ensure continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
 - .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
 - .2 Size glass to withstand wind loads, dead loads and positive and negative live loads to National Building Code 2010 and BCBC 2012.
 - .3 Limit glass deflection to 1/200 with full recovery of glazing materials.
- .2 Flat Glass:
 - .1 Exterior Insulated glass unit: performance requirements for insulated glass units with 13 mm air space and two 6mm lites, interior lite clear, outer clear with low e coatings both tempered, shall be as follows:
 - .1 Transmittance: UV-18%, Visible-70%, Solar-32%.
 - .2 Outdoor reflectance: Visible-11%, Total Solar Energy-29%.
 - .3 U-Value W/m²/°C: Winter 1.6466 (029 BTU/Hr/Ft²/°F) Summer 1.5898 (028 BTU/HR/Ft²/°F)
 - .4 Solar heat gain coefficient: 0.38

- .5 Shading coefficient: 0.43
- .6 Warm Spacer

2.2 ACCESSORIES

- .1 Setting blocks: neoprene Shore A durometer hardness to ASTM D 2240, minimum 100 mm x width of glazing rabbet space minus 1.5 mm x height.
- .2 Spacer shims: neoprene Shore A durometer hardness to ASTM D 2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self-adhesive on one face.
- .3 Glazing tape:
 - .1 Preformed butyl compound Shore A durometer hardness to ASTM D 2240; coiled on release paper; black colour. Width x thickness recommended by manufacturer to suit installation.
- .4 Glazing splines: resilient neoprene, extruded shape to suit glazing channel retaining slot, black colour as selected.
- .5 Glazing clips: manufacturer's standard type.
- .6 Lock-strip gaskets: to ASTM C 542.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for glazing installation in accordance with manufacturer's written instructions.
 - .1 Verify that openings for glazing are correctly sized and within tolerance.
 - .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
 - .3 Visually inspect substrate in presence of Departmental Representative.
 - .4 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .5 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

- .1 All glass shall be cushioned and rattle free. Draw marks shall be installed horizontally unless prohibited by the size of the sheet.
- .2 Install all glass on glazing blocks with spacer blocks, of sizes required to ensure shim spaces as recommended by the glass manufacturer with adequate space for glazing compounds and sealants.
- .3 Fill gap between glass and applied stop with sealant to depth equal to bite of frame on glass but not

more than 10 mm below sightline.

- .4 Apply sealant to uniform and level line, flush with sightline and tooled or wiped with solvent to smooth appearance.

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.
 - .1 Remove traces of primer, caulking.
 - .2 Remove glazing materials from finish surfaces.
 - .3 Remove labels.
 - .4 Clean glass and mirrors using approved non-abrasive cleaner in accordance with manufacturer's instructions.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 After installation, mark each light with an "X" by using removable plastic tape or paste.
 - .1 Do not mark heat absorbing or reflective glass units.
- .3 Repair damage to adjacent materials caused by glazing installation.

END OF SECTION 08 80 50

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Rough Carpentry for Minor Works Section 06 08 99
- .2 Joint Sealants Section 07 92 00
- .3 Non-Structural Metal Framing Section 09 22 16
- .4 Interior Painting Section 09 91 23

1.2 REFERENCES

- .1 Aluminum Association (AA)
 - .1 AA DAF 45-03 (R2009), Designation System for Aluminum Finishes.
- .2 ASTM International
 - .1 ASTM C 475-12 Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .2 ASTM C 514-04 (2009e1), Standard Specification for Nails for the Application of Gypsum Board.
 - .3 ASTM C 557-03 (2009) e1, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - .4 ASTM C 840-11, Standard Specification for Application and Finishing of Gypsum Board.
 - .5 ASTM C 954-07, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .6 ASTM C 1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .7 ASTM C 1047-10a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .8 ASTM C 1280-13, Standard Specification for Application of Gypsum Sheathing.
 - .9 ASTM C 1177/C 1177M-08, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - .10 ASTM C 1178/C 1178M-08, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Board.
 - .11 ASTM C 1396/C 1396M-06a, Standard Specification for Gypsum Wallboard.
- .3 Association of the Wall and Ceiling Contractors (AWCC)
 - .1 Specifications Standards Manual 2012
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86 (R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
 - .2 CAN/CGSB-71.25-M88, Adhesive, for Bonding Drywall to Wood Framing and Metal Studs.
- .5 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 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 gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Sustainable Design Submittals.

.1 Low-Emitting Materials:

.1 Submit listing of adhesives and sealants and used in building, showing compliance with VOC and chemical component limits or restriction requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store gypsum board assemblies materials level off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.

.3 Protect from weather, elements and damage from construction operations.

.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.

.5 Protect prefinished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

.6 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

1.5 AMBIENT CONDITIONS

.1 Maintain temperature 10 degrees C minimum (21 degrees C maximum) for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Standard board: to ASTM C 1396/C 1396M regular, 12.7mm and 15.9 mm thick Type X, 12.7 mm and 15.9 mm thick, 1200 mm wide x maximum practical length, ends square cut, edges tapered.
- .2 Water-resistant board: to ASTM C 1396/C 1396M regular, 12.7mm and 15.9 mm thick and Type X, 12.7mm and 15.9mm thick, 1220 mm wide x maximum practical length.
- .3 Glass mat water-resistant gypsum backing board: to ASTM C 1178/C 1178M, 12.7 and 15.9 mm thick, 1200 mm wide x maximum practical length.
- .4 Glass mat gypsum substrate sheathing: to ASTM C 1177/C 1177M, 15.9 mm thick, 1200 mm wide x maximum practical length.
- .5 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .6 Resilient clips and drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.
- .7 Nails: to ASTM C 514.
- .8 Steel drill screws: to ASTM C 1002.
- .9 Laminating compound: as recommended by manufacturer, asbestos-free.
- .10 Casing beads, corner beads, control joints and edge trim: to ASTM C 1047, metal, zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.
- .11 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.
 - .2 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.
- .12 Joint compound: to ASTM C 475, asbestos-free.

3.0 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies 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 ERECTION

- .1 Do application and finishing of gypsum board to ASTM C 840 except where specified otherwise.
- .2 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C 840 except where specified otherwise.
- .3 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

- .4 Install work level to tolerance of 1:1200.
- .5 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.
- .6 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.
- .7 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .8 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- .9 Install wall furring for gypsum board wall finishes to ASTM C 840, except where specified otherwise.
- .10 Furr openings and around built-in equipment, cabinets, access panels on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .11 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

- .1 Apply gypsum board after bucks, anchors, blocking as specified in Section 06 08 99, sound attenuation, electrical and mechanical work have been approved by Departmental Representative.
- .2 Apply single or double layer gypsum board to wood furring or framing using screw fasteners for first layer, screw fasteners for second layer. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings prior to application of walls to ASTM C 840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:
 - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.
- .3 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, and ducts, in partitions where perimeter sealed with acoustic sealant.
- .4 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .5 Install gypsum board with face side out.
- .6 Do not install damaged or damp boards.

- .7 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Construct control joints of preformed units set in gypsum board facing and supported independently on both sides of joint.
- .6 Provide continuous polyethylene dust barrier behind and across control joints.
- .7 Locate control joints at changes in substrate construction at approximate 10 m spacing on long corridor runs at approximate 15 m spacing on ceilings.
- .8 Install control joints straight and true.
- .9 Construct expansion joints as detailed, at building expansion and construction joints. Provide continuous dust barrier.
- .10 Install expansion joint straight and true.
- .11 Install cornice cap where gypsum board partitions do not extend to ceiling.
- .12 Fit cornice cap over partition, secure to partition track with two rows of sheet metal screws staggered at 300 mm on centre.
- .13 Splice corners and intersections together and secure to each member with 3 screws.
- .14 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .15 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .16 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:
 - .1 Levels of finish:
 - .1 At typical wall and ceiling locations. Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and edges.

- .17 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .18 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .19 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .20 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

3.5 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.

3.6 PROTECTION

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

END OF SECTION 09 21 16

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Rough Carpentry for Minor Works Section 06 08 99
- .2 Thermal Insulation Section 07 21 00
- .3 Gypsum Board Assemblies Section 09 21 16

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C 645- 13, Specification for Nonstructural Steel Framing Members.
 - .2 ASTM C 754- 11 , Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
- .2 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .3 Association of Wall and Ceiling Contractors of BC (AWCC)
 - .1 Specification Standards Manual, 2012 Edition.

1.3 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 gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada. Submit Letter of Assurance Model Schedule B and C-B.
 - .2 Indicate system dimensions, framed opening requirements and tolerances, adjacent construction, anchor details anticipated deflection under load, affected related Work, weep drainage network, expansion and contraction joint location and details, and field welding required.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management And Disposal.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Steel Studs & Steel Stud Furring:
 - .1 Conform to ASTM C645, non-loadbearing; C-shape, hot dipped galvanized steel studs with Z180 (G60) zinc coating.
Studs to have knurled face and pre-punched pass-through holes for horizontal runs of wiring and piping. Length to suit, no splicing allowed.
 - .2 Flange: Depth not less than 32mm, edges bent back 90 deg. and edges hemmed 5mm minimum.
 - .3 Widths: As scheduled and indicated.
 - .4 Gauges: Interior steel stud to be a minimum of 0.88mm (20 gauge). Interior door jamb studs: 0.88 mm (20 gauge), two (2) studs each side of opening. Increase gauge of steel studs at over-height locations to suit stud manufacturer's design tables, in order to maintain overall partition dimension as detailed in wall schedule and in accordance with the BC Building Code. Exterior steel stud to be minimum 1.23 mm (18 gauge).
 - .5 Colour code steel studs for gauge in accordance with AWCC colour code chart.

- .2 Stud Tracks:
 - .1 Top and bottom runner tracks fabricated from same materials as studs; leg design min. 32mm high, slightly bent in to hold studs; widths to equal stud width.
 - .2 Use extended leg top track to partitions as required for deflection.
 - .3 Stud Fasteners: Manufacturer's standard, suitable for intended application.
 - .4 Shaft Wall Framing Supports: Stud and track metal components fabricated from hot-dipped zinc coated steel meeting ASTM C645. Zinc coating shall be Z180 (G60). Steel I-studs, J-tracks, T-splines, L-runners, fasteners shall be of design gauge as used within appropriate shaft wall system tested under design numbers indicated in wall schedule.
 - .5 Furring Channels: Hat section; roll formed from 0.53mm hot dipped galvanized steel having a Z180 (G60) coating, dimensions 68.2 mm or 66.7mm overall width, face width 35 mm by 22.2mm deep, face knurled.
 - .6 "Z-bar" Furring: Roll formed from 0.46mm (26 ga.) hot dipped galvanized steel having a Z180 (G60) coating, 32mm face dimension x depth to suit rigid insulation thickness, see drawings and wall schedule.
 - .7 Gypsum Board Ceiling Framing: Conform to Section 9.7, Part 2, Item 4 of the A.W.C.C. Standards which are minimum and as otherwise described below to exceed that minimum.
 - .1 Tie Wire: 1.62mm (16 ga.) galvanized steel tie wire.
 - .2 Hangers: 3.6mm (9 ga.) diameter galvanized soft annealed steel wire, or 4.8mm diameter zinc coated or cadmium plated steel rods. Ceiling area supported:

Area	Size of Hangers
Up to 1.15m ²	3.6 mm (9 ga.) diameter galvanized wire.
Up to 1.48 m ²	4.8mm diameter rods
 - .3 Inserts: Able to develop full strength of supported hangers.
 - .4 Main Carrying Channels: Cold formed steel channels of dimension and weight as follows and protected with rust inhibitive coating. Main carrying channels shall not be less than 38mm x 12.7mm x 1.37mm cold formed channels.

Maximum Spacing of Hangers	Maximum Spacing of Main Runners
900mm	1200mm
1000mm	1000mm
1200mm	900mm
 - .5 Cross Furring/Ceilings: Cross furring members shall be hat-shaped furring

channels as specified in Clause 2.5, above. Max. spacing between furring channels shall conform to the following requirements, based on gypsum board thicknesses and layers.

- .8 **Metal Backing Plates:** Flat sheet from 0.91mm (20ga.) thick galvanized steel of same type as are the studs as blocking to support work of other sections.

Maximum

<u>Gypsum Board Thickness</u>	<u>Furring Spacing</u>
Single 12.7mm board	400 mm
Single 15.9mm board	600 mm
Double layer	400 mm

3.0 EXECUTION

3.1 ERECTION

- .1 Fire Resistance Rated Walls: Comply with requirements of testing agency approved by the Consultant for wall systems detailed on Drawings.
- .2 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum.
- .3 Place studs vertically at on centre as detailed and not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in tracks at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.
- .4 Erect metal studding to tolerance of 1:1000.
- .5 Attach studs to bottom and ceiling track using pop rivets.
- .6 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .7 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .8 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .9 Install heavy gauge single jamb studs at openings.
- .10 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .11 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .12 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .13 Extend partitions to ceiling height except where noted otherwise on drawings.
- .14 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to

- studs. Use 50 mm leg ceiling tracks.
- .15 Install continuous insulating strips to isolate studs from uninsulated surfaces.
 - .16 Install two continuous beads of acoustical sealant under studs and tracks around perimeter of sound control partitions.
 - .17 Provide clearances and isolation felt to ensure no contact between steel stud system and adjacent metal components to eliminate electrolytic action.

3.2 CHASE WALLS

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.3 SHAFT WALL ERECTION

- .1 At shaft wall partitions, use the methods of assembly as used in the fire test specimen to maintain fire and sound ratings. Coordinate with Section 09 21 16, Gypsum Board Assemblies.
- .2 Coordinate construction of shaft walls to suit installation of services.

3.4 CEILING AND SOFFIT SUSPENSION

- .1 Hangers:
 - .1 Ensure hangers for suspended gypsum board ceilings support independent of walls, columns, pipes, ducts, and are erected plumb and securely anchored to structural frame or imbedded in concrete slabs. Do not use powder actuated fasteners/anchors.
 - .2 Space hangers at 1200mm maximum centers along runner channels and not more than 150mm from boundary walls, interruptions of continuity and change in direction.
 - .3 Provide at least 25mm clearance at walls.
- .2 Runner Channels:
 - .1 Space channels at max. 900mm centers and not more than 150mm from boundary walls, interruptions of continuity and change in direction. Provide clearance of at least 25mm at walls.
 - .2 Run the channels transversely to structural framing members.
 - .3 Where splices are necessary, lap members at least 200mm and wire each end with 2 loops. Avoid clustering or lining up splices.
 - .4 Attach to rod hangers by bending hanger sharply under bottom flange of runner and securely wire in place with a saddle tie.
- .3 Cross Furring:
 - .1 Erect furring channels transversely across runner channels, or other supports.
 - .2 Space furring channels at 400mm centers and not more than 150mm from boundary walls, openings, interruptions in ceiling continuity and change in direction. Provide a clearance of at least 25mm at walls.
 - .3 Secure furring channels to each support with clips or double 1.62 mm (16 ga.) dia. wire ties. Splice joints by nesting and tying channels together.
 - .4 Level furring channels to a maximum tolerance of 1:1000.
- .4 At openings, including ceiling access panels, in ceiling suspension system that interrupts the main carrying channels of furring channels, reinforce grillage with 19mm cold rolled channels, wire tie to top and parallel to main runner channels, extend 19mm channels minimum 300mm past each end of openings.

3.5 WALL FURRING

- .1 Place furring channels attached to masonry or concrete surfaces at 400mm o.c. and not more than 100mm from corners and openings.
- .2 Secure flanges to wall with hardened nails, power actuated fasteners or equivalent fastenings. Maximum spacing 600 mm alternating to opposite flanges.

3.6 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION 09 22 16

1.0 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Concrete Unit Masonry Section 04 22 00
- .2 Metal Fabrications Section 05 50 00
- .3 Finish Carpentry Section 06 20 00

1.2 REFERENCES

- .1 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33
- .2 Environmental Protection Agency (EPA)
 - .1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual, November 2007.
 - .2 MPI Maintenance Repainting Manual, latest edition.
- .5 National Fire Code of Canada - 2010
- .6 Society for Protective Coatings (SSPC)
 - .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.
 - .3 Apprentices: working under direct supervision of qualified trade's person in accordance with trade regulations.
- .2 Conform to the standards contained in the Master Painters Institute Architectural Painting Specification Manual, latest edition (hereafter referred to as MPI Painting Specification Manual) for all painting products including preparation and application of materials. MPI Painting Specification Manual as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.
- .3 All paint manufacturers and products used shall be as listed under the "Approved Products" section of the MPI Painting Specification manual.
- .4 Other paint materials shall be the highest quality product of an approved manufacturer listed in MPI Painting Specification Manual and shall be compatible with other coating materials as required.
- .5 Single-Source Responsibility: provide primers and undercoat paint produced by the same manufacturer as the finish coat.

- .6 All painting and decorating work shall be inspected by Paint Inspection Agency (inspector) acceptable to the specifying authority and the local MPI Accredited Quality Assurance Association. The painting contractor shall notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.
- .7 All surfaces requiring painting or repainting shall be inspected by the inspection agency who shall advise on all aspects of painting work including preparation, notifying the Consultant, the Contractor and the Trade Contractor of any defects or problems prior to commencing painting work or after the prime coat shows defects in the substrate, and as the work progresses.
- .8 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.4 PERFORMANCE REQUIREMENTS

- .1 Environmental Performance Requirements:
 - .1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.
- .2 Green Performance in accordance with MPI Standard GPS-1.

1.5 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.
- .2 Obtain written authorization from Departmental Representative for changes in work schedule.
- .3 Schedule painting operations to prevent disruption of occupants.

1.6 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit product data and instructions for each paint and coating product to be used.
 - .2 Submit product data for the use and application of paint thinner.
 - .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 35 33 - Health and Safety Requirements.
- .3 Samples:
 - .1 Submit manufacturer's standard range of color choices on each specified color type as listed in Colour Schedule of this section for selection, review and acceptance of each color.
 - .2 Submit triplicates 200 x 300 mm sample panels of each paint with specified paint in colours, gloss/sheen and textures required, based on selected colors, to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm plate steel for finishes over metal surfaces.
 - .2 50 mm concrete block for finishes over concrete or concrete masonry surfaces.
 - .3 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.

- .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface. 50mm concrete block for finishes over concrete or concrete masonry surfaces.
- .4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Lead, cadmium and chromium: presence of and amounts.
 - .2 Mercury: presence of and amounts.
 - .3 Organochlorines and PCBs: presence of and amounts.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .7 Closeout Submittals: submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 MPI Environmentally Friendly classification system rating.

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section 01 78 00 - Closeout Submittals.
 - .2 Quantity: provide one - 4 litre (1 gallon) can of each type and colour of primer stain finish coating. Identify colour and paint type in relation to established colour schedule and finish system.
 - .3 Delivery, storage and protection: comply with Departmental Representative requirements for delivery and storage of extra materials.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Packing, Shipping, Handling and Unloading:
 - .1 Pack, ship, handle and unload materials in accordance with Section 01 61 00 - Common Product Requirements and manufacturer's written instructions.
- .2 Acceptance at Site:
 - .1 Identify products and materials with labels indicating:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Storage and Protection:
 - .1 Provide and maintain dry, temperature controlled, secure storage.
 - .2 Store materials and supplies away from heat generating devices.
 - .3 Store materials and equipment in well-ventilated area with temperature range 7 degrees

C to 30 degrees C.

- .5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
- .6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.
- .7 Remove paint materials from storage only in quantities required for same day use.
- .8 Fire Safety Requirements:
 - .1 Provide one Type ABC fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.
- .9 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Place materials defined as hazardous or toxic in designated containers.
 - .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.
 - .7 Ensure emptied containers are sealed and stored safely.
 - .8 Unused paint, coating materials must be disposed of at official hazardous material collections site as approved by Departmental Representative.
 - .9 Paint, stain and wood preservative finishes and related materials (thinners and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.
 - .10 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
 - .11 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
 - .12 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
 - .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - .4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.
 - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
 - .13 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

- .14 Set aside and protect surplus and uncontaminated finish materials. Deliver to or arrange collection by organizations for verifiable re-use or re-manufacturing.

1.9 SITE CONDITIONS

- .1 Heating, Ventilation and Lighting:
 - .1 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.
 - .2 Provide continuous ventilation for seven days after completion of application of paint.
 - .3 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.
 - .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
 - .5 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless pre-approved written approval by Paint Inspection Agency Authority and product manufacturer, perform no painting when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
 - .4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.
 - .5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
 - .6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
 - .2 Perform painting work when maximum moisture content of the substrate is below:
 - .1 Allow new concrete and masonry to cure minimum of 28 days.
 - .2 15% for wood.
 - .3 12% for plaster and gypsum board.
 - .3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
 - .4 Test concrete, masonry and plaster surfaces for alkalinity as required.
- .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
- .4 Additional interior application requirements:
 - .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

- .2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

1.10 GUARANTEE

- .1 Furnish a 100% two (2) year Maintenance Bond.
- .2 Painting and decorating Subcontractors providing a Maintenance Bond shall provide a maintenance bond consent from a reputable surety company licensed to do business in Canada. Cash or certified cheque are not acceptable in lieu of surety consent.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- .2 Provide paint materials for paint systems from single manufacturer.
- .3 Only qualified products with E2 "Environmentally Friendly" rating are acceptable for use on this project.
- .4 Conform to latest MPI requirements for interior painting work including preparation and priming.
- .5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.
- .6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.
- .7 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - .1 Water-based.
 - .2 Non-flammable.
 - .3 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - .4 Manufactured without compounds which contribute to smog in the lower atmosphere.
 - .5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- .8 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- .9 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.
- .10 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

- .11 Recycled water-borne surface coatings must not contain:
 - .1 Lead in excess of 600.0 ppm weight/weight total solids.
 - .2 Mercury in excess of 50.0ppm weight/weight total product.
 - .3 Cadmium in excess of 1.0ppm weight/weight total product.
 - .4 Hexavalent chromium in excess of 3.0 ppm weight/weight total product.
 - .5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

- .1 Departmental Representative will provide Colour Schedule after Contract award. Submit proposed Colour Schedule to Departmental Representative for approval.
- .2 Colour schedule will be based upon selection of five base colours and three accent colours. No more than eight colors will be selected for entire project and no more than three colours will be selected in each area.
- .3 Selection of colours will be from manufacturers full range of colours.
- .4 Where specific products are available in restricted range of colours, selection will be based on limited range.
- .5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.
- .6 Refer to Colour Schedule of this Section, and Section 09 06 00 Finish Schedule and drawings for identification and location of colours.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Departmental Representative for tinting of painting materials.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

.1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 Matte	Max.5	Max.10
Finish (flat) Gloss Level 2 -Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 -Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 -Satin-Like Finish	20 to 35	Min.35
Gloss Level 5 -Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 -Gloss finish	70 to 85	
Gloss Level 7 -High Gloss Finish	More than 85	

.2 Gloss level ratings of painted surfaces as indicated.

2.5 INTERIOR PAINTING SYSTEMS – NEW CONSTRUCTION

- .1 Concrete masonry units: smooth and split face block and brick:
 - .1 INT 4.2D - High Performance Architectural Latex gloss level 3 finish.
- .2 Structural steel and metal fabrications: columns, beams, joists:
 - .1 INT 5.1R – High Performance Architectural Latex gloss level 5 coating.
- .3 Steel - high heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):
 - .1 INT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.
- .4 Galvanized Metal (steel deck, ducts, pipes)
 - .1 INT 5.3M – High Performance Architectural Latex gloss level 5.
- .5 Plaster & Gypsum Board
 - .1 INT 9.2B – High Performance Architectural Latex Gloss level 4.
- .6 All paint systems to be MPI Premium Grade 3 coat systems.

2.6 SOURCE QUALITY CONTROL

- .1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by Standards Council of Canada.
 - .1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
 - .2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
 - .3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

3.0 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 data sheet.

3.2 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .3 Maximum moisture content as follows:
 - .1 Stucco, plaster and gypsum board: 12%.
 - .2 Concrete: 12%.
 - .3 Clay and Concrete Block/Brick: 12%.
 - .4 Wood: 15%.

3.4 PREPARATION

- .1 Protection:
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Departmental Representative.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .3 Protect factory finished products and equipment.
 - .4 Protect passing pedestrians, building occupants and general public in and about the building.
- .2 Surface Preparation in accordance with MPI Repainting Manual:
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and other surface debris by wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

- .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
- .4 Allow surfaces to drain completely and allow to dry thoroughly.
- .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
- .6 Use trigger operated spray nozzles for water hoses.
- .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

- .5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.

- .6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

- .7 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes or vacuum cleaning.

- .8 Touch up of shop primers with primer as specified.

- .9 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.5 APPLICATION

- .1 Method of application to be as approved by Departmental Representative. Apply paint by brush, roller, air or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.

- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.

- .3 Spray application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.

- .4 Brush out immediately all runs and sags.
- .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .7 Sand and dust between coats to remove visible defects.
- .8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .9 Finish closets and alcoves as specified for adjoining rooms.
- .10 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ELECTRICAL EQUIPMENT

- .1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.
- .2 Boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- .3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .5 Do not paint over nameplates.
- .6 Keep sprinkler heads free of paint.
- .7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .8 Paint fire protection piping red.
- .9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .10 Paint natural gas piping yellow.
- .11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
- .12 Do not paint interior transformers and substation equipment.

3.7 SITE TOLERANCES

- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 FIELD QUALITY CONTROL

- .1 Interior painting and decorating work shall be inspected by a Paint Inspection Agency (inspector) acceptable to the specifying authority and local Painting Contractor's Association. Painting contractor shall notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.
- .2 Interior surfaces requiring painting shall be inspected by Paint Inspection Agency who shall notify Departmental Representative and General Contractor in writing of defects or problems, prior to commencing painting work, or after prime coat shows defects in substrate.
- .3 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer shall provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.
- .4 Advise Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .5 Cooperate with inspection firm and provide access to areas of work.
- .6 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.

3.9 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and patters immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

3.10 PAINT COLOUR SCHEDULE

- .1 All exterior bollard - yellow
- .2 All concrete masonry units, steel structure, metal deck and gypsum wall board – white.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 35 00 – Special Procedures
- .2 Section 01 45 00 – Quality Control
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Closeout Submittals
- .6 Section 09 91 23 – Interior Painting
- .7 Section 23 05 00 – Common Work Results for HVAC
- .8 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC

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 equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet." Identify section and paragraph number.

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 equipment for incorporation into manual.

- .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
- .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .5 Commissioning report, including commissioning checksheets and system set-points as set.
- .5 Approvals:
 - .1 Submit one (1) copy of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

- .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of testing, adjusting, and balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting, and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Furnish spare parts as follows:
 - .1 One glass for each gauge glass.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management

Plan 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 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for 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 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

- .1 Clean interior and exterior of all systems including strainers.
- .2 Follow recommended procedures for all systems, including Compressed Air, RO Water, Tempered Water, etc.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 -ACTION AND INFORMATIONAL SUBMITTALS.
- .2 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 - ACTION AND INFORMATIONAL 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.

3.5 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 CLEANING

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

3.7 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 Related Work

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 Scope of Work

- .1 Refer to Section 23 05 20 - Thermometers and Pressure Gauges for HVAC. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .2 In addition to the piping, equipment, and systems listed in Section 23 05 20, provide thermometers and pressure gauges on all plumbing piping systems and equipment including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Tanks and all other equipment.
- .3 Provide thermometers in brass or stainless steel wells at all heat exchangers, water heaters, and other equipment intended to change the temperature of the fluid.
- .4 Provide pressure gauges complete with isolation ball valves on both sides of all pressure reducing valves, backflow prevention stations, pumps, compressors and other equipment intended to change the pressure of the fluid. Provide snubbers for all pressure gauges located adjacent pumps or compressors. Provide vacuum gauges at all vacuum units.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Also refer to Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment, and Section 22 05 49 - Seismic Restraint Systems for Plumbing Piping and Equipment.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .2 The contractor is to arrange and pay for the services of a BC registered professional engineer to provide all required engineering services necessary for the complete design, sizing and detailing of all anchors and anchor supports to the structure required for the project. Submit details for approval.
- .3 In addition to the piping, equipment and systems listed in Section 23 05 29, provide hangers and supports on all plumbing piping and equipment including:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Storm drainage.
 - .5 Tanks and all other equipment.
 - .6 Underslab piping where the building is on piles, or supported by other structural systems, or where called for on the drawings or in other sections of the specification.
- .4 Hangers, threaded rods, nuts and associated components for hanging of underslab piping shall be stainless steel and shall be fixed to the foundation or structural slab.
- .5 Spacing of hangers shall comply with BC Building Code Table 7.3.4.5.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Also refer to Section 22 07 19 - Plumbing Piping Insulation.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 05 33 - Heat Tracing for HVAC Piping. Comply with all requirements of that section of work as related to general requirements, products and execution.
- .2 In addition to the piping and systems listed in Section 23 05 33 provide heat tracing for freeze protection on all plumbing piping systems in exterior or unheated areas including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
- .3 Provide domestic hot water temperature maintenance cables and controls on all domestic hot water systems and domestic tempered water systems greater than five (5) metres in length that do not have recirculation.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Also refer to Section 22 05 49 - Seismic Restraint Systems for Plumbing Piping and Equipment.

1.2 SCOPE OF WORK

- .3 Refer to Section 23 05 48 - Vibration Isolation for HVAC Piping and Equipment. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .4 In addition to the piping, equipment and systems listed in Section 23 05 48, provide vibration isolation on all plumbing piping and equipment including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Storm drainage.
 - .5 Tanks and all other equipment.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Also refer to Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 05 49 - Seismic Restraint Systems for HVAC Piping and Equipment. Comply with all requirements of that section of work as related to general requirements, products and execution.
- .2 In addition to the piping, equipment, and systems listed in Section 23 05 49, provide seismic restraints on all plumbing piping and equipment including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Tanks and all other equipment including flush tank urinal tanks.

1.3 DOCUMENT SUBMITTALS

- .1 Provide letters of assurance signed and sealed by the contractor's specialist registered Professional Engineer.
- .2 Submit 'Schedule B-1: Assurance of Professional Design and Commitment for Field Review' and 'Schedule B-2: Summary of Design and Field Review Requirements' in accordance with the BC Building Code 2012, to the Consultant and to the local Authority Having Jurisdiction at the time of the shop drawing submission.
- .3 Submit 'Schedule C-B: Assurance of Professional Field Review and Compliance' in accordance with the BC Building Code 2012 to the Consultant and to the local Authority Having Jurisdiction a minimum of 10 working days prior to Occupancy.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 05 53 - Identification for HVAC Piping and Equipment. Comply with all requirements of that section of work as related to general requirements, products and execution.
- .2 In addition to the piping, equipment and systems listed in Section 23 05 53, provide identification on all plumbing piping, valves and equipment including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Tanks and all other equipment.
- .3 Identification of all medical gas systems must comply with the requirements of the applicable CSA Standard where the requirements of that standard exceed these specifications.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .1 In addition to the piping, equipment and systems listed in Section 23 05 93, provide testing, adjusting and balancing for all plumbing piping, equipment and systems including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Tanks and all other equipment.
- .2 Balancing of the domestic hot water and tempered water recirculation systems by a recognized balancing agency and submission of a balancing report is mandatory.
- .3 Pressure test all plumbing piping systems in accordance with the specific requirements of the specification sections that describe those systems.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Also refer to Section 22 07 19 - Plumbing Piping Insulation.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 07 16 - HVAC Equipment Insulation. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .2 In addition to the equipment and systems listed in Section 23 07 16, provide equipment insulation on all plumbing equipment and systems including the following:
 - .1 Domestic hot water storage tanks.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Also refer to Section 22 07 16 - Plumbing Equipment Insulation.

1.2 SCOPE OF WORK

- .1 Refer to Section 23 07 19 - HVAC Piping Insulation. Comply with all requirements of that Section of work as related to general requirements, products and execution.
- .2 In addition to the piping and systems listed in Section 23 07 19, provide piping insulation on all plumbing piping systems including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Domestic tempered water.
 - .4 Sanitary waste and p-traps, grey and black water systems in exterior and unheated areas.
 - .5 All piping provided with heat tracing cable for freeze protection, or domestic hot water temperature maintenance.
 - .6 Offset waste piping, p-traps and supplies under all wheelchair accessible lavatories and sinks.
 - .7 Provide foil faced flexible insulation on components requiring adjustment or servicing including booster pumps, meter sets, pressure reducing valves, valve bodies, strainers etc.
 - .8 Sanitary vent stacks for the last 3 metres [10 feet] prior to penetrating the roof or penetrating into a cold attic or similar space.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE OF WORK

- .1 Domestic water systems include domestic cold water, domestic hot water, and domestic tempered water systems.
- .2 Interior domestic water piping shall be provided as depicted on the drawings to all plumbing fixtures, appliances and equipment that require domestic water service.
- .3 New interior domestic water piping shall be connected to receive domestic water supply from the existing domestic water piping as depicted on the drawings.
- .4 New interior domestic water piping shall be connected to receive domestic water supply from the exterior cold water building service as depicted on the drawings and specified in Division 2 (see Section 33 10 00 Water Utilities).
- .5 Non-functioning existing interior domestic water piping shall be removed where access is readily available or capped off and abandoned in place as referenced on the drawings.
- .6 Mechanical makeup water piping systems and forcemain or pressure waste water piping systems shall be constructed of materials, installed and tested as specified in this section of the work.

1.3 CROSS CONNECTION CONTROL

- .1 There is a cross connection control program in effect at the University and all installations shall be in accordance with the recommendations contained in the latest edition of the Cross Connection Control Manual published by Pacific Northwest Section of the American Water Works Association. Copies of test forms are available through the Construction Division, Plant Design and Construction Department.
- .2 Double check valve assemblies and reduced pressure principle backflow prevention devices shall have approval from the Foundation for Cross Connection Control, University of Southern California.
- .3 Vacuum breakers shall conform to the requirements of C.S.A. B64.5.
- .4 Following installation, a test report completed by a certified tester shall be submitted to the Owner, indicating satisfactory operation of each device.
- .5 Tests are to be conducted in the period 30 to 60 days prior to date of Substantial Completion.

- .6 Provide one repair kit for every cross connection control device installed.

Part 2 Products

2.1 PIPE AND FITTINGS

- .1 Buried water pipe and fittings inside the building:
 - .1 100 mm [4"] and smaller.
 - .1 Type 'K' seamless soft copper tubing to ASTM B88 or copper pipe to ASTM B42 with cast brass or wrought copper fittings and silver soldered joints all encased in a polyethylene piping system.
 - .2 100 mm [4"] and larger.
 - .1 Centrifugally spun cement lined cast iron pipe with rubber ring type joints for 1380 kPa [200 psi] working pressure.
 - .2 Ductile iron cement lined Class 50 or 52 pipe with rubber ring, or mechanical type joints for 1380 kPa [200 psi] working pressure to AWWA C151.
 - .3 Cast iron fittings with rubber ring or mechanical type joints for 1380 kPa [200 psi] working pressure.
 - .4 All fittings shall be provided with integral tie lugs. Weld on lugs are not acceptable.
 - .5 Tie rods, bolts and nuts shall conform to the requirements of ASTM specifications for steel bridges and buildings, serial designation A-7. All bolts shall have American Standard coarse screw threads with a Class 2 free fit. Rolled threads are unacceptable.
- .2 Above ground water pipe inside the building:
 - .1 Ductile iron pipe to ANSI/AWWA C150 and C151, minimum thickness Special Class 54 for use with cut grooved fittings, cement mortar lining to ANSI/AWWA C104 and asphaltic seal coat on the inside. Pipe to be ULC Listed.
 - .1 Acceptable Product: Canada Pipe Company Limited.
 - .2 Ductile iron pressure fittings to ANSI/AWWA C-606, cement mortar lined, black asphalt coated, NSF 61 listed.
 - .3 Ductile iron pressure couplings to ANSI/AWWA C-606 for grooved end AWWA fittings and cut grooved AWWA ductile iron pressure pipe with synthetic gasket, plated carbon steel bolts, alkyd phenolic primer and protective enamel finish.
 - .4 Cold water:
 - .1 Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42. All copper water tubing shall be certified by the Canadian Standards Association or Warnock Hersey Professional Services Ltd. to ASTM B88.

- .5 Hot water:
 - .1 Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42. All copper water tubing shall be certified by the Canadian Standards Association or Warnock Hersey Professional Services Ltd. to ASTM B88.
- .3 Above ground copper water pipe fittings inside the building:
 - .1 Use of the 'T-Drill' system of joining copper piping is unacceptable.
 - .2 Cast brass or wrought copper solder joint pressure fittings with 95/5 Sn/Sb or Silvabrite 100 solder joints; or
 - .3 Cast bronze or wrought copper roll grooved pressure fittings with grooved mechanical pipe connector couplings with angle bolt pad and Victaulic style of 'flush seal' gaskets or Shurjoint 'Gap Seal' gaskets.
 - .4 Acceptable Products:
 - .1 Victaulic 'The Copper Connection System for Copper Tubing (CTS)' with 606 couplings, 600 Series fittings and 641 flange adaptors.
 - .2 Shurjoint copper series for copper tube sizes CTS, cast bronze fittings, C305 rigid couplings, C306 reducing couplings, C341 flange adaptors and C307 transition couplings.
 - .5 Exception: Where compression fittings are required they shall be to ANSI B16.22-1973.

2.2 VALVES

- .1 Gate: (for shut-off and isolation)
 - .1 50 mm [2"] and smaller, bronze body, solid wedge disc, bronze or stainless steel trim, non-rising stem, 860 kPa [125 psi] rating.
 - .2 Acceptable Products:
 - .1 Solder joint type: Jenkins 300P, Kitz 41, Red & White / Toyo 281A.
 - .2 Threaded joint type: Crane 428, Grinnell 3000, Grinnell Powell 507, Jenkins 810, Kitz 40, Lunkenheimer 2127, Newman-Hattersley A40AT or 33X, Nibco T113, Red & White / Toyo 280A.
 - .3 65 mm [2½"] and larger, flanged ends, cast iron body, solid wedge disc, bronze or stainless steel trim, rising stem, outside screw and yoke. Acceptable Products: Crane 465-1/2, Grinnell 6020A, Grinnell Powell 1793, Jenkins 404, Kitz 72, Lunkenheimer 1430C, Newman-Hattersley 504, Nibco F617-0, Red & White / Toyo 421A.
- .2 Ball: (in lieu of gate valves or as specified)
 - .1 50 mm [2"] and smaller, brass two piece body, blow-out proof stem, PTFE seats, brass chrome plate ball, lever handle operator, 1035 kPa [150 psi] rating.
 - .2 Acceptable Products:
 - .1 Solder joint type: Red & White / Toyo 5049A, Apollo 70-100, Crane, Grinnell 171S, Jenkins, Kitz 59, Lunkenheimer 746FS or 747FS, MAS B-4, Newman-Hattersley, Nibco, Watts, Worcester.

- .2 Threaded joint type: Red & White / Toyo 5044A, Apollo-70-200 Series, Crane 93-TF, Grinnell 171N, Jenkins-1101-T, Kitz 58, Lunkenheimer 746F or 747F, MAS B-3, Newman-Hattersley 1969AT, Nibco T-580-BR, Watts B-6000, Worcester 4211-RT.
- .3 Butterfly: (in lieu of gate valves or as specified)
 - .1 65 mm [2½"] and larger, 1,380 kPa [200 psig] rating, wafer style or threaded lug style cast iron body, EPDM seat liner, bronze disc, 403 stainless steel stem, 10 position lever lock handle operator on 150 mm [6"] diameter and smaller, handwheel worm gear operator on 200 mm [8"] diameter and larger, for installation between Class 125 / 150 flanges.
 - .2 Acceptable Products:
 - .1 Wafer style: Apollo 141, Center Line L200W/G200W (EPDM), Grinnell 7721
 - .2 Lug style: Apollo 143, Center Line L200L/G200L (EPDM)
 - .3 With "Victaulic" **copper** grooved end pipe system, use Victaulic style #608 bronze body grooved valve with an EPDM encapsulated disk, 300 psi rating
 - .4 With "Victaulic" **ductile iron** grooved end pipe system, use Victaulic style #300 PPS coated grooved end valve with an EPDM encapsulated disk, 300 psi rating
 - .5 With "Shurjoint" **copper** grooved end pipe system, use Shurjoint style SJ-C300 bronze body grooved valve with an EPDM encapsulated disk, 300 psi rating
- .4 Globe: (for throttling, bypass and make-up applications)
 - .1 50 mm [2"] and smaller, bronze body, bronze or stainless steel trim, 860 kPa [125 psi] rating.
 - .2 Acceptable Products:
 - .1 Solder joint type with bronze bevel type disc: Crane 1320, Grinnell 3200, Grinnell Powell 650, Jenkins 300P, Kitz 10, Lunkenheimer 2125, Newman-Hattersley A41SE, Nibco S-211-B, Red & White / Toyo 212,
 - .2 Threaded joint type with composition type disc: Crane 7, Grinnell 3210, Grinnell Powell 650TD, Jenkins 106A, Kitz 03, Lunkenheimer 2942, Newman-Hattersley 13, Nibco T-211-Y, Red & White / Toyo 220.
 - .3 265 mm [2½"] and larger, flanged ends, cast iron body, bronze or cast iron bevel-type disc, bronze or stainless steel trim, rising stem, outside screw and yoke.
 - .4 Acceptable Products: Crane 351, Grinnell 6200A, Grinnell Powell 241, Jenkins 2342, Kitz 76, Lunkenheimer 3731, Newman-Hattersley 731, Nibco F-718-B, Red & White / Toyo 400A.
- .5 Check: (for horizontal installation)
 - .1 50 mm [2"] and smaller, threaded joint type, bronze body, bronze or stainless steel swing disc holder with Teflon disc, 860 kPa [125 psi] rating.

- Acceptable Products: Crane 37, Grinnell 3330, Grinnell Powell 578, Jenkins 4092, Kitz 22, Lunkenheimer 2144, Newman-Hattersley A60AT, Nibco T-413-B, Red & White / Toyo 236.
- .2 65 mm [2½"] and larger, flanged ends, cast iron body, bronze or cast iron swing disc, bronze or stainless steel trim, 860 kPa [125 psi] rating.
Acceptable Products: Crane 373, Grinnell 6300A, Grinnell Powell 559, Jenkins 587, Kitz 78, Lunkenheimer 1790C, Newman-Hattersley 651, Nibco F-918-B, Red & White / Toyo 435A.
- .3 With "Shurjoint" **copper** grooved end pipe system, use Shurjoint style SJ-C900 bronze body grooved end swing check valve with a rubber encapsulated disk, 250 psi rating
- .6 Balance: (for domestic hot water recirculation)
- .1 30 mm [1¼"] and smaller, globe lockshield, for maximum system temperature, bronze body and trim, Teflon; polytetrafluoroethylene (PTFE), disc, female by male union connection, 690 kPa [100 psi] rating.
.1 Acceptable Products: Dahl 13012 or 13013 with memory stop, Dunham Bush 840A, Red & White / Toyo 250LS or 251LS, Grinnell GBV-T threaded, Tour & Anderson circuit balancing valve
- .2 40 mm [1½"] and larger, plug type, wrench adjustable stop, for maximum system temperature, semi-steel body, resilient plug seals, EPT or RS 55, max. 120°C [250°F] operating temperature, 860 kPa [125 psi], threaded end connections for up to 50 mm [2"], flanged end connections on 65 mm [2½"] and larger.
.1 Acceptable Products: DeZurik 435 with 487 adjustable stop, Homestead Ballcentric, Newman-Hattersley 170M or 171M, Grinnell GBV-T or GBV
- .7 Vacuum relief: (for hot water tanks installations)
- .1 Up to 12 mm [½"], 860 kPa [125 psi] rating.
.1 Acceptable Products: 12 mm [½"] Watts 36A, Cash Acme
- .2 12 mm [½"] and larger, 860 kPa [125 psi] rating.
.1 Acceptable Products: 18 mm [¾"] Watts 36A, Cash Acme
- .8 Pressure reducing:
- .1 6 mm [¼"] to 9 mm [3/8"], 860 kPa [125 psi] rating.
.1 Acceptable Products: Watts 215, Cash Acme, Singer.
- .2 12 mm [½"] to 50 mm [2"], 860 kPa [125 psi] rating.
.1 Acceptable Products: Watts 223, Braukman, Conbraco, Cash Acme, Singer.
- .3 65 mm [2½"] and larger, 860 kPa [125 psi] rating.
.1 Acceptable Products: BCA 317 PR, Clayton 90 or 90B, Singer 106PR.
- .9 Pressure reducing valve with integral low flow bypass:
- .1 40 mm [1½"] and larger, 860 kPa [125 psi] rating.
.1 Acceptable Products: Watts PV-10-06M, Clayton, Singer, Wilkins.

- .10 Drain Valves and Hose Bibbs:
 - .1 Hose Bibbs: Lockshield globe type with bronze body and trim suitable for maximum system operating pressure.
 - .1 Acceptable Products: Dahl 2316.
 - .2 Drain Valves: Ball type with brass body, cap & chain and chrome plated brass ball.
 - .1 Acceptable Products: Kitz 58CC, Red & White / Toyo 5046, Dahl.
 - .3 Stop and Drain Valves: Emco 10151
- .11 Solenoid:
 - .1 Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, UL and CSA approved, 120 volt.
 - .1 Acceptable Products: ASCO
- .12 Mixing:
 - .1 Mixing valves shall be thermostatic in operation, not mechanical mixing valves. This includes individual mixing valves at single fixtures or groups of fixtures including lavatories, sinks, showers, emergency fixtures etc.
 - .2 On both the up-stream hot and cold supplies, in an accessible location, provide isolation valves, positive swing check valves and strainers. This requirement does not apply when such components are supplied with or integral to the mixing valves itself. Where required, provide an access panel to the isolation valves, check valves and strainers.

2.3 VACUUM BREAKERS

- .1 Pressure type:
 - .1 CSA approved, mechanically independent spring loaded poppet type check valve with a downstream spring loaded air inlet valve, with upstream and downstream isolation valves and test cocks.
 - .2 Acceptable Products: Cla-Val 27, Conbraco 40-500, Febco 765, Watts 800, Wilkins 720A
- .2 Atmospheric type:
 - .1 CSA approved, bronze body, chrome plate finish where exposed.
 - .1 Acceptable Products: Conbraco 38-100; Febco 710 / 715A; Watts 288A, 288AC; Wilkins 30; Rainbird
- .3 All vacuum breakers shall be sized in accordance with the following table:

Pipe Size mm [in.]	Pressure Type Size mm [in.]	Atmospheric Type Size
12 - 25 [½ - 1]	12 [½]	Full Pipe Size
30 - 40 [1¼ - 1½]	19 [¾]	Full Pipe Size
50 - 75 [2 - 3]	25 [1]	Full Pipe Size

2.4 BACKFLOW PREVENTION STATIONS

- .1 Double check valve assembly (DCVA), factory assembled station to CAN/CSA-B64.10 and CAN/CSA-B64.10.1.
 - .1 Acceptable Products: Watts Series 709; Ames 3000 Series; Beeco #FDC, #2, CXm F-72; Cla-Val D, D2; Conbraco 400-100; Hersey #1; Neptune 550, DHC; Febco 805; Wilkins 950, MBD-10.
- .2 Reduced pressure principle backflow prevention device (RPPD), with inlet and outlet shut-off valves, double check valve assembly, differential relief outlet and repair/maintenance kit to CAN/CSA-B64.10 and CAN/CSA-B64.10.1.
 - .1 Acceptable Products: Watts Series 909; Ames 4000 Series; Beeco #FRP-11, #6CM; Cla-Val RP; Conbraco 40-200; Febco 835B, 825; Neptune 575; Wilkins 975, MBC-8, MBC-10.

2.5 STRAINERS

- .1 Sized on a 4 to 1 ratio of basket open area to connecting pipe cross-sectional area, 'Y' pattern, 304 stainless steel screen.
- .2 6 mm [¼"] to 50 mm [2"]; threaded ends, bronze body, 1034 kPa [150 psi] rating. Acceptable Products: Red & White / Toyo 380, Crane 988-1/2, Armstrong, Muessco, RP&C 59, Sarco (Canada), Kitz 15.
- .3 65 mm [2½"] and larger, flanged ends, cast iron body, 860 kPa rating. Acceptable Products: Red & White / Toyo 381A, RP&C 531, Crane 989-1/2, Armstrong, Muessco, Sarco (Canada), Kitz 80.
- .4 With "Shurjoint" copper grooved end pipe system, use Shurjoint style C726 bronze body grooved end Y-strainer with stainless steel screen, 300 psi rating.

2.6 WATER HAMMER ARRESTORS

- .1 Bellows or piston manufactured style with stainless steel casing and welded stainless steel nesting bellows if of the bellows style. Air chambers are unacceptable.
- .2 Acceptable Products: Zurn Z-1700 Series bellows style, Jay R. Smith, Ancon, Amtrol, Watts; Precision Plumbing Products Inc. piston style.

2.7 THERMOMETERS AND PRESSURE GAUGES

- .1 Refer to Section 22 05 22 Thermometers and Pressure Gauges for Plumbing.

2.8 TEMPERATURE AND PRESSURE RELIEF VALVES

- .1 Design: A.S.M.E. rated for the energy input to the system and the pressure rating of the equipment.
- .2 Acceptable Products: Watts, Cash Acme.

2.9 PIPE JOINTS

- .1 Solders and fluxes having a lead content and self cleaning acid type fluxes shall not be used.
- .2 All copper to steel or iron and flanged adaptors shall be brass, not copper.
- .3 All unions or similar interconnections between dissimilar metals shall be dielectric couplings.
 - .1 Acceptable Products: Epco Dielectric Pipe Fittings, Victaulic dielectric waterway

2.10 AIR VENTS

- .1 Design: Automatic float type, 1035 kPa [150 psi] max. operating pressure.
- .2 Acceptable Products: Armstrong 11-AV, Maid-o-Mist 71, Taco 426, Amtrol.

2.11 HYDRANTS AND/OR HOSE BIBBS

- .1 Hose Bibb Type 'D': (standard with key type):
 - .1 Faucet with hose end spout in chrome plate finish.
 - .2 Removable "T" type lockshield handle.
 - .3 Watts screw on vacuum breaker on outlet in chrome plate finish.
 - .4 Acceptable Products: Emco 3713.

2.12 TRAP SEAL PRIMERS

- .1 Provide flow actuated type priming device piped to nearest fixture so that device will introduce regulated amount of water into trap whenever fixture is used. Acceptable Products: Watts A200-T, Zurn, Watts, Jay R. Smith
- .2 Provide pressure actuated type priming device piped where the nearest fixture is remote to the floor drain requiring trap priming. Acceptable Products: Precision Plumbing Products Model P-1

2.13 WATER HEATER & TANK (*ELECTRIC*)

- .1 Glass-lined, electric hot water heater and tank, ASME construction, CSA listed, rated for 1034 kPa [150 psi] working pressure.
- .2 Plated copper elements, fully automatic controls, manually adjustable thermostat, 120 volt control circuit powered by a fused transformer.
- .3 Extra density, vermin proof, glass fibre insulation with heavy gauge steel jacket finished with baked enamel finish over bonderized under coat.
- .4 Magnesium anode protection, heavy duty magnetic contactors, fuse protection against excessive current flows.

- .5 Recovery of 419 lph [111 USgph] at a 56°C [100°F] temperature rise.
- .6 Storage capacity of 757 litres [200 USgal].
- .7 Input rating of 15 kilowatts, 600 volt / 3 phase / 60 Hertz.
- .8 Acceptable Products: A.O. Smith Model DVE-200, Ruud, Rheem, State, PVI.

2.14 EXPANSION TANK FOR HOT WATER SYSTEM

- .1 Carbon steel expansion tank of welded construction, ASME model, xxx USgal total volume, stainless steel connection, heavy duty butyl diaphragm, rigid polypropylene liner and integral floor stand, NSF-61 listed for potable water systems.
- .2 Acceptable Products: Amtrol ST-5-C Therm-x-trol, State, Sparco.

2.15 MIXING VALVE FOR 82°C [180°F] HOT WATER SYSTEM

- .1 Provide a 20 mm [¾"] temperature control mixing valve for 1.26 lps [20 USgpm] at 55 kPa [8 psi] pressure differential reverse acting with 1.22 metre [4'] capillary and 9.5 mm x 100 mm [3/8" x 4"] copper bulb, standard adjustment dial range 0°C to 150°C [32°F to 300°F].
- .2 Provide for control air to mixing valve from control air system.
- .3 Acceptable Products: Powers xxx, Flowrite with Accritem xxx.

Part 3 Execution

3.1 CONCEALED SUPPLY PIPING

- .1 Concealed water supply piping to plumbing fixtures, trim items, equipment, hose bibbs, etc. shall be installed using cast brass 90 degree drop ear elbow or drop ear tees as the piping design dictates.
- .2 Blocking shall be provided within the concealed space and the elbows and tees shall be secured to the blocking using brass screws to provide a rigid installation.

3.2 VALVE INSTALLATION

- .1 Where possible, disassemble solder end joint valves before soldering.
- .2 Where disassembly and the subsequent reassembly is not possible, the contractor shall give special regard to solder jointing in order not to damage, melt or deform and valve parts.

3.3 SHUT OFF VALVES:

- .1 Install shut-off or isolation valves whether shown on the drawings or not at the following locations:
 - .1 At the point where the water service first enters the building.
 - .2 At the base of each building riser.
 - .3 At each main branch supply point; provide a valve on each outlet leg from the tee or cross.
 - .4 At each single plumbing fixture (i.e. normally this requirement is satisfied by the provision of the angle valve specified with the specific fixture).
 - .5 At each single piece of equipment.
 - .6 At all points as indicated on the drawings.
 - .7 At all points where the plumbing code requires same.
- .2 Balancing Valves:
 - .1 Install circuit balancing valves in hot water recirculating branch mains and branch connections to return mains whether indicated on drawings or not.
- .3 Pressure Reducing Valves:
 - .1 Pressure reducing valve stations, as a minimum shall consist of the following:
 - .1 A high flow or main pressure reducing valve; which shall be one pipe size smaller than the incoming or outflowing building service, and shall be provided with a strainer, a reducer, shut off valve and union on the inlet side and a union, reducer and a shut off valve on the outlet side.
 - .2 A low flow pressure reducing valve; which shall be a minimum 25 mm [1"] in size, and shall be provided with a strainer, shut off valve and union on the inlet side and a union and shut off valve on the outlet side.
 - .3 A pressure gauge and gauge cock on each side of the pressure reducing valve.
 - .4 Where a pressure reducing valve with integral low flow bypass is used the piping, fittings and accessories shall be arranged as described in 3.2.6.1.1 above.
 - .2 Set main pressure reducing valve at 415 kPa [60 psi] outlet pressure.
 - .3 Set small flow pressure reducing valve at 35 kPa [5 psi] higher outlet pressure than main pressure reducing valve.
- .4 Drain Valves:
 - .1 Install drain valves 18 mm [3/4"] minimum, or line size where the piping is smaller than 18 mm [3/4"].
 - .2 Install a hose-end adaptor, cap and chain on the discharge side of each drain valve or pipe to drain where indicated.

- .5 Mixing:
 - .1 On both the up-stream hot and cold supplies, in an accessible location, provide positive swing check valves and strainers. This is a requirement in addition to any check valve device that is common to the mixing valve. Where required, provide an access panel to the check valves and strainers.

3.4 VACUUM BREAKER INSTALLATION

- .1 Install at each fixture or item of equipment where contamination of the domestic water system can occur.

3.5 BACKFLOW PREVENTION STATION INSTALLATION

- .1 Install at each fixture or item of equipment where contamination of the water system can occur.
- .2 Pipe differential relief outlet to drain.
- .3 Backflow prevention stations shall be in complete accordance with CAN/CSA-B64.10 and CAN/CSA-B64.10.1 Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices.
- .4 Complete testing of all double check valve assemblies and reduced pressure principle backflow prevention devices shall be carried out by a certified tester under this section of the work prior to final acceptance of plumbing systems. Submit a certificate for each device duly signed and witnessed that testing was successfully completed.

3.6 STRAINER INSTALLATION

- .1 Install strainer blow-off connections.
- .2 Blow-off connections shall be full drain connection size and shall include:
 - .1 Up to 50 mm [2"] - nipple and cap (hot services).
 - .2 65 mm [2½"] and larger - nipple, globe valve and nipple (hot services).
 - .3 All sizes (cold services) - plug the blow-off connection only.

3.7 FLANGES AND UNIONS

- .1 Provide on all connections to pumps, reducing valves, control valves, fixtures, and equipment.
- .2 Connections up to and including 50 mm [2"] size shall be all bronze union, 1,035 kPa [150 psi] rating with ground seat; larger connections shall be flanged.

3.8 PRESSURE GAUGES

- .1 Install pressure gauge at all pump suction and discharge points and at each pressure reducing station inlet and outlet.

3.9 WATER HAMMER ARRESTORS

- .1 Size in accordance with the Plumbing and Drainage Institute PD1-WH-201 sizing procedures.
- .2 Install on branch lines to flush valves, solenoid valves, self-closing faucets, quick closing valves and on refrigeration, kitchen and laundry equipment incorporating solenoid valves.

3.10 THERMOMETERS

- .1 Install at domestic hot water storage tank inlet and outlet.
- .2 Locate for ease of readability and such that their sensing elements are directly in the flowing medium and immediately adjacent to the sensing elements.
- .3 When installed to sense the water temperature in a pipe; install its sensing element in a non-ferrous, separable well filled with a heat conducting paste. Install the separable well in a form which minimizes the restriction to water flow; if necessary, in a section of oversized pipe.

3.11 PIPE JOINTS

- .1 Install dielectric type couplings where copper piping and accessories connect to plumbing equipment such as steel storage tanks, pressure reducing stations and ductile iron pipe.
- .2 Where the water service enters the building terminate at the edge of the building and excavation with a Smith Blair standard sleeve coupling having stainless steel nuts and bolts. Bridge the excavation with ductile iron pipe.
- .3 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.
- .4 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

3.12 AIR VENTS

- .1 Install on tees and not on horizontal piping or radiused elbows.
- .2 Install 12 mm [$\frac{1}{2}$ "] minimum isolating gate valve ahead of each air vent.
- .3 Pipe all air vent discharge connections separately to nearest building drain using 6 mm [$\frac{1}{4}$ "] hard drawn copper.

3.13 HYDRANTS AND/OR HOSE BIBBS

- .1 Provide operating keys to the Owner for all hose bibbs that do not possess an attached handle.
- .2 Provide an isolating shut-off valve upstream of all hose bibbs.
- .3 Exterior ground type hose bibb boxes shall be set flush and anchored in a 460 mm [18"] square x 200 mm [8"] thick concrete collar all set at 25 mm [1"] above surrounding grade.
- .4 Connect drain ports on floor mount type hose bibbs indirectly to drainage system where such drainage ports are located within the confines of the building.
- .5 Seal around the perimeter of hose bibs with silicone caulk in a neat manner, for a waterproofing seal. Where a water proof membrane is present, provide a hose bibb with a membrane clamp.

3.14 TRAP SEAL PRIMERS VALVES

- .1 Provide floor drain trap primers in watercloset rooms and other areas connected to the sanitary sewer in accordance with the plumbing code and as designated on the drawings.
- .2 Locate at locations that are readily accessible by the building maintenance staff.

3.15 HOT WATER TANKS AND HEATERS

- .1 Provide temperature and pressure relief valves. Install such that probe properly senses the temperature. Pipe relief port full outlet size to drain. Position discharge at drain to prevent splash-over.
- .2 Provide vacuum relief valve and check valve on cold water supply.
- .3 Provide isolating valves at all tank and heater water connections.
- .4 Provide a corrosion resistant water tight pan under any hot water storage tank and/or hot water heater/storage tank in compliance with the B.C. Plumbing Code or Vancouver Building By-Law.

3.16 TESTING AND INSPECTION

- .1 Testing shall consist of hydraulic pressure testing at 1,400 kPa [200 psi] for 8 hours.
- .2 Submit signed and dated pressure test reports for all sections of the water distribution systems.

3.17 FLUSHING AND CHLORINATION OF WATER LINES

- .1 Thoroughly flush all water piping so that it is free from scale, sediment and debris as soon as possible after the system is filled with water.

- .2 On completion of installation and testing, all water piping shall be pre-flushed, chlorinated and flushed again in accordance with AWWA C-601.
- .3 Retain a reputable firm qualified to supervise and inspect the chlorination and flushing procedures and perform chemical biological tests as required.
- .4 The piping shall be chlorinated so that a chlorine residual of not less than 10 ppm remains in the water after standing for 24 hours. Hypochlorite and water is recommended as a disinfectant. AWWA C-601 recommends the amount of chlorine required.
- .5 Submit to the Consultant a certificate from the testing firm stating that chlorination and flushing has been successfully completed.
- .6 On projects with water piping being connected to the existing water distribution system including system piping modifications, piping extensions, tenant fit outs etc flushing and chlorination of all new piping remains a requirement. Provide all required isolation, fill and drain valves required to flush and chlorinate the new piping without impacting the existing system piping.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 74 11 – Cleaning
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .4 Section 01 77 00 – Closeout Procedures
- .5 Section 22 05 00 – Common Work Results for Plumbing
- .6 Section 23 05 05 – Installation of Pipework
- .7 Section 23 05 23.01 – Valves-Bronze
- .8 Section 23 05 23.02 – Valves-Cast Iron
- .9 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
 - .1 ANSI/ASME B16.15-2013, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-2011, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 ASTM International Inc.
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM A536-84-2014, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B88M-14, Standard Specification for Seamless Copper Water Tube (Metric).
- .3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)
 - .1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B242-(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-02a, Butterfly Valves.
 - .2 MSS-SP-70-11, Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-11, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80-13, Bronze Gate, Globe, Angle and Check Valves.
- .8 National Research Council (NRC)/Institute for Research in Construction
 - .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2010.
- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.3 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 and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

Part 2 Products

2.1 PIPING

- .1 Domestic hot, and cold systems, within building.
 - .1 Above ground: copper tube, hard drawn, type K to ASTM B88M.
 - .2 Buried or embedded: copper tube, soft annealed, type K to ASTM B88M, in long lengths and with no buried joints.

2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class 150 300: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125 250: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger: ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.
- .6 NPS 1 and smaller: wrought copper to ANSI/ASME B16.22 cast copper to ANSI/ASME B16.18; with 301stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.

2.3 JOINTS

- .1 Rubber gaskets, latex free, 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5 tin copper alloy.
- .4 Teflon tape: for threaded joints.
- .5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM gasket.
- .6 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

2.4 GATE VALVES

- .1 NPS 2 and under, soldered:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.
- .3 NPS 2 1/2 and over, in mechanical rooms, flanged:
 - .1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS Y bronze trim specified Section 23 05 23.02 - Valves - Cast Iron.
- .4 NPS 2 1/2 and over, other than mechanical rooms, flanged:
 - .1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.5 GLOBE VALVES

- .1 NPS2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.

2.6 SWING CHECK VALVES

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.
- .3 NPS 2 1/2 and over, flanged:
 - .1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, regrind renewable seat, bronze disc, bolted cap specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.7 BALL VALVES

- .1 NPS 2 and under, screwed:
 - .1 Class 150.
 - .2 Bronze Forged Brass body, chrome plated brass stainless steel ball, PTFE adjustable packing, brass gland and PTFE Buna TFE seat, steel lever handle as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, soldered:
 - .1 To ANSI/ASME B16.18, Class 150.
 - .2 Bronze body, chrome plated brass stainless steel ball, PTFE adjustable packing, brass gland and PTFE Buna seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves - Bronze.

2.8 BUTTERFLY VALVES

- .1 NPS 2-1/2 and over, wafer lug grooved:
 - .1 To MSS-SP-67, Class 200.
 - .2 Cast iron body, ductile iron chrome plated disc, stainless steel stem, EPT liner.

- .3 Lever operated, NPS8 and over, gear operated.
- .2 NPS 2-1/2 and over, grooved ends:
 - .1 Class 300 psig CWP, bubble tight shut-off, bronze body EPDM coated ductile iron disc with integrally cast stem.
 - .2 Operator:
 - .1 NPS 4 and under: lever handle.
 - .2 NPS 6 and over: gear operated.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install in accordance with NPC.
- .2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Lead free joints only. Do not use self-cleaning flux.
- .6 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .7 Buried tubing:
 - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - .2 Bend tubing without crimping or constriction. Minimize use of fittings.
 - .3 Water piping from trap primer to floor drain to be PEX tubing where cast into concrete, and protected in polyurethane sleeve where buried below slab. Provide Type L copper where exposed in the building.

3.3 VALVES

- .1 Isolate equipment, fixtures and branches with gate, butterfly, or ball valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.4 PRESSURE TESTS

- .1 Conform to requirements of Section 22 05 00 - Common Work Results for Plumbing.

- .2 Test pressure: greater of one (1) times maximum system operating pressure or 860 kPa.

3.5 FLUSHING AND CLEANING

- .1 Flush entire system for 8 h. Ensure outlets flushed for two (2) hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean copper to Federal potable water guidelines. Let system flush for additional two (2) hours, then draw off another sample for testing.

3.6 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.7 DISINFECTION

- .1 Flush out, disinfect and rinse system to requirements of Authority Having Jurisdiction.
- .2 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

3.8 START-UP

- .1 Timing: start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
 - .3 Bring HWS storage tank up to design temperature slowly.
 - .4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.
 - .5 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

3.9 PERFORMANCE VERIFICATION

- .1 Scheduling:
 - .1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.
- .2 Procedures:
 - .1 Verify that flow rate and pressure meet Design Criteria.
 - .2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
 - .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
 - .4 Sterilize HWS and HWC systems for Legionella control.
 - .5 Verify performance of temperature controls.
 - .6 Verify compliance with safety and health requirements.
 - .7 Check for proper operation of water hammer arrestors. Run [one] outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
 - .8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.
- .3 Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
 - .2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.10 OPERATION REQUIREMENTS

- .1 Coordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05 - Installation of Pipework.
- .2 Operational requirements in accordance with Section 01 77 00 – Closeout Procedures, Operation, include:
 - .1 Cleaning materials and schedules.
 - .2 Repair and maintenance materials and instructions.

3.11 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 for 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 RELATED WORK

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE OF WORK

Interior sanitary waste and vent piping shall be provided as depicted on the drawings to plumbing fixtures that will discharge sanitary waste and shall be connected to discharge to the exterior sanitary building service as depicted on the drawings and specified in Division 33.

- .1 Non-functioning existing interior sanitary waste and storm drainage piping shall be removed where access is readily available or capped off and abandoned in place as referenced on the drawings.

Part 2 Products

2.1 INTERIOR DRAIN, WASTE AND VENT PIPE AND FITTINGS

- .1 Buried pipe and fittings:
 - .1 Class 4000 cast iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CSA CAN3-B70.
 - .2 Acrylonitrile-Butadiene-Styrene (ABS) Drain Waste and Vent Pipe Fittings conforming to CSA CAN 3-B181.1-M85.
 - .3 Polyvinyl Chloride (PVC) Drain Waste and Vent Pipe and Pipe Fittings conforming to CSA B181.2.
- .2 Above ground pipe and fittings:
 - .1 Class 4000 cast iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CSA CAN3-B70 up to 200 mm [8"].
 - .2 DWV copper drainage pipe with cast brass or wrought copper drainage pattern fittings with 50/50 Sn/Pb recessed solder joints.
- .3 Additional requirements:
 - .1 Pressure waste piping from pumping stations and other equipment shall be pressure piping and fittings as specified for domestic water.
 - .2 Plastic (PVC or ABS) piping where used underground shall adapt to approved non-plastic material prior to penetration above the building slab.

2.2 FLOOR DRAINS

- .1 Floor drains connected to the sanitary system shall include trap primer connections.

- .2 Floor Drain 'B': (standard for unfinished areas).
 - .1 Cast iron floor drain with secondary drainage flange, 216 mm [8½"] top, round cast iron grate. Cast iron parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn Z-556-P, Watts, Jay R. Smith, Mifab
- .3 Floor Drain 'C': (funnel for finished areas).
 - .1 Cast iron floor drain with secondary drainage flange and 125 mm [5"] diameter adjustable nickel bronze strainer with 90 mm x 230 mm [3¼" x 8"] nickel bronze oval funnel. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn ZN-415-BF-P, Watts, Jay R. Smith, Mifab
- .4 Floor Drain 'D': (funnel for unfinished areas).
 - .1 Cast iron floor drain with secondary drainage flange and 125 mm [5"] diameter adjustable cast iron strainer with 90 mm x 230 mm [3½" x 9"] cast iron oval funnel. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn Z-415-F-P, Watts, Jay R. Smith, Mifab
- .5 Floor Drain 'G': (for exterior patios).
 - .1 Cast iron floor drain with 150 mm [6"] square heavy duty secured nickel bronze grate and sediment bucket. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn ZXN-211-HY-P, Watts, Jay R. Smith, Mifab
- .6 Floor Drain 'I': (standard for surface membrane floors).
 - .1 Cast iron floor drain with surface clamping ring and grate and 150 mm [6"] diameter nickel bronze strainer. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn ZN-415-R-P, Watts, Jay R. Smith, Mifab
- .7 Floor Drain 'J': (funnel for surface membrane floors).
 - .1 Cast iron floor drain with surface clamping ring and grate and 150 mm [6"] diameter nickel bronze strainer with funnel. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn ZN-415-R-P with ZN-414-1, Watts, Jay R. Smith, Mifab
- .8 Floor Drain 'K': (flushing rim)
 - .1 Drain: Cast iron floor drain with 275 mm [11"] diameter nickel bronze hinged strainer and 20 mm [¾"] flushing rim connection. Cast iron non-plated parts to be coated for rust prevention. - Acceptable Products: Zurn ZN-310-P, Watts, Jay R. Smith, Mifab
 - .2 P-trap: Deep seal P-trap with 20 mm [¾"] horizontal flush connection entering invert of trap base pointing downstream.

- .3 Valve: Concealed rough cast brass, externally adjustable, integral vacuum breaker, 25 mm [1"] angle screwdriver stop, chrome plated metal oscillating handle, chrome plated wall flange. - Acceptable Products: Zurn Z 6190, Crane, , Sloan, Delta Commercial
- .4 Connect flush valve discharge through 25 mm [1"] minimum line subsequently connecting to a tee with a 20 mm [3/4"] line to each connection at the drain and P-trap.
- .9 Floor Drain 'M': (floor sink).
 - .1 Cast iron floor sink with secondary drainage flange and 240 mm [9½"] square nickel bronze grate and frame, white acid resisting epoxy coated interior, aluminum interior anti-splash dome strainer and aluminum sediment bucket. Cast iron non-plated parts to be coated for rust prevention.
 - .2 Acceptable Products: Zurn ZN-1901-K-P -33-23, Watts, Jay R. Smith, Mifab

2.3 PRESSURE WASTE VALVES

- .1 Plug type: full port valve, flanged ends, screwed ends are acceptable for valves smaller than 50 mm [2"]
 - .1 Up to 50 mm [2"] size - Keystone round port ballcentric valve with flanged ends, Homestead #1512 Ballcentric with screwed ends.
 - .2 50 mm [2"] and larger - Keystone round port ballcentric valve with flanged ends, Homestead #1522 Ballcentric with flanged ends.
- .2 Gate valves shall not be used on sewage service unless specifically shown on drawings.
- .3 Check valves:
 - .1 75 mm [3"] size and smaller: APCO rubber flapper, Terminal City outside lever and weight, ITT Flygt HDL Model 5087.
 - .2 100 mm [4"] size and larger - APCO series 6000 cushioned swing check valve complete with oil operated dashpot, Terminal City outside lever and weight, ITT Flygt HDL Model 5087.

Part 3 Execution

3.1 FLOOR DRAINS

- .1 Install floor drains set low to provide proper drainage.
- .2 Generally do not locate floor drains in the center of mechanical rooms. Locate floor drains in close proximity to the equipment and / or devices that will be discharging water to them, such that drain connections from the equipment and / or devices can be piped to the floor drains without creating a tripping hazard.
- .3 Do not locate floor drains in front of doors.

- .4 Water piping from trap primer to floor drain to be PEX tubing where cast into concrete and protected in a polyethylene sleeve where buried below slab. Provide Type L copper where exposed within the building.

3.2 SAFES, FLASHING AND VENT TERMINALS

- .1 Terminate all vent terminals a minimum of 25 mm [1"] above the water level at which roof drainage overflows through roof overflow scuppers or drains.
- .2 All cleanouts passing through walls or floors subject to hydrostatic pressure and waterproofed by means other than a membrane shall be provided with clamping collars and flashings of 25 kg/m² [5 lb/ft²] lead.
- .3 Chloraloy 240 lining material may be used as an alternate to lead under built-up floor sinks and showers; and at floor drains and cleanouts. Materials shall be solvent welded to manufacturer's installation instructions. Lead shall not be used on roofs where the roofing material is applied by a torch-on method. Dow reinforced sheeting 45R may be used as an alternative to lead in all applications except in areas in which a rubberized or plastic membrane must be clamped to a drain.
- .4 Supply and fix 25 kg/m² [5 lb/ft²] sheet lead flashings to all cleanouts and drains. Securely fix to flashing clamps and extend 300 mm [12"] beyond edge of cast iron fittings.
- .5 Supply and install 25 kg/m² [5 lb/ft²] lead safes under built-up showers and mop sinks on any floor which is not slab-on-grade. The safes shall extend across the floors and up walls and curb to a minimum height of 150 mm [6"] and shall be turned into the floor drain flange, unless specifically noted otherwise. Seams shall be welded (burned), not soldered. Any metal shall be commercially pure lead only. Treat both sides of the safe with two coats of asphalt.
- .6 Vent flashing minimum 450 mm x 450 mm [18" x 18"] base dimension shall terminate flush with the top of 300 mm [12"] high vent pipe and the gap between the flashing and pipe shall be closed with a 25 kg/m² [5 lb/ft²] separate lead cap 75 mm [3"] high. The main flashing shall not be turned over the pipe.
- .7 Provide intrinsically safe barriers for all sump pumps located within parking garages, vehicle service or parking bays and in other areas which can receive fuels.

3.3 PIPING

- .1 Do not install ABS, PVC or other plastic piping upstream of any oil interceptors.
- .2 Do not install piping with glued joints at temperatures below those recommended by the solvent manufacture.

3.4 TESTING AND INSPECTION

- .1 Tests on the sanitary waste and storm drainage systems shall consist of hydraulic pressure testing of 3000 mm [10'] for eight (8) hours.
- .2 An air test in accordance with the Plumbing Code may be used during freezing conditions.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 74 11 – Cleaning
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .4 Section 01 61 00 – Common Product Requirements
- .5 Section 23 05 05 – Installation of Pipework

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM B32-08 (2014), Standard Specification for Solder Metal.
 - .2 ASTM B306-02, Standard Specification for Copper Drainage Tube (DWV).
 - .3 ASTM C564-14, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .2 Canadian Standards Association (CSA International).
 - .1 CSA B67-1972(R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
 - .2 CAN/CSA-B70-12, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .3 CAN/CSA-B125.3-11, Plumbing Fittings.
- .3 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 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 and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .4 Waste Management and Disposal:
 - .1 Separate waste materials for re-use or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for re-use or recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 COPPER TUBE AND FITTINGS

- .1 Above ground sanitary and vent Type DWV to: ASTM B306.
 - .1 Fittings.
 - .1 Cast brass: to CAN/CSA-B125.3.
 - .2 Wrought copper: to CAN/CSA-B125.3.
 - .2 Solder: tin-lead, 50:50, type 50A and lead free, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

- .1 Buried sanitary and vent minimum NPS 3, to: CAN/CSA-B70, with one layer of protective coating.
 - .1 Joints:
 - .1 Mechanical joints:
 - .1 Neoprene or butyl rubber compression gaskets: to CAN/CSA-B70.
 - .2 Hub and spigot:
 - .1 Caulking lead: to CSA B67.
 - .2 Cold caulking compounds.
- .2 Above ground sanitary, storm, and vent: to CAN/CSA-B70.
 - .1 Joints:
 - .1 Hub and spigot:
 - .1 Caulking lead: to CSA B67.
 - .2 Mechanical joints:
 - .1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 In accordance with Section 23 05 05 - Installation of Pipework.
- .2 Install in accordance with National Plumbing Code.

3.3 TESTING

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- .4 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 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 for 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 RELATED REQUIREMENTS

- .1 Section 01 31 19 – Project Meetings
- .2 Section 01 33 00 – Submittal Procedures
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Closeout Submittals
- .6 Section 01 91 13 – General Commissioning (Cx) Requirements
- .7 Section 22 05 00 – Common Work Results for Plumbing

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A126-04(2014), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM B62-2015, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .2 American Water Works Association (AWWA)
 - .1 ANSI/AWWA C700-2015, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.
 - .2 ANSI/AWWA C701-12, Standard for Cold Water Meters-Turbine Type for Customer Service.
 - .3 ANSI/AWWA C702-2015, Standard for Cold Water Meters-Compound Type.
- .3 CSA International
 - .1 CSA-B64 Series-11, Backflow Preventers and Vacuum Breakers.
 - .2 CSA B79-08, Commercial and Residential Drains and Cleanouts.
 - .3 CAN/CSA-B356-10, Water Pressure Reducing Valves for Domestic Water Supply Systems.
- .4 Plumbing and Drainage Institute (PDI)
 - .1 PDI-WH201-R2010, Water Hammer Arresters Standard.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting one (1) week prior to beginning work of this Section on-site installation, with contractor's representative, Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building construction subtrades.

- .4 Review manufacturer's written installation instructions and warranty requirements.

1.4 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 plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two (2) copies of WHMIS MSDS in accordance with Section 01 35 43 - Environmental Procedures. Indicate VOC's.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .2 Indicate on drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions construction and assembly details accessories for following:
 - .1 Soap dispensing system.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturers' Field Reports: manufacturers' field reports specified.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.
 - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.

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 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect plumbing materials from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 CLEANOUTS

- .1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
- .2 Access Covers:
 - .1 Wall Access: face or wall type, stainless steel, square or round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
 - .2 Floor Access: rectangular or round cast iron body and frame with adjustable secured nickel bronze top and:
 - .1 Plugs: bolted bronze with neoprene gasket.
 - .2 Cover for Unfinished Concrete Floors: nickel bronze, round or square gasket, vandal-proof screws.
 - .3 Cover for Terrazzo Finish: polished nickel bronze or brass with recessed cover for filling with terrazzo, vandal-proof locking screws.
 - .4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.
 - .5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

2.2 WATER HAMMER ARRESTORS

- .1 Stainless steel or Copper construction, bellows type: to PDI-WH201.

2.3 BACK FLOW PREVENTERS

- .1 Preventers: to CSA-B64 Series, application reduced pressure principle type or double check valve assembly and vacuum breaker.

2.4 VACUUM BREAKERS

- .1 Breakers: to CSA-B64 Series, vacuum breaker atmospheric or laboratory faucet intermediate.

2.5 PRESSURE REGULATORS

- .1 Capacity: as indicated.
 - .1 Inlet pressure: 1034 kPa.
 - .2 Outlet pressure: 413 kPa.
- .2 Up to NPS 1-1/2 bronze bodies, screwed: to ASTM B62.
- .3 NPS 2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class [B].

- .4 Semi-steel spring chambers with bronze trim.

2.6 BACKWATER VALVES

- .1 Galvanized body with bronze seat, revolving bronze flapper and threaded cover.
- .2 Access:
 - .1 Surface access.
 - .2 Access pipe with cover: maximum [300] mm depth.
 - .3 Steel housing with gasketed steel cover.
 - .4 Concrete access pit with cover, as indicated.

2.7 TRAP SEAL PRIMERS

- .1 Provide flow actuated type priming device piped to nearest fixture so that device will introduce regulated amount of water into trap whenever fixture is used.

2.8 STRAINERS

- .1 860 kPa, Y type with 20 mesh, monel, bronze or stainless steel removable screen.
- .2 NPS 2 and under, bronze body, screwed ends, with brass cap.
- .3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

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 plumbing specialties and accessories 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 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 Install in accordance with National Plumbing Code of Canada.
- .2 Install in accordance with manufacturer's instructions and as specified.

3.4 CLEANOUTS

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.5 WATER HAMMER ARRESTORS

- .1 Install on branch supplies to fixtures or group of fixtures.

3.6 BACK FLOW PREVENTERS

- .1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.
 - .1 Drains.
 - .2 Backwater Valves.
 - .3 Water Make-up Assembly.
- .2 Pipe discharge to terminate over nearest drain or service sink.

3.7 BACKWATER VALVES

- .1 Install in main sewer lines and where indicated, as well as at weeping tile connection in pit provided at building cleanout.
- .2 Install in access pit as indicated.

3.8 TRAP SEAL PRIMERS

- .1 Install for floor drains and elsewhere, as indicated.
- .2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Departmental Representative.
- .3 Install soft copper or plastic tubing to floor drain.

3.9 STRAINERS

- .1 Install with sufficient room to remove basket for maintenance.

3.10 START-UP

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Timing: start-up only after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.

- .3 Provide continuous supervision during start-up.

3.11 TESTING AND ADJUSTING

- .1 General:
 - .1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
- .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After certificate of completion has been issued by authority having jurisdiction.
- .3 Application tolerances:
 - .1 Pressure at fixtures: +/- 70 kPa.
 - .2 Flow rate at fixtures: +/- 20%.
- .4 Adjustments:
 - .1 Verify that flow rate and pressure meet design criteria.
 - .2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.
- .5 Floor drains:
 - .1 Verify operation of trap seal primer.
 - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
 - .3 Check operations of flushing features.
 - .4 Check security, accessibility, removability of strainer.
 - .5 Clean out baskets.
- .6 Vacuum breakers, backflow preventers, backwater valves:
 - .1 Test tightness, accessibility for O M of cover and of valve.
 - .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
 - .3 Verify visibility of discharge from open ports.
- .7 Access doors:
 - .1 Verify size and location relative to items to be accessed.
- .8 Cleanouts:
 - .1 Verify covers are gas-tight, secure, yet readily removable.
- .9 Water hammer arrestors:
 - .1 Verify proper installation of correct type of water hammer arrester.
- .10 Pressure regulators, PRV assemblies:
 - .1 Adjust settings to suit locations, flow rates, pressure conditions.

- .11 Strainers:
 - .1 Clean out repeatedly until clear.
 - .2 Verify accessibility of cleanout plug and basket.
 - .3 Verify that cleanout plug does not leak.

3.12 CLOSEOUT ACTIVITIES

- .1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.
- .2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

3.13 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 for 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.

3.14 PROTECTION

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 11 00 – Summary of Work
- .2 Section 01 14 00 – Work Restrictions
- .3 Section 01 35 00 – Special Procedures
- .4 Section 01 45 00 – Quality Control
- .5 Section 01 61 00 – Common Product Requirements
- .6 Section 01 74 11 – Cleaning
- .7 Section 01 78 00 – Close-out Submittals
- .8 Section 09 91 23 – Interior Painting
- .9 Section 21 05 05 – Common Work Results for Fire Suppression
- .10 Section 22 05 00 – Common Work Results for Plumbing
- .11 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
- .12 Section 25 05 00 – EMCS General Requirements

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 equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.3 CLOSE-OUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 – Close-out Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for equipment for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .5 Commissioning Report, including commissioning check sheets and system set-points, as set. Include in Maintenance Manual.
 - .5 Approvals:
 - .1 Submit one (1) copy of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
 - .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

- .7 Site records:
 - .1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings. Make required adjustments and corrections.
 - .5 Arrange for and be responsible for the preparation of as-built drawings in AutoCAD computerized drafting system. Be responsible for the cost of preparation of as-built drawings. Submit electronic copy of the as-built drawings on CD/DVD media in CAD and PDF format, as well as 2 sets of hard copies. Submit as-built drawings before requesting Substantial Completion.
 - .6 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
 - .1 One casing joint gasket for each size pump.
 - .2 Two spare temperature and two spare pressure gauges for each measuring range.
 - .3 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 HVAC and R Equipment:
 - .1 Refrigerant:
 - .1 HCFC based refrigerant shall not be permitted.
 - .2 HFC based refrigerant shall not be permitted.

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 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 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 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 - ACTION AND INFORMATIONAL 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.

3.5 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 Supply air
 - .2 Exhaust air
 - .3 Domestic water and tempered water system
 - .4 Control and monitoring systems
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 CLEANING

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

- .3 Waste Management: separate waste materials for 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.

3.7 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Use of mechanical systems during construction.
- .2 Related Requirements
 - .1 Section 23 05 00 - Common Work Results for HVAC

1.2 USE OF SYSTEMS

- .1 Use of existing permanent ventilating systems for supplying temporary heat is permitted only under following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned; water treatment is being continuously monitored.
 - .3 Building has been closed in; areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage.
 - .5 Supply ventilation systems are protected by 60 % filters, inspected daily and changed every two (2) weeks or more frequently as required.
 - .6 Return systems have approved filters over openings, inlets, outlets.
 - .7 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions,
 - .2 Operated by Contractor,
 - .3 Monitored continuously by Contractor.
 - .8 Warranties and guarantees are not relaxed.
 - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
 - .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.

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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 07 84 00 – Firestopping
- .6 Section 22 05 00 – Common Work Results for Plumbing
- .7 Section 23 05 00 – Common Work Results for HVAC
- .8 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems
- .9

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-2013, Ready-Mixed Organic Zinc-Rich Coating.
- .2 National Fire Code of Canada (NFCC Section 23 21 13.04 - Hydronic Systems: Steel -- Preinsulated 2005)
- .3 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2011, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 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 datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 QUALITY ASSURANCE

- .1 Sustainability Standards Certification:
 - .1 Low-Emitting Materials: provide listing of sealants, coatings used in the project, comply with VOC and chemical component limits or restriction requirements.

1.5 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:

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Primers, paints, coatings: in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250g/L to Standard GS-11.
 - .3 Paints: maximum VOC limit 150g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install manual air vents to CSA B139 at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install buried piping in accordance with Section 23 21 13.04 - Hydronic Systems: Steel -- Preinsulated
- .9 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

- .10 Slope piping, except where indicated, in burie of flow for positive drainage and venting.
- .11 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .12 Group piping wherever possible and as indicated.
- .13 Ream pipes, remove scale and other foreign material before assembly.
- .14 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .15 Provide for thermal expansion as indicated.
- .16 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate, ball, butterfly valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install plug cocks or ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400mm above floor in Mechanical Rooms.

3.8

SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-

hardening mastic.

- .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
- .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel..
- .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test

pressure or media.

- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative a minimum of 10 days prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

3.14 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 for 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 SUMMARY

- .1 Section includes:
 - .1 Electrical motors, drives and guards for mechanical equipment and systems.
 - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 35 29.6 – Health and Safety Requirements
 - .3 Section 01 45 00 – Quality Control
 - .4 Section 01 61 00 – Common Product Requirements
 - .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .6 Section 01 78 00 – Closeout Submittals
 - .7 Section 22 05 00 – Common Work Results for Plumbing
 - .8 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-11, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of systems supplier's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with Canadian Environmental Assessment Agency (CEAA) and applicable Provincial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle 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 Construction/Demolition Waste Management and Disposal: separate waste materials for re-use or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 1/2 HP: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.
- .3 Motors 373W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3-phase, 208 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .5 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

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 datasheet.

3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 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.

3.4 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 Waste Management: separate waste materials for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE

- .1 Flexible pipe connections.
- .2 Expansion joints and compensators.
- .3 Pipe loops, offset and swing joints.

1.3 REFERENCE STANDARD

- .1 Conform to Standard of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

1.4 SHOP DRAWINGS

- .1 Product data shall include manufacturer; model number; pressure and temperature rating; axial, lateral, angular movement handled; nominal size and dimensions; details of construction and assembly.
- .2 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

1.5 GENERAL REQUIREMENTS

- .1 Examine piping layout and notify the Consultant of additional anchors or expansion joints required to adequately protect system.
- .2 Make provision for expansion and contraction of all pipe work. All piping shall be anchored and supported in such a manner that strain and/or weight does not come upon any apparatus and pipe branch connections. Expansion joints and compensators shall be installed and guided as per manufacturer's recommendations. All equipment shall be connected with unions or flanges to provide for easy removal. Where piping passes through walls or floor slabs, the sleeves shall be of sufficient size to accommodate the expansion and the pipe insulation without binding or crushing the insulation, or preventing the expansion of the piping.
- .3 All grooved joint couplings, fittings, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - .1 All castings shall be date stamped for quality assurance and traceability.

Part 2 Products

2.1 FLEXIBLE HOSES - BRAIDED

- .1 Phosphor bronze convoluted bellows with braided bronze sleeve or stainless steel convoluted bellows with braided stainless steel sleeve.
- .2 Suitable for system operating temperature and pressure.
- .3 Connections:
 - .1 NPS 2 and under, screwed connections.
 - .2 NPS 2-1/2 and over, flanged connections.
- .4 Length shall be as recommended by manufacturer, unless noted otherwise.
- .5 Acceptable Products:
 - .1 Flexonics Flex Con, Flextech Industries, Hydro Flex, Keflex, Vibra-Flo.

2.2 FLEXIBLE PIPE CONNECTORS

- .1 Flexible pipe connectors complete with control rods, manufactured from polyester tire cords and bridge bearing quality neoprene or EPDM; cover and liner to CSA Standard CAN3-S6-M88, Section 11.5.8.3. Provide flanges, bolts, etc. for outdoor installation. Do not make attachments between equipment and piping other than on equipment side of flexible connector.
- .2 Twin sphere design with reinforcing ring.
- .3 Suitable for a maximum temperature of 40°C [140°F] (chilled and condenser water systems only).
- .4 Safety factor for burst and flange pullout shall be a minimum of 3:1.

2.3 EXPANSION COMPENSATORS

- .1 Bronze or stainless steel convoluted bellows.
- .2 Suitable for up to 414 kPa [60 psig] working pressures.
- .3 20 mm [3/4"] to 32 mm [1-1/4"] diameter, suitable for 12 mm [1/2"] compression and 6 mm [1/4"] extension.
- .2 Steel Pipe Expansion Compensator
 - .1 Factory assembled unit, with stainless steel or phosphor bronze bellows in carbon steel casing.
 - .2 Anti-torque groove in casing, internal pipe guide at both ends, full length internal liner.
 - .3 Suitable for 1035 kPa [150 psig] operating pressure.

- .4 Suitable for 38 mm [1-1/2"] compression and 6 mm [1/4"] extension.
- .5 Acceptable Products:
 - .1 Adsko, Flexonics, Flextech Industries, Hydroflex, Metraflex, Vibra-Flo.

2.4 EXPANSION JOINTS

- .1 Bellows type, corrugated, packless.
- .2 Designed for maximum operating pressure and temperature of 860 kPa [125 psig] and 45°C [110°F].
- .3 External stainless steel guide sleeves.
- .4 External machined cast iron control rings, full circumference.
- .5 With external guide rods.
- .6 Flanged ends.
- .7 Shrouds over external surfaces for insulation.
- .8 Two sets of alignment guides on each side of expansion joint, spaced to manufacturer's recommendations, complete with guiding cylinder and base, cast or fabricated spider.
- .9 Consultant reserves right to compress one or more of each size of joint to its solid height to ensure that nameplate traverse is met. After which, joint shall be expanded to its shipping face to face dimension and rechecked hydrostatically. On joint failing, joints shall be removed as unacceptable.
- .10 Acceptable Products:
 - .1 Adsko, Anaconda, Flexonics, Hydro-Flex, Tube Turns, United Flexible, Vibra-Flo
- .2 Grooved End Type:
 - .1 Packless, Gasketed, Slip, Expansion Joints: 2400 kPa [350-psig] maximum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, PTFE modified polyphenylene sulfide coated slide section, with grooved ends. Suitable for axial end movement to 80mm [3"]. Victaulic Style 150.
 - .2 Expansion joint consisting of a series of grooved end pipe nipples joined in tandem with Victaulic Style 77 flexible couplings. Total joint movement dependent on the number of couplings and nipples used. Victaulic Series 155.
 - .3 Acceptable Products:
 - .1 Victaulic Company.

2.5 ANCHORS

- .1 Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.
- .2 Anchors shall securely attach piping to structural members. Size the anchors to accommodate the forces due to the pipe expansion and weight.

- .3 Where bolts secure anchor to the structure, weld the bolts to the plate. Arrange anchors so that bolts are in shear not in tension.
- .4 Provide anchors on both sides of expansion devices, as indicated on the drawings, and as required to control the flexing of the piping system.

2.6 EXPANSION LOOPS

- .1 Provide expansion loops as required.
- .2 Expansion loops shall be of all welded construction with long radius elbows. The three legs of the expansion loop shall be equal.
- .3 For water systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic instructions and as approved by the engineer.) Where expansion loops are required, use Victaulic Style 77 couplings on the loops.

2.7 GUIDES

- .1 Pipe alignment guides shall be Hyspan Series 9500 or equal. Size to accommodate pipe insulation.

Part 3 Execution

3.1 INSTALLATION

- .1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building. Pay particular attention to piping running horizontal across building expansion joints and provide adequate expansion and contraction for all such piping.
- .2 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections.
- .3 Where necessary provide two (2) pipe guides per side of expansion joint or expansion loop so that movement takes place along axis of pipe only.
- .4 Install expansion loops, cold sprung 50% of the calculated expansion.
- .5 Install at least three (3) elbows in all branch connections. Where space does not permit three (3) elbows, install braided flexible pipe connectors in accordance with manufacturer's recommendations. Three (3) elbow branch connections shall have sufficient developed length to ensure that excessive stresses are not generated in the piping and in no case less than 900 mm [36"].

3.2 EXPANSION JOINTS

- .1 Install expansion joints, where shown on the drawings, in strict accordance with the manufacturers detailed installation instructions.
- .2 Take care to be aware of the temperature at which the expansion compensator is installed to properly establish the length.
- .3 Ensure that expansion joints are not damaged during hydrostatic testing.
- .4 The piping shall be tested hydrostatically with the expansion joints in place using cold water.
- .5 Bellows Type:
 - .1 Install a union at one end of each screwed expansion joint.
 - .2 Remove slippage bolts and spacers after installation.
 - .3 Locate expansion joint[s] centrally between anchors and position guides to manufacturer's specific requirement. Provide structure as required to properly mount guides.
 - .4 Ensure that piping is properly aligned through expansion joint[s], over the full travel.
 - .5 Adjust the installed length of the expansion joint[s] to suit the ambient temperature at the time of installation.
- .6 Sleeve Type:
 - .1 Locate expansion joint[s] centrally between anchors and position guides to manufacturer's specific requirement. Provide structure as required to properly mount guides.
 - .2 Set and secure base, if base mounted. Provide structure as required.
 - .3 Ensure that piping is properly aligned through the expansion joint[s], over the full travel.
 - .4 Adjust the installed length of the expansion joint[s] to suit the ambient temperature at the time of installation.
 - .5 Pack the joint[s] for service.
- .7 Grooved End Type:
 - .1 Install in accordance with Victaulic written instructions.
 - .2 Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer.
 - .3 The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

3.3 FLEXIBLE HOSES - BRAIDED

- .1 Install braided flexible hoses where shown on the drawings and as the flexible connections to designated heating/cooling terminal units.
- .2 On screwed connections, install a union on one end.
- .3 Take care not to torque the hose.
- .4 Ensure braided flexible hoses are not damaged during hydrostatic testing.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 23 05 00 – Common Work Results for HVAC
- .6 Section 23 05 05 – Installation of Piping

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2012, Power Piping.
 - .2 ANSI/ASME B31.3-2010, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-[2007]:
 - .1 BPVC 2007 Section I: Power Boilers.
 - .2 BPVC 2007 Section V: Non-destructive Examination.
 - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1-2012, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-2010, Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-12, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-14, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-14, Certification of Welding Inspectors.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications Departmental Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
 - .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.
 - .3 Certifications:
 - .1 Registration of welding procedures in accordance with CSA B51.
 - .2 Copy of welding procedures available for inspection.
 - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for re-use and return or by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 PRE-INSULATED PIPING MAINS

- .1 Refer to section 23 21 13.04 Hydronic Systems: Steel – Preinsulated for piping and welding requirements related to preinsulated underground mains.

Part 2 Products

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 APPLICATION

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

3.2 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1 and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, special procedures specified elsewhere in Division 23, and applicable requirements of provincial Authority Having Jurisdiction.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Arrange for services, and pay for services of a qualified Inspector for Welding and Welding. The inspector shall review welder's credentials, attend sample welding for the buried piping, and inspect all welds (buried and aboveground piping).
- .4 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .5 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.
- .6 Inspector shall provide an affidavit that the welding has been inspected, and that it meets the industry and specified standards.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and

- requirements of authority having jurisdiction.
- .3 Inspect and test 10 % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination magnetic particle (hereinafter referred to as "particle") tests spot full gamma ray radiographic (hereinafter referred to as "radiography") tests.
 - .2 Hydrostatically test welds to ANSI/ASME B31.1.
 - .3 Visual examinations: include entire circumference of weld externally and, wherever possible, internally.
 - .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of total of up to ten (10) Departmental Representative tests.
 - .5 Full radiographic tests for condenser water piping systems.
 - .1 Spot radiography:
 - .1 Conduct spot radiographic tests of up to [10]% of welds, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit Departmental Representative. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, condenser water systems:
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

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 for 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 SUMMARY

- .1 Section Includes:
 - .1 Materials and components for metering condenser water including installation.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 35 29.06 – Health and Safety Requirements
 - .3 Section 01 61 00 – Common Product Requirements
 - .4 Section 01 74 11 – Cleaning
 - .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .6 Section 01 78 00 – Close-out Submittals
 - .7 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition 1971.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
- .3 Submittals to include:
 - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
 - .2 Service conditions.

- .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
- .4 Accuracy statements for each component at specified flow rates and other conditions.
- .5 Flow and temperature ranges.
- .6 Signal processor calibration data.
- .7 Minimum turndown ratio.
- .4 Samples:
 - .1 Submit sample in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include:
 - .1 Full size samples of recorder charts, integrator readings.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of systems supplier's installation instructions.
- .6 Close-out Submittals:
 - .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 ACCURACY

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy = $(E(\text{accuracy of individual components of system})^2)^{1/2}$.
- .2 Components to include:
 - .1 Primary flow measuring elements.
 - .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
 - .3 RTD's.
 - .4 Signal processors, recorders.
 - .5 Calibration of signal processors: assume 0.20% per processor.
 - .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.
- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

2.2 CONDENSER WATER METERING

- .1 Type of metering:
 - .1 Wide range Thermal power (i.e. demand), thermal energy consumption, supply return temperature, compensated for specific gravity.
- .2 Design data:
 - .1 Flow rates:
 - .1 100% Design: Refer to respective pump flow.
 - .2 Normal design flow rate: 70% of 100% design flow rate.
 - .3 Minimum flow rate: 40% of maximum.
 - .2 Pressure: 860 kPa.
 - .3 Supply temperature: 25 degrees C.
 - .4 Return temperature: 55 degrees C.
- .3 State in proposal:
 - .1 Point of change-over.
 - .2 How change-over will be achieved.
- .4 Design differential pressure at normal design flow rate: [25] kPa.
- .5 Maximum accuracy of complete meter installation at normal design flow and design temperatures to be plus or minus [5]%

- .6 Primary flow measuring elements:
 - .1 Insertion type.
- .7 Flow transmitters may form an integral part of primary flow measuring element.
- .8 Standard of design for primary flow measuring elements: ASME Fluid Meter Handbook.
- .9 State in proposal maximum irrecoverable head loss (IHL).
- .10 Available lengths of straight pipe to first fitting, and intrusion: 5 pipe diameters.
- .11 State in proposal minimum lengths of straight pipe required upstream and downstream of primary element to meet specified accuracy requirements.
- .12 Temperature sensors:
 - .1 100 ohm RTD.
 - .2 Thermowells to NPS 3/4 stainless steel thermowell filled with conductive paste with following insertion lengths:
 - .1 Up to NPS 6: 75 mm.
 - .2 NPS 8 and over: 150 mm.
 - .3 Sensors for temperature difference measurements to be matched pairs.
- .13 Acceptable types of transmitters: BACnet compatible.
 - .1 Transmitters: BACnet compatible.
- .14 Acceptable types of readout instruments:
 - .1 Integrators: 6-digit, [8] mm high lettering, non-reset.
- .15 Read-out instrument display:
 - .1 Thermal power: 0 - 9999 kW.
 - .2 Thermal energy consumption: 0 - 999999 MJ.
 - .3 Water flow rate: 0 – 100.00 L/s.
 - .4 Temperature [difference]: 0 - 50 degrees C.
- .16 Ambient conditions at transmitters: temperature: 50 degrees C; non-condensing
- .17 Signal transmission between primary measuring element and signal conditioners:
 - .1 Power: 24 VDC.
 - .2 Signal: 4-20 mA or 0-10 VDC.
 - .3 Cable: colour coded, twisted and shielded pair with grounding wire.
- .18 Locations:
- .19 Connection to Building Automation System (BAS):
 - .1 BACnet compatible.

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 datasheet.

3.2 PREPARATION

- .1 Before final purchase of measure:
 - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
 - .2 For concentricity of pipe.
 - .3 Parameters recommended by manufacturer.

3.3 INSTALLATION OF PRIMARY ELEMENT

- .1 Follow manufacturer's instructions.

3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
- .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.5 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

3.6 INSTALLATION OF SIGNAL TRANSMISSION CABLE

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.7 START-UP

- .1 Follow manufacturer's recommendations.

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 for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

Part 2 Products

2.1 GENERAL

- .1 Select thermometers and pressure gauges so that their operating range falls in the middle half of the scale range.

2.2 THERMOMETERS - PIPING

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 All thermometers to be in accordance with Canadian General Standards Board CGSB 14.4 - M88.
 - .2 Pipe mounted stem type, adjustable angle type.
 - .3 Mercury content is not acceptable
 - .4 Refer to flow schematics for location of pipe mounted thermometers and wells.
- .3 Case:
 - .1 Stem type - cast aluminum alloy, either anodized or coated with baked enamel. The case shall be provided with a clear glass or heat resistant plastic window.
- .4 Scale:
 - .1 Stem type - 225 mm [9"] scale length.
 - .2 White background with temperature range in black.
 - .3 Dual Celsius and Fahrenheit scale.

2.3 THERMOMETERS - DUCT/PANEL MOUNTED

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 All thermometers to be in accordance with Canadian General Standards Board CGSB 14-GP-2a.
 - .2 Mercury content is not acceptable
 - .3 Duct mounted dial type - solid liquid filled with remote capillary element.
 - .4 Panel mounted dial type (surface) type - vapour filled direct mounting.
 - .5 Panel mounted dial type (flush) type - remote liquid filled capillary element.

- .3 Case:
 - .1 Dial type - cast aluminum, black enamel steel or stainless steel with stainless steel or chrome-plated face ring.
- .4 Scale:
 - .1 Dial type - nominal 115 mm [4-1/2"] unless otherwise indicated.
 - .2 White background with temperature range in black.
 - .3 Dual Celsius and Fahrenheit scale.

2.4 PRESSURE GAUGES - PIPING

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 All gauges to be in accordance with ANSI B40.1 Grade "A" level.
 - .2 115 mm [4-1/2"] cast aluminum, black steel or stainless steel case, with stainless steel or chrome plated face ring.
 - .3 White background with pressure range in black.
 - .4 Dual kilopascal and psig scale.
 - .5 Phosphor bronze bourdon tube, silver brazed tip and socket 1/4" NPT lower connection.
 - .6 Rotary type bushed movement, silicone dampened to prevent pointer oscillation.
 - .7 Gauges to be registered with Provincial Boiler and Pressure Vessel Safety Branches with CRN number.
 - .8 ULC listed for use on fire protection systems.
 - .9 Accuracy shall be 1% off full scale over the middle half of the scale.
- .3 Accessories:
 - .1 Install a needle valve ahead of each gauge.
 - .2 Install an anti-syphon loop (suitable for steam pressure) ahead of each gauge on steam systems.

2.5 TEST PLUGS FOR PRESSURE / TEMPERATURE

- .1 Provide 6mm [1/4"] NPT solid brass test plug fitting c/w brass chain where indicated.
- .2 Test plugs shall be capable of receiving either a pressure or temperature 3mm [1/8"] O.D. Dual seal core shall be Nordel suitable for temperature of 177°C [350°F] and shall be rated zero leakage from vacuum to 6895kPa [1000psig).
- .3 Provide 1 master test kit containing 2 - test pressure gauge of suitable range, 1 gauge adaptor 3mm [1/8"] O.D. probe and 2 - stem pocket testing thermometers of suitable range.
- .4 Acceptable Products:
 - .1 Sisco P/T Plugs.



.2 Flow Design - Superseal.

2.6 TEST THERMOMETER

- .1 Hand over a test thermometer in protective case to the Owner during the Owner's Demonstration and Instruction Period. Provide the same make and type as the permanently installed thermometers suitable for use with pipe mounted wells. Range 0°C to 115°C [30°F to 240°F].
- .2 Obtain two signed receipts from the Owner certifying that the test thermometer has been received. Hand one over to the Consultant.

2.7 THERMOMETER WELLS

- .1 For copper pipe use copper or bronze. For steel pipe use brass, separable socket, 3/4 NPT.
- .2 Thermowell to be registered with Provincial Boiler and Pressure Vessels Safety Branch with CRN number.

Part 3 execution

3.1 GENERAL

- .1 Install thermometers and gauges so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.
- .2 Install engraved lamoid nameplates as specified in (Section 23 05 53 – Identification) identifying medium.

3.2 THERMOMETERS

- .1 Install in wells on all piping.
- .2 Install the separable well so as to minimize the restriction to flow and, if necessary, install in a section of oversized pipe.
- .3 Install wells where indicated for use with test thermometers.
- .4 Install in locations as indicated and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Water heating and cooling coils.
 - .3 Water boilers.
 - .4 Chillers - condenser and chilled water.
 - .5 Cooling towers.
 - .6 DHW tanks.
- .5 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.

- .2 Upstream and downstream of PRV's.
 - .3 Inlet and outlet of waterside of coils (excluding terminal unit coils) and heat exchangers.
 - .4 In other locations as indicated.
- .2 Use extensions where pressure gauges are installed through insulation.
 - .3 Where a single gauge is used to measure multiple points provide needle valves to isolate each point, including pressure gauge.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 78 00 – Close-out Submittals
- .5 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-[2013], Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-[2012], Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276-[15], Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-[02], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-[14], Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-[14], Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-[2013], Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-[2013], Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-[2010], Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 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 and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .3 Pressure rating
 - .1 Pressure rating shall meet or exceed pressure rating of the system.

- .2 Rated to hold against differential pressure of min 860 kPa (open ended rating).
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .2 Submit data for valves specified in this Section.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every [10] valves each size, minimum [1].
 - .2 Discs: one for every [10] valves, each size. Minimum [1].
 - .3 Stem packing: one for every [10] valves, each size. Minimum [1].
 - .4 Valve handles: [2] of each size.
 - .5 Gaskets for flanges: one for every [10] flanged joints.
 - .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

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:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.

- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends or grooved ends to ANSI/ASME B16.18.
 - .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide [10] keys of each size: malleable iron cadmium plated.
 - .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
 - .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: handwheel or lockshield.
 - .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
 - .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed or union bonnet.
 - .2 Operator: handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.

- .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
- .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel or lockshield.
- .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel or lockshield.
- .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
- .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: handwheel or lockshield.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number [6] composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders or solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
- .9 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, [2068 kPa] with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever or handwheel.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 23.01 – Valves – Bronze

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-[2015], Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International Inc.
 - .1 ASTM A49-[01(2006)], Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-[04], Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM A536-[84(2014)e1], Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-[15], Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM B85/B85M-[08], Standard Specification for Aluminum-Alloy Die Castings.
 - .7 ASTM B209-[14], Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-[2009], Pressure Testing of Steel Valves.
 - .2 MSS SP-70-[2011], Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP-71-[2011], Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP-82-[2003], Valve Pressure Testing Methods.
 - .5 MSS SP-85-[2002], Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 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 datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .3 Submit data for valves specified in this Section.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 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:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every [10] valves each size, minimum [1].
 - .2 Discs: one for every [10] valves, each size, minimum [1].
 - .3 Stem packing: one for every [10] valves, each size, minimum [1].
 - .4 Valve handles: [2] of each size.
 - .5 Gaskets for flanges: one for every [10] flanged joints.
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B or ductile iron to ASTM A536 Grade 65-45-12.
 - .2 Connections: flanged ends plain face with 2 mm raised face with serrated finish to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non-rising stem, inside screw, bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: handwheel. Provide operating chain if hand wheel cannot be operated from floor level.

- .9 Bypass: complete with union and NPS gate valve as Section 23 05 23.01 - Valves – Bronze.
- .2 NPS 10 - 24, non rising stem, inside crew, bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: cast iron to ASTM A126 Class B for sizes up to NPS 14, Class C for sizes NPS 16 and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges.
 - .2 Pressure ratings: Class 125.
 - .3 Disc: solid offset taper wedge, with bronze rings to ASTM B62 rolled into cast iron disc, secured to stem.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Stem: bronze to ASTM B62.
 - .6 Disc: solid offset taper wedge, cast iron secured to stem.
 - .7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
 - .8 Stem: wrought steel.
 - .9 Operator: handwheel or manual gear.
 - .10 Bypass: complete with union and NPS globe valve.
- .3 NPS 2 1/2-8, outside screw and yoke (OS Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.
 - .9 Operator: handwheel or manual gear.
 - .10 Bypass: complete with union and NPS globe.
- .4 NPS 10 - 24, outside screw and yoke (OS Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: NPS 10 - 14: cast iron to ASTM A126 Class B. With bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges, yoke, yoke hub, yoke sleeve and nut.
 - .2 Pressure ratings: Class 125.
 - .1 NPS 10-12: WP = 1.4 MPa CWP.

- .2 NPS 14-24: WP = 1.03 MPa CWP.
- .3 Disc: solid offset taper wedge, bronze disc rings to ASTM B62 rolled into cast iron disc, secured to stem through integral forged T-head disc-stem connection.
- .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
- .5 Stem: nickel-plated steel.
- .6 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
- .7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
- .8 Stem: nickel-plated steel.
- .9 Pressure-lubricated operating mechanism.
- .10 Operator: handwheel or manual gear.
- .11 Bypass: complete with union and NPS globe.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B); ductile iron to ASTM A536 Grade 65-45-12.
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass: ASTM B16.
 - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on NPS 4 and over.
 - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
 - .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
 - .12 Operator: handwheel.
 - .13 Bypass: complete with union and NPS globe.

2.4 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

- .5 Seat ring: renewable, regrindable, screwed into body.
- .6 Stem: bronze to ASTM B62.
- .7 Operator: handwheel or manual gear.
- .8 Bypass: complete with union and NPS globe.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
 - .2 Main valve NPS 10 and over: NPS 1.
- .3 Type of bypass valves:
 - .1 On gate valve: globe, with bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.
 - .2 On globe valve: globe, with bronze disc, bronzetrim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.6 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

2.7 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B or ductile iron ASTM A536 Grade 65-45-12.
 - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B62 or stainless steel type 316.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62 or stainless steel.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy; bushings: malleable iron.

- .9 Identification tag: fastened to cover.
- .10 Hinge: stainless steel.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
 - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.
 - .3 Rating: 250 psi steam; 500 psi CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 NPS 4 - 8: iron faced with ASTM B61 bronze.
 - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
 - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
 - .7 Hinge: galvanized malleable iron.
 - .8 Identification tag: fastened to cover.

2.8 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: malleable ductile iron with integral seat.
 - .2 Pressure rating: Class 125, WP = 860 kPa.
 - .3 Connections: grooved ends.
 - .4 Disc: bronze or stainless steel renewable rotating disc.
 - .5 Seat: renewable, EPDM.
 - .6 Stainless steel spring, heavy duty.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Closeout Submittals
- .6 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-[2013], Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1-[05], Gray Iron Pipe Flanges and Flanged Fittings: Classes 25,125 and 250.
 - .3 ANSI/ASME B16.5-[2013], Pipe Flanges and Flanged Fittings: NPS through 24.
 - .4 ANSI/ASME B16.11-[05], Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-[2010], Buttwelding Ends.
 - .6 ANSI/ASME B16.34-[2013], Valves - Flanged, Threaded and Welding Ends.
- .2 American Petroleum Institute (API)
 - .1 API Std. 609-[2009], Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .3 ASTM International Inc.
 - .1 ASTM A126-[04], Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM A536-[84(2014)], Standard Specification for Ductile Iron Castings.
 - .3 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B209M-[14], Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-67-[02a], Butterfly Valves.

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 datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit data for valves specified in this section.
 - .3 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 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:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every [10] valves each size, minimum [1].
 - .2 Discs: one for every [10]valves, each size, minimum [1].
 - .3 Stem packing: one for every [10] valves, each size, minimum [1].
 - .4 Valve handles: [2] of each size.
 - .5 Gaskets for flanges: one for every [10] flanged joints - minimum [1] for each size.
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

Part 2 Products

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service – minimum 2000 kPa [300 psi] open ended differential pressure.
- .3 CRN registration number required for products.
- .4 Sizes:
 - .1 Wafer type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 - 12: [200] psig.
- .6 Minimum seat temperature ratings to 121 degrees C.
- .7 Application: on-off operation.
- .8 Full lug body (threaded).
- .9 Operators:
 - .1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
 - .2 NPS 8 - 30: manual enclosed gear operator.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
 - .1 Body ductile iron.
 - .2 Disc: aluminum bronze or 316 SS.
 - .3 Seat: EPDM or Buna-N.
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS Monel.
 - .6 Key: carbon steel.
 - .7 O-Ring: Buna-N or EPDM.
 - .8 Bushings: luberized bronze.

2.2 MOUNTING FLANGES

- .1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

Part 3 Execution

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- .1 Air hoses or electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 61 00 – Common Products Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 05 12 23 – Structural Steel for Buildings
- .7 Section 05 50 00 – Metal Fabrications
- .8 Section 23 05 00 – Common Work Results for HVAC
- .9 Section 23 05 05 – Installation of Pipework

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-12, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-1996(2013), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2014, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 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 and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of systems supplier's installation instructions.

1.4 CLOSE-OUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Close-out Submittals.

1.5 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:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .2 Performance Requirements:
- .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
 - .1 Rod: 13 mm FM approved.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed or FM approved.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut, UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye [6] mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed or FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies: to SMACNA; submit shop drawings or SMACNA detail.

- .2 Steel brackets: to SMACNA; submit shop drawings or SMACNA detail.
- .3 Sway braces for seismic restraint systems: to Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use [22] mm or [28] mm rod.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with two (2) nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated, galvanized, or with formed portion plastic coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with two (2) springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

2.10 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

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 datasheet.

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with four (4) minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.

- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within [300] mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Follow manufacturer's recommendations.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.

- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report.
- .2 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 - ACTION AND INFORMATIONAL 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.

3.8 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 for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE

- .1 Electric heat tracing for freeze protection of piping system.

Part 2 Products

2.1 PIPE HEAT TRACING

- .1 Provide complete, CSA approved system of heat tracing on piping exposed outdoors where indicated.
- .2 The entire design and installation of the system shall comply with the Canadian Electrical Code and the requirements of the local inspection authority.
- .3 Provide all necessary materials to provide a complete system.
- .4 Use Raychem Chemelex Auto Trace self-regulating, shielded, jacketed cable type XL-TRACE (use XTV for hot water piping systems) or equal. System shall be thermostatically controlled using Chemelex Automatrix Thermostat #AMC-F5 with non-adjustable set point of 5°C [40°F] complete with 900 mm [36"] capillary.

Part 3 Execution

3.1 INSTALLATION

- .1 Install heater system in accordance with manufacturer's instructions/recommendations and these specifications.
- .2 Prior to installing heating cables, ensure the pipe systems are complete and have passed all necessary tests.
- .3 Cables to be secured to pipes using Raychem Type G554 glass cloth tape at 300 mm [12"] intervals on pipe.
- .4 Wrap all valves with a minimum of 1320 mm [52"] of heater cable. Follow manufacturer's recommendations for installation of cable around valves and flanges.
- .5 Install sensing bulb on side of pipe at least 1000 mm [40"] away from valves, flanges, pumps, etc.
- .6 After pipes are traced test all lengths prior to insulation of pipe insulation.
- .7 Provide suitable identification for those pipe systems provided with heat tracing. At intervals of 6000 mm [20 ft], provide on outside surface of insulation an adhesive backed nameplate "Caution - Heat Tracing".

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Vibration isolation materials and components, seismic control measures and their installation.
 - .2 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including duct work, fire protection, communications, equipment and systems, both vibration isolated and statically supported.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 35 29.06 – Health and Safety Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .5 Section 22 05 00 – Common Work Results for Plumbing
 - .6 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2013, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) - 2010

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Provide detailed drawings of seismic control measures for equipment and piping.

- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of system supplier's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle 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 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for 100% relative humidity installations.
- .4 Colour code springs.

2.3 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Performance: as indicated.

2.4 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

2.5 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.6 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.7 STRUCTURAL BASES

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.

2.8 INERTIA BASE

- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.
- .3 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.9 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Seismic control systems to work in every direction.
 - .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .3 Drilled or power driven anchors and fasteners not permitted.
 - .4 No equipment, equipment supports or mounts to fail before failure of structure.
 - .5 Supports of cast iron or threaded pipe not permitted.
 - .6 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Suspended equipment:
 - .1 Use one or more of following methods, depending upon site conditions, or as indicated:
 - .1 Install tight to structure.
 - .2 Cross brace in every direction.
 - .3 Brace back to structure.
 - .4 Cable restraint system.
 - .3 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

- .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .3 As indicated.
- .4 Piping systems:
 - .1 Fire protection systems: to NFPA 13.
 - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .3 Compatible with requirements for anchoring and guiding of piping systems.
 - .4 To SMACNA Guidelines.
- .5 Bracing methods:
 - .1 Approved by Departmental Representative.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

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 datasheet.

3.2 INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

- .7 Provide lateral brace on piping systems at every 12m and longitudinal brace at every 24m minimum. Allow for thermal expansion.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative within three (3) days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC system[s] after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Take vibration measurements for equipment as indicated.
 - .3 Provide Departmental Representative with notice 24h in advance of commencement of tests.
 - .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
 - .5 Submit complete report of test results (including sound curves).

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 Waste Management: separate waste materials for 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 SUMMARY

- .1 Section Includes:
 - .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including duct work, fire protection, communications, equipment and systems, both vibration isolated and statically supported.
- .2 Related Requirements
 - .1 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .2 Section 01 33 00 – Submittal Procedures
 - .3 Section 01 78 00 – Close-out Submittals
 - .4 Section 22 05 00 – Common Work Results for Plumbing
 - .5 Section 23 05 00 – Common Work Results for HVAC
 - .6 Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA G40.20/G40.21-[13], General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 National Building Code of Canada (NBC) - [2010]

1.3 DEFINITIONS

- .1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: acronym for Seismic Restraint System.

1.4 DESCRIPTION

- .1 SRS fully integrated into, and compatible with:
 - .1 Noise and vibration controls specified elsewhere.
 - .2 Structural, mechanical, electrical design of project.
- .2 Systems, equipment not required to be operational during and after seismic event.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .4 Designed by Professional Engineer specializing in design of SRS and registered in Province of British Columbia.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
- .3 Submit design data including:
 - .1 Full details of design criteria.
 - .2 Working drawings (prepared to same standard of quality and size as documents forming these tender documents), materials lists, schematics, full specifications for components of each SRS to be provided.
 - .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
 - .4 Separate shop drawings for each SRS and devices for each system, equipment.
 - .5 Identification of location of devices.
 - .6 Schedules of types of SRS equipment and devices.
 - .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
 - .8 Installation procedures and instructions.
 - .9 Design calculations including restraint loads to NBC and Supplement.
 - .10 Detailed work sheets, tables. Simplified, conservative assumptions may be acceptable.
 - .11 Detailed design of SRS including complete working drawings prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, specifications.
- .4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
 - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle 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 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SRS MANUFACTURER

- .1 SRS from one manufacturer regularly engaged in SRS production.

2.2 GENERAL

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
 - .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
- .7 Seismic control measures not to interfere with integrity of firestopping.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

- .1 Floor-mounted equipment, systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure.

- .2 Cross-brace in every direction.
- .3 Brace back to structure.
- .4 Slack cable restraint system.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

- .1 Floor mounted equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers.
 - .2 Vibration isolators and separate snubbers.
 - .3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.
 - .2 SRS to resist complete isolator unloading.
 - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
 - .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.

2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

2.6 SERVICE UTILITIES ENTRANCE INTO BUILDING AND AT FLEXIBLE JOINTS

- .1 Provide flexibility to prevent breakage in the event of earthquake activity.
- .2 Provide flexibility to allow for thermal expansion.

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 datasheet.

3.2 INSTALLATION

- .1 Attachment points and fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
 - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
 - .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
 - .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
 - .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
 - .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .3 Install SRS at least 25 mm from equipment, systems, services.
- .4 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.
- .6 Vertical tanks:
 - .1 Anchor through house-keeping pad to structure.
 - .2 Provide steel bands above centre of gravity.
- .7 Horizontal tanks:
 - .1 Provide at least two straps with anchor bolts fastened to structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

- .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at [25]% and [60]% completion stages.
 - .4 Upon completion of installation.
- .3 Submit manufacturer's reports to Departmental Representative within [3] days of manufacturer representative's review.
- .2 Inspection and Certification:
 - .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
 - .2 Provide written report to Departmental Representative with certificate of compliance.
- .3 Commissioning Documentation:
 - .1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built" conditions.

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 Waste Management: separate waste materials for 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 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 74 21 – Waste Management and Disposal
 - .3 Section 09 91 23 – Interior Painting

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-[97], Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-[92], Identification of Piping Systems.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-[2013], Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-[2003], Standard for the Installation of Standpipe and Hose Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle 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 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Dispose of unused paint and coating material at official hazardous material collections site approved by Departmental Representative.
 - .3 Do not dispose of unused paint and coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # [5].
 - .2 Equipment in Mechanical Rooms: use size # [9].
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.
 - .3 Terminal cabinets, control panels: size #5.
 - .3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.

- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive [plastic-coated cloth] [vinyl] with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Make-up water	Yellow	MAKE-UP WTR
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

- .1 Identification in English.
- .2 Use one nameplate and label for each language.

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 datasheet.

3.2 TIMING

- .1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC or CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.

- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC, Plumbing, and Fire Suppression systems.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.
- .3 Related Requirements
 - .1 Section 01 11 00 – Summary of Work
 - .2 Section 01 14 00 – Work Restrictions
 - .3 Section 01 33 00 – Submittal Procedures
 - .4 Section 01 35 00 – Special Procedures
 - .5 Section 01 35 29.6 – Health and Safety Requirements
 - .6 Section 01 45 00 – Quality Control
 - .7 Section 01 74 11 – Cleaning
 - .8 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .9 Section 01 91 13 – General Commissioning (Cx) Requirements
 - .10 Section 22 05 00 – Common Work Results for Plumbing
 - .11 Section 23 05 00 – Common Work Results for HVAC
 - .12 Section 23 05 13 - Common Motor Requirements for HVAC
 - .13 Section 25 05 00 – EMCS General Requirements

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Departmental Representative within [90] days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2014.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2003.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads Submit report with all checklists and default settings and set-points as set. Include report in the Maintenance Manual.
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions, for each phase of the project.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of each project phase.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 START OF TAB

- .1 Notify Departmental Representative seven (7) days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .3 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .4 Application of weatherstripping, sealing, and caulking.
 - .5 Pressure, leakage, other tests specified elsewhere Division 23.
 - .6 Provisions for TAB installed and operational for each phase.
 - .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Air HVAC systems: plus 5 %, minus 5 %.
 - .2 Hydronic systems: plus or minus 5%.

1.11 ACCURACY TOLERANCES

- .1 Measured values accurate to within plus or minus 2% of actual values.

1.12 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within three (3) months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.15 TAB REPORT

- .1 Format in accordance with Section 01 33 00 – Submittal Procedures.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit two (2) copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.

- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.19 AIR SYSTEMS

- .1 Do TAB of components specified in Division 23.
- .2 Standard: TAB to most stringent of this section.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct size, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, and run-out (or grille, register or diffuser).

1.20 WATER SYSTEMS

- .1 Do TAB of components specified in Division 22 and 23.
- .2 Standard: TAB to most stringent of this section.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: water quality, water velocity, static pressure, flow rate, pressure drop (or loss),

temperatures (inlet and outlet for equipment), RPM, electrical power, voltage, noise, vibration.

- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Cooling Towers: Outlet of cooling tower dampers, spray pump, fan, other equipment causing changes in conditions.
 - .2 Pumps: pump operating parameters (flow, head), pressure drop at inlet strainer, suction guide and discharge valves, minimum flow set-points.
 - .3 Existing chillers: inlet and outlet flows, pressure drops, minimum flow set-points.
 - .4 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: piping mains, new main branches, new sub-branches, new run-outs to equipment.

1.21 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times during both winter and summer design conditions.
- .3 Control systems
 - .1 Coordinate and work with Controls Contractor to measure and establish operating points, minimum flow, and various mode set-points
- .4 Measurement of noise and vibration from equipment specified in Division 23.
 - .1 TAB procedures:
 - .1 All air conditioning units.
 - .2 Cooling Towers
 - .3 Pumps.
 - .4 Motors over 7.5 HP.
- .5 Measurement of spatial noise and vibration :
 - .1 TAB procedures:
 - .1 At fence for the Chemical Storage.
 - .2 At building – location closest to the cooling towers.

1.22 POST-OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in Chemical Storage Building.
- .2 Measure flows and pressure drops at all cooling towers, pumps, and existing chillers.

- Confirm minimum water flows for all equipment Including existing chillers).
- .3 Participate in systems checks twice during Warranty Period - #1 approximately three (3) months after acceptance and #2 within one (1) month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and methods for pressure testing ducts over 5m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 35 29.06 – Health and Safety Requirements

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 2011.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three (3) months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
 - .2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.

- .6 Manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning on-site installations in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .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.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- [3] % of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .5 Re-calibrated every six (6) months thereafter.

2.2 EQUIPMENT LEAKAGE TOLERANCES

- .1 Equipment and system components leakage: 5%.

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 datasheet.

3.2 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 2%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

- .1 Test ducts before installation of insulation or other forms of concealment.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services.
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: 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, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
- .4 Obtain reports, within three (3) days of review, and submit, immediately, to Departmental Representative.
- .2 Performance Verification:
 - .1 Departmental Representative to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 CLEANING

- .1 Upon 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 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 23 05 00 – Common Work Results for HVAC.
- .6 Section 23 05 29 – Hangers and Support for HVAC Piping and Equipment

1.2 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-10, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ASTM International Inc.
 - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C547-15, Standard Specification for Mineral Fiber Pipe Insulation.
 - .4 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .5 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 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 and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
- .4 Samples:
 - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12 mm plywood board.
 - .3 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations, special handling criteria, installation sequence and cleaning procedures.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, and have at least three (3) years successful experience in this size and type of project, qualified to standards.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for re-use and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction / Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
 - .1 Maximum VOC limit 50g/L to SCAQMD Rule 1168.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Tape: self-adhesive, aluminum, reinforced, 50mm wide minimum.

- .4 Contact adhesive: quick-setting
 - .1 Maximum VOC limit 50g/L to SCAQMD Rule 1168.
- .5 Canvas adhesive: washable.
 - .1 Maximum VOC limit 50g/L to SCAQMD Rule 1168.
- .6 Tie wire: 1.5mm stainless steel.
- .7 Banding: 19mm wide, 0.5mm thick stainless steel.
- .8 Facing: 25mm galvanized steel hexagonal wire mesh stitched on both faces of insulation.
- .9 Fasteners: 4mm diameter pins with 35mm diameter square clips, length to suit thickness of insulation.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use two (2) layers with staggered joints when required nominal thickness exceeds 75mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum [2] rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	[C-1]	[yes]	[50]
Round cold and dual temperature supply air ducts	[C-2]	[yes]	[50]
Rectangular warm air ducts	[C-1]	[no]	[25]
Round warm air ducts	[C-1]	[no]	[25]
Supply, return and exhaust ducts exposed in space being served	[none]		
Acoustically lined ducts	[none]		

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	TIAC Code	TIAC Code
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

3.5 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 for 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 SUMMARY

- .1 Section includes:
 - .1 Thermal insulation for piping and piping accessories in commercial type applications.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 35 29.06 – Health and Safety Requirements
 - .3 Section 01 61 00 – Common Product Requirements
 - .4 Section 01 74 11 – Cleaning
 - .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .6 Section 22 05 00 – Common Work Results for Plumbing
 - .7 Section 23 05 00 – Common Work Results for HVAC
 - .8 Section 23 05 05 – Installation of Pipework

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-10, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric].
 - .2 ASTM C335-10, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2011, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2011, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-2013, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-2010, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-10, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
 - .3 "OUTDOOR" – will mean outdoor exposed piping – not buried
 - .4 "BURIED" – outdoor pre-insulated piping – see Pre-insulated Piping Section.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available one (1) copy of systems supplier's installation instructions.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least three (3) years successful experience in this size and type of project, qualified to standards of TIAC.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC – S702.
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to ASTM C533.
 - .2 Maximum "k" factor: to CAN/ULC – S702.
 - .3 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, [50] mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: [1.5] mm diameter stainless steel.
- .5 Bands: stainless steel, [19]mm wide, [0.5] mm thick.

2.4 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.5 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.6 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.7 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: white.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 2 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Special requirements:
 - .1 Outdoor: UV rated material at least [0.5] mm thick.

- .2 ABS Plastic:
 - .1 One-piece moulded type with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint by Departmental Representative.
 - .3 Minimum service temperatures: -40 degrees C.
 - .4 Maximum service temperature: 82 degrees C.
 - .5 Moisture vapour transmission: 0.012 perm.
 - .6 Thickness: [0.75] mm.
 - .7 Fastenings:
 - .1 Solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .8 Locations:
 - .1 For outdoor use ONLY.
- .3 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.

2.8 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

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 datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.

- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: PVC, high temperature fabric.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturer's instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: [A-1].
 - .1 Securements: tape and SS bands at [300] mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: [A-3].
 - .1 Securements: tape and SS bands at [300] mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: [A-6].
 - .1 Insulation securements: tape and SS bands at [300] mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: [C-2] with vapour retarder jacket.
 - .1 Insulation securements: tape and SS bands at [300] mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: [A-2].
 - .1 Insulation securements: tape and SS bands at [300] mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.

- .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			Run out to 2 (50) (up to 3 m long)	to 1 (25)	1 1/4 to 2 (32 to 50)	2 1/2 to 4 (65 to 100)	5 (125) and Larger
Domestic HWS and Recirculation		[A-1]	25	25	25	38	38
Condenser Water Outdoors		[A-3].		75	75	75	75
Condenser Water Indoors		[A-3]	50	50	50	50	50
Domestic CWS		[A-3]	25	25	25	38	38
Domestic CWS with vapour retarder		[C-2]	25	25	25	38	38
Refrigerant (hot gas, liquid and suction)	4 - 13	[A-6]	25	25	38	38	38
Refrigerant (hot gas, liquid and suction)	below 4	[A-6]	25	25	38	50	50
RWL and RWP		[C-2]	25	25	25	25	25

- .8 Finishes:
 - .1 Exposed indoors: canvas.
 - .2 Exposed in mechanical rooms: canvas.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Outdoor: Aluminum jacket.
 - .6 Finish attachments: SS bands, at 150 mm on centre. Seals: wing.
 - .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 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 for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 GENERAL

- .1 Provide thermal insulation on all piping, valves, fittings and radiant ceiling panels, as called for and as scheduled. Note items listed that do not require insulation.
- .2 Journeyman insulation applicators, skilled in this trade, shall perform the work.
- .3 Be responsible for ensuring that sufficient space is always provided to allow proper installation of insulation materials.
- .4 As applicable, use the latest edition of the "B.C. Insulation Contractors Association (BCICA) Quality Standards Manual", as a reference standard if sufficient detail/information is not contained herein.

1.3 REGULATORY REQUIREMENTS

- .1 Flame spread ratings and smoke developed classifications shall be as required by the 1998 B.C. Building Code and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50.
- .2 Insulation thickness and insulating values shall be in accordance with NRC Model National Energy Code of Canada for Buildings (MNECB).

1.4 QUALIFICATIONS AND SAMPLES

- .1 Submit, for approval, substantiating manufacturer's documentation (and samples when requested) for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.
- .2 Submit, for approval, samples of each type of firestopping, smoke seal and accessory.

1.5 DEFINITIONS

- .1 "CONCEALED" insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings (services in tunnels are not considered to be concealed.)
- .2 "EXPOSED" will mean not concealed.

1.6 ASBESTOS INSULATING MATERIALS

- .1 When insulating materials containing asbestos are being removed, the work shall be carried out in accordance with the authorities having jurisdiction, including Ministry of Environment and the Workers Compensation Board of British Columbia and by contractors experienced in this specialty.
- .2 All work performed on systems with asbestos insulation must be reported to W.C.B. before work commences.

1.7 CONNECTIONS TO EXISTING PIPING

- .1 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping.

1.8 HEAT TRACED PIPING

- .1 All piping, subject to freezing is specified to be heat traced by Division 26. Insulation shall cover heat tracing.

Part 2 Products

2.1 PREFORMED PIPE COVERING

- .1 Mineral Fibre - Low and Medium Temperature:
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal conductivity at 24°C - 0.033 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Manson Alley K, Owens Corning SSL-11, Knauf 850 ASJ/SSL, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL.
- .2 Calcium Silicate - High Temperature:
 - .1 Without integral jacket.
 - .2 Thermal Conductivity at 93°C - 0.059 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Manson Cal Silite, Johns Manville Thermo-12.
- .3 Perlite Insulation - High Temperature:
 - .1 Without integral jacket.
 - .2 Thermal Conductivity at 90°C - 0.071 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Knauf Temperlite 1200.

- .4 Mineral Fibre - High Temperature:
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal Conductivity at 93°C - 0.040 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Manson Alley Kapt, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL, Roxul ASJ/SL.
- .5 Flexible Foamed Elastomeric:
 - .1 Thermal Conductivity at 24°C - 0.040 W/m/deg.C.
 - .2 Acceptable Products:
 - .1 AP Armaflex, Rubatex R-180-FS.
- .6 Flexible Closed Cell:
 - .1 Thermal Conductivity at 24°C - 0.036 W/m/deg.C.
 - .2 Acceptable Products:
 - .1 Bondtex Polyethylene, Therma-Cel.
- .7 Phenolic closed cell – rigid:
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal conductivity @ 24°C - 0.019 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Kingspan Koolphenk

2.2 FIRE STOPPING AND SMOKE SEAL MATERIALS

- .1 References:
 - .1 CAN4-S115-M, Standard Method of Fire Tests of Firestop Systems.
 - .2 ASTM E814 Standard Method of Fire Tests and Through-Penetration Firestops.
 - .3 1997 Certifications Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).
 - .4 Underwriters Laboratories of Canada. Listing of Equipment and Materials Vol. 3 Fire Resistance Ratings -Revision 4/95.
- .2 Work Included:
 - .1 Furnish all labour, material, equipment and services necessary to supply and install firestopping and smoke seals around mechanical service piping and duct penetrations through fire rated wall and floor assemblies, as indicated and as specified.

- .3 Quality Assurance:
 - .1 The work of this section shall be carried out only by an approved specialist firm, employing skilled tradesmen experienced in firestopping and smoke seal application and approved, licensed and supervised by the manufacturer of fire stopping materials.
 - .2 All work to be of the highest quality according to best trade practice and in strict accordance with manufacturer's printed specifications.
- .4 Submittals:
 - .1 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation.
 - .2 Submit manufacturers' product data for materials and prefabricated devices. Include assembly/location design system number references with copies of test information. Construction details should accurately reflect actual job conditions.
 - .3 For building assemblies which do not correspond to any previously tested and rated assemblies, submit proposals based on related designs using accepted fireproofing design criteria.
- .5 Materials:
 - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC CAN4-S115 and not to exceed opening sizes for which they are intended.
 - .2 Service penetration assemblies and design numbers: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19. 1997 Certification Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).
 - .3 Service penetration firestop components: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC or equivalent approved tests by Warnock Hersey.
 - .4 Fire resistance rating of installed fire stopping assembly shall be not less than the fire resistance rating of surrounding floor and wall assembly.
 - .5 Acceptable Products:
 - .1 DOW FS 2000/2001, Tremco Fyre-Sil, 3M 1000 silicone, 3M CP25WB, Firestop Systems 4800DW, Nuco Self Seal Fire Stops.

2.3 ACCESSORIES

- .1 Insulation Fastenings:
 - .1 1.6 mm [16 ga.] galvanized wire or 1.6 mm thick copper wire as commercially available.

- .2 Jacket Fastenings:
 - .1 Thermocanvas and All Service:
 - .1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.
 - .2 Metal Jackets:
 - .1 Sheet metal screws, pop rivets, bands.
 - .3 PVC Jacket and Fitting Covers:
 - .1 PVC self-adhesive tape, plastic pop rivets, bonding cement.
- .3 Adhesives:
 - .1 Flexible elastomeric and flexible closed cell insulation adhesive:
 - .1 Armstrong 520, Therma-Cel 1590, RubatexR-373, Zipcoat 8A.
 - .2 Vapour barrier jacket adhesive:
 - .1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20.
 - .3 Fabric adhesive, to insulation pipe covering:
 - .1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag.
- .4 Coatings:
 - .1 Vapour barrier coating on reinforcing membrane or on insulating cement:
 - .1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36.
 - .2 Childers CP-30 (refrigeration suction lines only).
 - .2 Flexible elastomeric and flexible closed cell insulation finish coating:
 - .1 Armstrong, Bakelite 120-13, Rubatex, Zipcoat.
- .5 Finish Jackets:
 - .1 Thermocanvas Jacket:
 - .1 Fattal's Thermocanvas, Robson Flamex FR Canvas or Tai-Can Canvas.
 - .2 All Service Jacket (with 0.03 mm [0.0019"] minimum thick foil):
 - .1 Fattal's Fat-Lock ASJ, Fiberglass ASJ, Knauf ASJ, Kingspan ASJ, Manson APT, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ.
 - .3 PVC Finishing Jacket (minimum 0.50 mm [0.02"] thick):
 - .1 Proto PVC, Speedline PVC, Zeston PVC.
 - .4 Aluminum Jacket:
 - .1 0.51 mm [22 ga.] thick corrugated or smooth aluminum jacketing with longitudinal slip joints and 50 mm [2"] end laps with factory applied protective liner on interior surface.
 - .1 Childers, Alco Thermoclad 1 or other as commercially available.

- .6 Reinforcing Membrane:
 - .1 Glass reinforcing membrane as commercially available.
- .7 Insulating Cement:
 - .1 Fibrex Superkote, Partek No. 1, Ryder Thermokote MW high temperature.
- .8 Finishing Cement:
 - .1 Ryder Thermokote 1 FW.
- .9 Flexible Insulation:
 - .1 Manson Alley-Wrap, Owens Corning AF 300 Series, Knauf Plain Wrap, Johns Manville Microlite, Roxul Wrap (RW).
- .10 Preformed Fitting Covers:
 - .1 Aluminum Fitting Covers:
 - .1 0.51 mm [22 ga.] thick, die shaped components with factory applied protective liner on interior surface.
 - .1 Childers Ell-Jacs, Perma-Ells or Shield-Ells or other as commercially available.
 - .2 PVC Fitting Covers:
 - .1 0.50 mm [0.020"] thick premoulded one piece covers.
 - .1 Certainteed Snapform, Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC.
- .11 Preformed Insulation fittings:
 - .1 Shur-Fit, Moulded Acoustic Products or from insulation fabricators.

2.4 SCOPE OF INSULATION

- .1 Heating Pipe, Fittings and Valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Hot water heating supply and return piping.
 - .2 Steam piping.
 - .3 Condensate piping.
 - .4 Boiler feed water piping.
 - .5 Antifreeze heating supply and return piping.
 - .6 Condenser water piping, outside building.
 - .7 Cooling tower sump, spray water, drain, overflow and chemical feed piping, outside building.
 - .8 Heat pump water piping, outside building.
 - .9 Flexible branch connections to ceiling radiant heat panels.

- .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping located within perimeter heating enclosures.
 - .2 Relief piping.
 - .3 Drain lines.
 - .4 Small branch risers to terminal heating elements just above floor level, from 150 mm [6"] below floor slab up to heating element.
 - .5 Flexible interconnections between ceiling radiant heating panels.
 - .6 Condenser water piping inside building.
- .3 Insulate the following valves and fittings if the pipe is insulated:
 - .1 Elbows, tees, reducers.
 - .2 Valve bodies on valves and check valves, over NPS 2-1/2".
 - .3 Flanges.
 - .4 Strainers.
- .4 The following hot pipe fittings that operate at 60° C [140° F] shall be coated with Thermalite –SG as per manufacturer's specifications to prevent skin burns:
 - .1 Valves, NPS 2-1/2" and smaller.
 - .2 Valve bonnets.
 - .3 Unions.
 - .4 Drip legs.
 - .5 Steam pressure reducing valves.
 - .6 Steam traps.
 - .7 Flexible connections.
 - .8 Expansion joints.
 - .9 Check valve covers.
- .2 Refrigerant piping, fittings and valves:
 - .1 Insulate and vapour seal the following systems, unless otherwise noted:
 - .1 Refrigerant suction piping for comfort cooling.
 - .2 Refrigerant suction piping for product refrigeration.
 - .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Drain lines for sumps 15°C [60°F] and over.
 - .3 Insulate and vapour seal the following fittings, if the pipe is insulated:
 - .1 Elbows, tees, reducers.
 - .2 Valves, (bodies and bonnets) except check valve covers.
 - .3 Strainers.
 - .4 Flanges.
 - .5 Unions.

- .3 Plumbing pipes, fire suppression pipes, fittings, valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Domestic cold water system.
 - .2 Domestic hot water supply and recirculation piping.
 - .3 Domestic tempered water supply and recirculation piping.
 - .4 Water valves, flanges, PRV's, strainers, check valves.
 - .5 Interior hose bibb supply piping.
 - .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping used exclusively for fire protection (unless in unheated spaces).
 - .2 Soil stacks, vents, etc.,
 - .3 All special service piping, e.g. gas, compressed air, etc.
 - .4 Unions.
 - .5 Flexible connections or expansion joints (unless noted on the drawings).
 - .6 Check valve covers.
 - .7 Strainer leg and basket covers.
 - .8 Flexible fixture connections.
- .4 Pipe penetrations through walls and floors:
 - .1 All material for the stuffing, sealing and caulking of the pipe penetration shall be supplied and installed under this section.

2.5 PIPE INSULATION THICKNESS TABLE - MM [INS]

Service	NOMINAL PIPE SIZE (NPS)					
	Design Operating Temperature	Runouts 2 and less (note 1)	1 and less	1 ¹ / ₄ to 2	2 ¹ / ₂ to 4	5 and larger
Condenser Water Inside Bldg.	30°C [86°F]	None	None	None	none	None
Condenser Water Outside Bldg.	30°C [86°F]	N/A	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Cooling Tower Sump Spray Water Piping, Drain, Overflow, Chemical Feed (Outside Bldg.)	32 °C [90 °F]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Refrigerant Suction and Hot Gas	5°C [40°F] or lower	25 [1]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Condensate (gravity)	100°C [212°F]	25 [1]	40 [1.5]	40 [1.5]	50 [2]	50 [2]
Domestic Cold Water	5°C [40°F]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]

Service	NOMINAL PIPE SIZE (NPS)					
	Design Operating Temperature	Runouts 2 and less (note 1)	1 and less	1 ¹ / ₄ to 2	2 ¹ / ₂ to 4	5 and larger
Domestic Hot & Tempered Water Supply and Recirculation	40-70 °C [105-160°F]	25 [1]	25 [1]	25 [1]	40 [1.5]	40 [1.5]

Note 1: Runouts to individual terminal units not to exceed 3.7 m [12 ft] in length.

Note 2: All piping forming part of the HVAC system or plumbing domestic hot water or domestic hot water recirculation piping, and located outside the building envelope (including piping located within unheated areas of the building such as underground parking levels) shall be insulated for the level specified in the Table for steam piping at pressures 334 kPa [121 psig] and greater.

Part 3 Execution

3.1 APPLICATION

- .1 Apply insulation to piping only after all tests have been made and systems accepted by Consultant as tight.
- .2 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform in diameter, smooth in finish, pleasing to the eye and with the longitudinal seams positioned to be concealed from view. Apply piping insulation materials, accessories and finishes in accordance with manufacturer's recommendations.
- .3 On piping NPS 2-1/2 and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than the length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
- .4 Insulation and vapour barrier shall be continuous through all non-rated separations.

3.2 INSULATION TERMINATION POINTS

- .1 Terminate insulation 75 mm [3"] back from all uninsulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth and vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed, hot services terminate insulation 75mm [3"] back from all uninsulated fittings, cut off at 90° and apply reinforced scrim cloth and breather mastic system.
- .2 Cut back insulation at 45° and finish with a silicone caulking sealant around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.3 VERTICAL RISERS

- .1 On vertical pipe over 75 mm [3"] provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 4.5 m [15 ft.] centres.

3.4 HOT APPLICATION 26.7°C [80°F] AND OVER

- .1 Piping:
 - .1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling the flap, with spreading staples at 75 mm [3"] centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints and secure with spreading staples.
- .2 Fittings:
 - .1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of the pipe insulation mitred to fit tightly, or with preformed insulation fittings (Shur-Fit) or from insulation fabricator.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation or insulate with preformed insulation fittings (Shur-Fit) or from insulation fabricator. Drains, blowoff plugs and caps shall be left uncovered.
- .4 Flanges and Victaulic Fittings:
 - .1 Do not insulate flanges on condenser/heat pump water piping inside the building.
 - .2 Insulate flanges on condenser/heat pump water piping outside the building.
 - .3 Insulate flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe insulation. Insulation to overlap adjoining insulation at least 75 mm [3"].

3.5 COLD APPLICATION 10°C [50°F] AND LESS

- .1 Piping:
 - .1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing the jacket flap. Seal all flaps with vapour barrier adhesive. Pipe insulation with integral self-sealing vapour barrier jackets will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50 percent for insulation O.D. 300 mm [12"] and above apply strips on 250 mm [10"] centres for additional securement.
- .2 Fittings:
 - .1 Insulate fittings to thickness of adjacent pipe insulation with sections of the pipe insulation mitred to fit tightly, or preformed insulation fittings (Shur-Fit), then apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.

- .2 Alternatively insulate fittings with tightly placed flexible insulation and apply premoulded 25/50 rated PVC fitting covers. Apply vapour-barrier adhesive and tape on all joints and overlaps.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies, bonnets and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation, then apply reinforcing membrane embedded in barrier coating. Alternately, insulate with preformed insulation fittings (Shur-Fit) covered with reinforcing membrane, stapled in place and covered with a barrier coating. Drains, blow-off plugs and caps shall be left uncovered.
- .4 Unions, Flange and Victaulic Fittings:
 - .1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe covering, then apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.

3.6 ANTI-SWEAT COATING

- .1 Coat with an anti-sweat coating - "No Sweat" by Robson Thermal Mfg. Ltd. or approved alternate the following uninsulated cold surfaces:
 - .1 Connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc.
- .2 The coating thickness shall be as recommended by the coating manufacturer for the system operation conditions.

3.7 PIPE INSULATION FINISHES

- .1 "Concealed" insulation in horizontal and vertical service spaces will require no further finish.
- .2 "Concealed" pipe insulation in damp locations, e.g. pipe trenches shall have a vapour barrier jacket, vapour sealed.
- .3 "Exposed" flexible insulation shall be painted with a heavy brush coating of foam plastic white insulation coating.
- .4 "Exposed" insulation inside the building shall be finished as follows:
 - .1 Premium Finish:
 - .1 Over a factory applied integral all-service type jacket on the pipe insulation, apply PVC jacket.
 - .2 Over insulated fittings apply PVC fitting covers. Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement.

- .3 Finish fabric with one (1) coat of fabric coating.
- .2 Economy Finish:
 - .1 Apply pipe insulation with an integral all-service type jacket. Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately secure jacketing longitudinal joint using integral self-sealing lap. Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50 percent. For insulation O.D. 300 mm [12"] apply strips on 250 mm [10"] centres for additional securement. PVC, especially, .020" thick should not be used as a vapour barrier alone. Should have 'ASJ' or mastic system under it. Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.
 - .2 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic. Over insulated valve bodies, valve bonnets, strainers and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with the reinforced mastic system on irregular surfaces.
- .3 "Exposed" outdoor insulation shall be finished as follows:
 - .1 Insulation shall have a vapour sealed vapour barrier jacket.
 - .2 Over the pipe insulation jacket apply aluminum weather protecting jacket. The longitudinal seam shall be located to shed water. Secure the jacket using necessary metal banding on approximately 250 mm (10") centres and at the overlaps. Screws are not permitted on cold operating systems, since they will penetrate the vapour barrier.
 - .3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fittings to provide a complete jacket system. Secure with necessary fastenings.
 - .4 Seal all outdoor jacketing watertight.

3.8 REFRIGERATION SUCTION PIPING OUTSIDE BUILDING

- .1 Install flexible foamed elastomeric or flexible closed cell preformed piping insulation. Secure longitudinal and butt joints with adhesive. Insulate all fittings and components. To obtain the specified thickness, apply in layers with staggered joints.
- .2 Finish with flexible elastomeric or flexible closed cell insulation coating.

3.9 FIRE STOPPING AND SMOKE SEALS

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
- .2 Maintain insulation around pipes penetrating fire separation only as permitted by Firestop Assembly Listing.

- .3 Submit Certificate of Inspection (Form MF173) that all work is complete and in accordance with the specified requirements before Substantial Completion.

3.10 INSULATION PACKING OF PIPE SLEEVES

- .1 Tightly pack the space between all pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation - Thermal Ceramics "Cerafiber" or Carborundum "Fiberfax" to full depth of sleeve to prevent transmission of sound and/or passage of smoke.

END OF SECTION

Information Required for Refrigeration Systems at Federal Facilities

Information to be Completed for all Forms

Name of Institution:				Equipment location:			
Make:				Model:			
Serial Number				Type of Halocarbon			
Halocarbon Charging Capacity of System (kg or lbs) <small>must include piping charge once installed</small>						Cooling Capacity (kW, BTU/hr or tons):	
Circuit 1	Circuit 2	Circuit 3	Circuit 4	Circuit 5	Total		
Name of Certified Person:				Certificate Number: BC# (provide copy of certificate)			

System Leak Test, Service and Commissioning Log

Was the System Leak Tested:				Date Leak Tested:			
Was a Leak Detected:				Date Leak Detected:			
Was the Leak Repaired and another leak test performed:				Date Leak Repaired:			
Was the System Isolated Pending Repairs:				Refrigerant Charge Capacity of Leaking Circuit:			
Halocarbons Charged during Service		Final Halocarbon Charge Following Service (kg or lbs)					
		Circuit 1	Circuit 2	Circuit 3	Circuit 4	Circuit 5	Total
Comment:							
Quantity of Halocarbon Recovered:				Date of Recovery:			
Quantity of Halocarbon Released*:				Date of Release:			

*For releases over 10kg/22lbs complete Halocarbon Release Report section)

Halocarbon Release Report N/A

Type of System (i.e. Air handling unit, chiller, roof top a/c, compressor, heat pump, etc.):
Circumstances Leading to the Release, Corrective Actions Taken to Prevent Subsequent Releases:

Dismantling, Decommissioning or Destruction Notice for a System N/A

Quantity of Halocarbon Recovered:		Date	
Type of System (i.e. Air handling unit, chiller, roof top a/c, compressor, heat pump, etc.):			
Final Destination of System:			

Technician Signature: _____ Date: _____

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 11 00 – Summary of Work
- .2 Section 01 33 00 – Submittal Procedures
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 07 84 00 – Firestopping
- .7 Section 22 05 00 – Common Work Results for Plumbing
- .8 Section 23 05 00 – Common Work Results for HVAC
- .9 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-[12], Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct test for every phase of work.
 - .2 Each system will be fully tested before connecting to existing system and taking over the operation.
 - .3 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .4 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Condenser loop operation.
 - .3 Control pressure failure.
 - .4 Maximum demand – condenser water loop.

- .5 Maximum cooling demand (condenser loop – process and chiller loops).
- .6 Maximum demand – Coding and Heating – Chemical Storage Building.
- .7 Cooling tower fan failure.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

1.6 CONDENSER WATER

- .1 In addition to procedures specified above, perform following:
 - .1 Add chemicals once per week as required.
 - .2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.
 - .4 Inject inhibitor into cooling tower sump.

1.7 COOLING TOWER

- .1 Test each cooling tower at multiple flow points and under fault signals and alarms.
- .2 Perform per manufacturer's recommendations.
- .3 Prove equipment capacity through testing.

1.8 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
 - .2 Check for proper operation of water hammer arrestors. Run one (1) outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

- .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.9 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- .4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.10 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate each fixture to verify drainage and no leakage.
- .5 Cleanouts: refer to Section 22 42 00 - Plumbing Fixtures.

1.11 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

1.12 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified herein.
 - .1 Include following:
 - .1 Condenser water loop,
 - .2 Tempered water loop,
 - .3 Compressed air loop,
 - .4 RO water loop,
 - .5 Condensate drainage,
 - .6 Floor drain system,
 - .7 Sprinkler system.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
 - .5 Section 07 84 00 – Firestopping
 - .6 Section 22 05 00 – Common Work Results for Plumbing
 - .7 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-[12], Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

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

Part 2 Products

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

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 datasheet.

3.2 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least four (4) weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.

- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier. Match chemicals and levels in existing facility.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design temperature (82 degrees C minimum). Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

- .5 Clean out strainers repeatedly until system is clean.
- .6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment Systems.
- .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- .8 Repeat with water at design temperature.
- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure slowly over a 48 hour period.
- .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .12 Adjust pipe supports, hangers, springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .16 Check operation of drain valves.
- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

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 Waste Management: separate waste materials for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCE STANDARDS

- .1 Do all piping system work in accordance with CAN1-B149.1 for natural gas and B.C. Code Amendments.

1.3 GAS INSPECTION

- .1 Submit to the Provincial Gas Inspection Department, drawings, applicable sections of specifications and detailed drawings as required to obtain approval for the gas installation before the work commences.
- .2 Approvals must be received prior to commencing work.

Part 2 Products

2.1 PIPE

- .1 Steel Pipe: Schedule 40 to ASTM A53-84a Grade B.

2.2 PIPE COATING

- .1 For buried gas lines:
 - .1 Factory extruded polyethylene jacket with field closures for jointing.

2.3 PIPE JOINTS

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47:1.
- .3 Flange gaskets: to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

2.4 PIPE FITTINGS - STEEL PIPE

- .1 Pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron screwed fittings (banded pattern): Class 150 to ANSI B16.3.
 - .2 Steel pipe flanges and flanged fittings: to ANSI B16.5.
 - .3 Steel butt-welding fittings: to ANSI B16.9a.

- .4 Unions, malleable iron, brass to iron ground joint type: to ANSI B16.3.
- .5 Bolts and Nuts: to ANSI B18.2.1 and ANSI B18.2.2.

2.5 GAS VALVES

- .1 NPS 2 and under, screwed.
- .2 NPS 2-1/2 and over, flanged.
- .3 Suitable for the temperature to which exposed.
- .4 Certified by Canadian Gas Association (CGA).
- .5 Acceptable Manufacturers:
 - .1 Crane F9202 (Ball Valve), Emco, Homestead, Kitz 68 (Ball Valve) Mueller, Newman Milliken, Toyo 5044C (Ball Valve), Wallaceburg

Part 3 Execution

3.1 PIPING

- .1 Install natural gas piping in accordance with CAN1-B149.1.
- .2 Cap off all redundant connections in Boiler room. Remove redundant piping.
- .3 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly.
- .4 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.
- .5 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .6 Slope piping down in direction of flow to low points.
- .7 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .8 Provide clearance for access for maintenance of equipment, valves and fittings.
- .9 Use dielectric type fittings where buried service enters and connects to building piping.
- .10 Joints:
 - .1 Gas service inside building - screw or weld NPS 2 and under. Weld NPS 2-1/2 and over.
 - .2 Gas service in ceiling plenums - weld all sizes.

- .3 Gas service outside building - weld all sizes below ground.

3.2 CONNECTIONS TO EQUIPMENT

- .1 Install unions or flanges in connections to all equipment and specialty components.
- .2 Arrange piping connections to allow ease of access and for removal of equipment.
- .3 Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless approved otherwise.
- .2 Install valves at all branch take-offs to isolate each piece of equipment, and as indicated.
- .3 Install valve on the main gas service entering the building. Valve to have locking lugs.

3.4 BURIED GAS PIPING PROTECTION

- .1 Heat shrink factory extruded polyethylene sleeves over bare pipe at weld
- .2 Employ an independent testing agency to test the continuity of the polyethylene jacket, once the piping is installed, using a 12,000 volt Holiday Detector.
- .3 Repair any breaks in polyethylene jacket with two layers of polyken tape.
- .4 Submit report from testing agency certifying continuity of polyethylene jacket.
- .5 Coordinate with other Divisions and lay the jacketed pipe on a 150 mm [6"] bed of fresh-water washed sand and arrange for a depth of covering of 300 mm [12"] of fresh-water washed sand.

3.5 GAS PIPING CATHODIC PROTECTION

- .1 Cathodically protect all buried natural gas piping downstream of gas meter, as required and approved by the B.C. Gas Inspection Department.
- .2 Cathodically protect all buried propane gas piping as required for natural gas, to meet the requirements of the B.C. Gas Inspection department.

3.6 TESTING

- .1 Test system in accordance with CAN1-B149.1.

- .2 Notify the Consultant and the Inspection Authority having jurisdiction, 48 hours in advance of intended test date.
- .3 Examine piping for leaks. Remake all leaking connections and joints.
- .4 Submit final gas inspection certificate.

3.7 PURGING

- .1 Purge after pressure test in accordance with CAN1-B149.1.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 21 05 05 – Common Work Results for Fire Suppression
- .7 Section 22 05 00 – Common Work Results for Plumbing
- .8 Section 23 05 00 – Common Work Results for HVAC
- .9 Section 23 05 05 – Installation of Pipe Work
- .10 Section 23 05 23.01 – Valves – Bronze
- .11 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .12 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping System

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-[11], AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .2 ASME
 - .1 ANSI/ASME B16.4-[2011], Gray-Iron Threaded Fittings Classes 125 and 250.
 - .2 ANSI/ASME B16.15-[2013], Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .3 ANSI B16.18-[12], Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-[12], Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 ASTM International
 - .1 ASTM B32-[2014], Standard Specification for Solder Metal.
 - .2 ASTM B61-[15], Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M-[2013], Standard Specification for Seamless Copper Water Tube [Metric].
 - .5 ASTM E202-[12], Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
 - .1 MSS SP67-[2011], Butterfly Valves.
 - .2 MSS SP70-[2011], Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP71-[2011], Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP80-[2008], Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP85-[2011], Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

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 hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit [2] copies of WHMIS MSDS in accordance with Sections 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .2 Indicate on manufacturer's catalogue literature the following: [valves].
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 hydronic systems for incorporation into manual.
- .3 Submit [2] copies of operation and maintenance manual and [2] copies of electronic format maintenance manual..

1.5 MAINTENANCE MATERIALS SUBMITTALS

- .1 Extra Materials:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.

- .4 Valve handles: two of each size.
- .5 Gaskets for flanges: one for every ten flanges.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial /Territorial regulations.

1.7 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 TUBING

- .1 Type A, B, C hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged ends.
- .2 Gate Valves: application: isolating equipment, control valves and pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, rising and non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel or lever.
 - .2 Elsewhere: rising stem, wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel or lever.
 - .3 Butterfly valves: application: isolating each cell or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):
 - .1 NPS 2 1/2 and over: lug type: as specified Section 23 05 17 - Pipe Welding.
 - .4 Globe valves: application: throttling, emergency bypass:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition or bronze disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Operators: handwheel or lever.
 - .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.

- .2 NPS 2 and under:
 - .1 Mechanical rooms: use flow measuring balance valves.
- .6 Drain valves: gate, Class 125 per Section 23 05 23.01 - Valves - Bronze.
- .7 Bypass valves on globe valves NPS [8] and larger: NPS [3/4], globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
- .8 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class [125], swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .9 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .10 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

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 hydronic systems 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 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

3.4 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install gate, ball, or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves in by-pass around control valves as indicated.
- .5 Install silent check valves on discharge of pumps, in vertical pipes with downward flow, and as indicated.
- .6 Install swing check valves in horizontal lines and as indicated.
- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.
- .8 Install ball valves for glycol service.
- .9 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 CIRCUIT BALANCING VALVES

- .1 Install flow measuring balancing valves for balancing purpose.
- .2 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.6 FLUSHING AND CLEANING

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test - refer to Section 23 08 02.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- .4 Refill system and chemically treat.

- .5 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.7 FILLING OF SYSTEM

- .1 Refill system with [clean water adding water treatment as specified] [glycol].

3.8 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
 - .2 For glycol systems, retest after cleaning. Repair leaking joints, fittings or valves.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus [5]% of design output.
 - .2 Refer to Section 23 05 93 for applicable procedures.

3.9 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 for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 21 05 05 – Common Work Results for Fire Suppression
- .7 Section 22 05 00 – Common Work Results for Plumbing
- .8 Section 23 05 00 – Common Work Results for HVAC
- .9 Section 23 05 05 – Installation of Pipe Work
- .10 Section 23 05 23.01 – Valves – Bronze
- .11 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .12 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping System

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11-[12], Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-[10], Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3-[2011], Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ASME B16.5-[09], Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .4 ASME B16.9-[07], Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1-[2012], Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Loded Head and Lag Screws (Inch Series).
 - .6 ASME B18.2.2-[10], Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .3 ASTM International
 - .1 ASTM A47/A47M-[99(2014)], Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-[10], Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-[84(2014)], Standard Specification for Ductile Iron Castings.

- .4 ASTM B61-[15], Standard Specification for Steam or Valve Bronze Castings.
- .5 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
- .6 ASTM E202-[12], Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 CSA International
 - .1 CSA B242-[05(R2011)], Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CSA W48-[14], Filler Metals and Allied Materials for Metal Arc Welding.
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-67-[2002a], Butterfly Valves.
 - .2 MSS-SP-70-[06], Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-[05], Gray Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-[08], Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-[02], Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

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 hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .2 Indicate on drawings:
 - .1 Components and accessories.

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 hydronic systems for incorporation into manual.
 - .1 Include special servicing requirements.

1.5 EXTRA STOCK MATERIALS

- .1 Supply spare parts as follows:
 - .1 Valve seats: [1] minimum for every ten valves, each size. Minimum one.
 - .2 Discs: [1] minimum for every ten valves, each size. Minimum one.
 - .3 Stem packing: [1] minimum for every ten valves, each size. Minimum one.

- .4 Valve handles: [2] minimum of each size.
- .5 Gaskets for flanges: [1] minimum for every ten flanges.

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 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop [Construction Waste Management Plan] related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan [Waste Reduction Workplan] in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade [B], as follows:
 - .1 To NPS 6: Schedule 40.
 - .2 NPS 8 and over, 10.
 - .3 NPS 12 and over, 10 mm wall thickness.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape and lead-free pipe dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: raised face, weld neck to ANSI/AWWA C111/ A21.11.
- .4 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .5 Pipe thread: taper.
- .6 Bolts and nuts: to ASME B18.2.1 or ASME B18.2.2.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class [150].
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class [125].

- .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M or ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2-1/2 and larger: flanged.
- .2 Gate valves: to MSS-SP-80 - application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms : Class 125, rising stem, wedge disc, as specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 Mechanical Rooms: rising stem, wedge disc, bronze trim, as specified in Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: manual.
 - .2 Elsewhere: non-rising stem, solid wedge disc, bronze trim, as specified in Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: manual (handwheel).
- .3 Butterfly valves: to MSS-SP-67 application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):
 - .1 NPS 2-1/2 and over: lug type: as specified in Section 23 05 17 - Pipe Welding.
- .4 Globe valves: to application: throttling, emergency bypass to MSS-SP- 85:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with solid disc, as specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 With composition or bronze disc, bronze trim, as specified in Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Operators: handwheel or lever.
- .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified this section.
 - .2 NPS 2 and under:
 - .1 Use flow measuring balance valves.

- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified in Section 23 05 23.01 - Valves - Bronze.
- .7 Swing check valves: to MSS-SP-71.
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 Flanged ends: as specified in Section 23 05 23.02 - Valves - Cast Iron.
- .8 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified in Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 Flanged ends: as specified in Section 23 05 23.02 - Valves - Cast Iron.
- .9 Ball valves:
 - .1 NPS 2 and under: as specified in Section 23 05 23.01 - Valves - Bronze.
- .10 Lubricated Plug Valves
 - .1 NPS 2-1/2 and over:
 - .1 As specified in Section 23 05 23.02 - Valves - Cast Iron.

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 hydronic systems 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 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.
- .2 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 CIRCUIT BALANCING VALVES

- .1 Install flow measuring balancing valves for balancing service.

3.4 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.5 TESTING

- .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.

3.6 BALANCING

- .1 Balance water systems to within plus or minus [5] % of design output.
- .2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems.

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 for 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.

3.9 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation, and where connected to existing systems.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 05 – Installation of Pipe Work
- .8 Section 23 05 23.01 – Valves – Bronze
- .9 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .10 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping System

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-[10], Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.5-[09], Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .3 ASME B16.9-[07], Factory-Made Wrought Buttwelding Fittings.
 - .4 ASME B18.2.1-[2012], Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
 - .5 ASME B18.2.2-[10], Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .2 ASTM International
 - .1 ASTM A47/A47M-[99(2014)], Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-[10], Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-[84(2014)], Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-[15], Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-[12], Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 CSA International
 - .1 CSA W48-[14], Filler Metals and Allied Materials for Metal Arc Welding.

- .4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-67-[2002a], Butterfly Valves.
 - .2 MSS-SP-70-[06], Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-[05], Gray Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-[08], Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-[02], Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
- .5 International (European) Standards
 - .1 EN 253 - Pre-insulated bonded pipe for hot water district heating
 - .2 EN 448 - Pre-insulated fittings
 - .3 EN 488 - Pre-insulated valves
 - .4 EN 489 -Joint kits
 - .5 EN 13941 - Design and installation

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 hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.
 - .2 Indicate on drawings:
 - .1 Components and accessories.
 - .3 Mock-up
 - .1 Provide a mock-up (sample) of the following pre-insulated pipe components:
 - .1 A pie weld (weld left exposed) with min. 0.6 m [2 ft] of pipe on each end; minimum 0.3 m [1 ft] of pre-insulated insulation with jacket to remain at each end of the sample.
 - .2 A welded joint with jacket seal kit installed; sample will have min 1.5 m [5ft] of piping at each end of the joint.
 - .3 Sample of unfinished joint kit.
 - .4 Hand over mock-ups to Departmental Representative.

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 hydronic systems for incorporation into manual.

- .1 Certificate of the weld inspection.
- .2 Certificate of pressure testing.
- .3 Include special servicing requirements.

1.5 EXTRA STOCK MATERIALS

- .1 Supply spare parts as follows:
 - .1 Valve handles: [2] minimum of each size.
 - .2 Gaskets for flanges: [1] minimum for every ten flanges.
 - .3 4 Joint kits (repair joint kit).

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 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan and Waste Reduction Work Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 GENERAL

- .1 Pre-insulated piping system, to serve the closed condenser water loop, shall comply to EN 253, and consist of steel carrier pipes, pipe polyurethane foam insulation with integral copper alarm wires and outer casing of polyethylene. The materials shall be fully bonded together to form a solid unit with shear and axial strength values as specified.

1.8 REGULATORY REQUIREMENTS

- .1 All components, products and fabrication techniques shall be provided in compliance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boilers and Pressure Vessel Safety Act and Regulations".
- .2 Welding materials and labour must confirm to ASME Code.
- .3 Installation shall be performed only by licensed Contractors and licensed Welders, certified for the work being done in accordance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boilers and Pressure Vessel Safety Act and Regulations". Pressure welders, carrying appropriate Trade Certification

- Tickets, shall be used for pre-insulated mains. Trade Certification Tickets shall be available for inspection.
- .4 Provide welder's qualifications and welding procedures to Owner's Representative.
 - .5 Welder shall be prequalified by Owner's Representative and testing agent as described under Welding Inspection And Tests, prior to welding of piping system.
 - .6 Procedures and welder certification as per ASME B31.1 applies to the pre-insulated mains. There shall be no splatter, arc strikes, or centre punch marks on piping.
 - .7 Welder shall pass competence test – 3 welds each in horizontal, vertical and overhead configuration. Welds shall be acceptable to inspection authority.
 - .8 All welding on pipes, fittings, and valves to be done by personnel who have passed an approved competence test and have been certified. Gas welding or electric arc welding may be used and the type of rods and filler used shall be selected to match the base metal alloy analysis.
 - .9 Substances containing chlorine or which will decompose to hydrogen chloride (e.g. coating to prevent adhesion of weld splatter) shall not be applied to any part of the piping.
 - .10 Engage and pay for the services of the BC Boiler Inspection Branch to inspect welds. Leave welds uncovered until inspected and approved by the Boiler Inspection Branch. Provide welder certificate.
 - .11 In the event of weld rejection, the Departmental Representative has the right to insist on further testing at the Contractor's cost. Repairs will also be at the Contractor's cost.

1.9 BACKFILL MATERIAL

- .1 Type 3 Backfill material
 - .1 Selected backfill material from excavations or other sources, applied over Type 4 material.
 - .2 Material to be selected to avoid settlement.
 - .3 Compaction may be carried out using flat bed vibrator with a maximum ground pressure of 100 kPa.
- .2 Type 4 Backfill Material
 - .1 Placed around pipes – refer to detail for minimum pipe covers.
 - .2 Sand: For use as bed and surround to all buried piping, shall be clean, natural sand material, free from deleterious, hydrocarbons, loam, friable, soluble or frozen materials, and vegetable matter.
 - .3 The backfilling material shall contain no more than 2% organics.

- .3 Backfill shall be graded within the following limits.

SIEVE SIZE	% PASSING
16 mm	100
4.75 mm	60-80
1.18 mm	15 - 60
0.425 mm	5 - 20
0.150 mm	1 - 10

- .4 Uniformity (d_{60} / d_{10}) > 1.8
.5 The backfill shall be packed with a shovel and compacted by hand around pipes.
.6 Remove any supports under the pipe during backfilling and compacting.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: as follows:
- .1 EN 253 - Pre-insulated bonded pipe for hot water district heating
 - .2 EN 448 - Pre-insulated fittings
 - .3 EN 489 -Joint kits
 - .4 EN 13941 - Design and installation
 - .5 To NPS 12: Steel pipe quality according to EN 253; ERW to EN 10217.
 - .6 Dimension \leq DN 300, P235GH or P235TR1 or 2
 - .7 All other dimensions > DN300, P235 GH
 - .8 Melt analysis (max. %): C_{max} 0.16; P_{max} 0.025; S_{max} 0.020; Mn_{max} 1.20; Si_{max} 0.35
 - .9 Dimensions and Tolerances shall comply with ISO 4200.
- .2 Piping material:
- .1 Tensile strength > 350 N/mm²
 - .2 Yield stress min. 235 N/mm²
 - .3 Young's modulus 2.1 x 10⁵ N/mm²
 - .4 Elongation at break: Min. 23%
 - .5 Weld factor: V = 1.0
 - .6 Inspection certificate: EN 10204 - 3.1
 - .7 Bevelling: EN ISO 9692-1
- .3 The outer surface of the pipe shall comply to EN ISO 8501 without pitting. Prior to insulation, the outer surface of the pipe shall be cleaned so that it is free from rust, mill scale, oil, grease, dust, paint, moisture and other contaminants.

2.2 CASING

- .1 The polyethylene casing shall be black coloured PE-HD bimodal classified at least PE 80 in accordance with EN ISO 12162. The casing may be a separately manufactured pipe or be applied directly onto the insulation by extrusion.
- .2 Material properties and casing properties minimum as required in EN 253.
 - .1 Thermal stability: Calculated continuous surface temperature $\geq 50^{\circ}\text{C}$ for 30 years
 - .2 Melt from rate (MFR): Parts are fully weldable within the melt flow index: MFR variation
 - .3 Oxidation induction time (OIT): > 30 min. at 210°C .
 - .4 Resistance against crack formation: Slow crack formation (notch sensitivity) > 2000 h Rapid crack propagation, RCP (cold sensitivity) > 5 bar
- .3 Ensure optimum adhesion between outer casing and insulation using corona-treated the internal surface of polyethylene casing or equivalent procedure.

2.3 POLYURETHANE RIGID FOAM INSULATION

- .1 Polyurethane foam shall be made from polyol and isocyanate with cyclopentane as blowing agent. Hard polyurethane foam (PUR) in accordance to EN 253.
- .2 The foam shall be homogenous with properties (Minimum as required in EN 253):
 - .1 Average foam cell size ≤ 0.5 mm.
 - .2 Density ≥ 60 kg/m³
 - .3 Closed cells $> 88\%$
 - .4 Water absorption if boiled $< 10\%$ (Vol)
 - .5 Compressive strength, At 10 % deformation > 0.3 N/mm²
 - .6 Axial shear strength > 0.12 N/mm²
 - .7 Tangential shear strength > 0.20 N/mm²
 - .8 Calculated continuous operating temperature (CCOT): $> 140^{\circ}\text{C}$ for 30 years
 - .9 Max. short-term operating temperature: 150°C .
- .3 Thermal conductivity: - Traditionally manufactured pipes (50°C): 0.027 W/m K. (These values are based on an average of the continuous measurements.)

2.4 PIPE JOINTS

- .1 All welded and bonded system.
- .2 Joint kit shall comply with EN 489. The joint kit installed shall be power transmitting, double water sealed system with 100% cross linked PE thermally shrinkable material. Joint kits to be BX type.
- .3 Flanges: raised face, weld neck to ANSI/AWWA C111/ A21.11.
- .4 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .5 Bolts and nuts: to ASME B18.2.1 or ASME B18.2.2.

2.5 PIPING DIMENSIONS

- .1 Piping dimensions per the following table:

Nominal pipe diameter	Pipe outside diameter (OD)	Pipe wall thickness	Jacket OD	Min. Jacket thickness
mm	mm	mm	mm	mm
50 (2")	60.3	2.9	125	3
65 (2½")	76.1	2.9	140	3
80 (3")	88.9	3.2	160	3
100 (4")	114.3	3.6	200	3.2
125 (5")	139.7	3.6	225	3.4
150 (6")	168.3	4	250	3.6
200 (8")	219.1	4.5	315	4.1
250 (10")	273	5	400	4.8
300 (12")	323.9	5.6	450	5.2
350 (14")	355.6	5.6	500	5.6

2.6 SURVEILLANCE / LEAK DETECTION SYSTEM (ALARM WIRES)

- .1 The pipes shall be supplied with two (2) copper wires, embedded in the insulation.
 .2 The piping mains will be monitored by an alarm wire circuit with a documented, proven technique.

2.7 FITTINGS

- .1 Pre-insulated fittings shall comply with EN 448, all fittings (elbows, anchors, Tees, etc.) shall be pre-insulated and have embedded copper wires for surveillance/leak detection.
 .2 Pipe flanges and flanged fittings:
 .1 Cast iron: to ASME B16.1, Class [125].
 .2 Steel: to ASME B16.5.
 .3 Butt-welding fittings: steel, to ASME B16.9.

2.8 VALVES

- .1 To EN 488 - Pre-insulated valves
 .2 Connections:
 .1 All welded or flanged.
 .3 Valves to manufacturer's recommendations for a fully integrated and certified system.

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 hydronic systems installation in accordance

with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Departmental Representative shall witness intermediate air pressure tests as well as the final hydraulic tests.
- .3 Work shall not be backfilled until it is reviewed and inspected by Departmental Representative.
- .4 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .5 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S TRAINING AND INSPECTION

- .1 Manufacturer's representative shall conduct on-site training for the installers.
- .2 Training shall include use of joint kits and repair kits.
- .3 Keep samples from the demonstration on-site for review and reference during construction. Protect from weather.
- .4 Manufacturer's representative shall perform reviews of the installation, and provide an affidavit that the system is installed in accordance with manufacturer's recommendation.
- .5 Manufacturer shall provide warranty for the system.

3.3 PREPARATION

- .1 Provide mock-ups as specified.
- .2 Lay out work in accordance with lines and grades as indicated.
- .3 Verify ground profiles, grades, lines, levels, and dimensions, as indicated against established Benchmarks. Report discrepancies to Departmental Representative and obtain written instruction.
- .4 Verify locations of all utilities in advance of the trench excavation by establishing stake-outs.
- .5 When required by Departmental Representative, provide drawings showing relative locations of various services.
- .6 It shall be the contractor's responsibility to verify that supply and return pipelines are orientated correctly to tie-in to existing supply and return pipes in mains and buildings.
- .7 Prior to making connections to any existing pipework the Contractor shall obtain permission from Departmental Representative.

3.4 HANDLING AND STORING PIPE.

- .1 Handling and storage of pipes shall be in accordance with manufacturer's instructions and recommendations.
- .2 Protect all pipe from damage during shipping, hauling and handling.

- .3 During storage, transportation, and laying, carefully protect pipes so that the jacket or insulation is not damaged in any manner. Cushion all saddles or bearings with burlap or other soft material. In handling the pipe, a cushioned sling will be acceptable or other devices and methods, as approved. Ropes, wire ropes and slings, chains, wedges, or levers shall not be used in handling or laying the pipe.
- .4 The pipe shall not be dragged, dropped, welded on, rolled, or handled in any manner that might damage the jacket or insulation. In lowering the pipe into the trench, every care shall be taken to prevent swinging impact or scuffing on the sides of the trench.
- .5 Place pipe along the side of the trench on cushioned blocks as close as possible to the location where it will be laid. If the pipe is to be moved longitudinally along the trench, it shall be walked by crane, loaded on a truck and moved, or moved by other acceptable means.
- .6 Both ends of the pipe shall be securely capped at all times to keep out foreign matter.

3.5 PIPING INSTALLATION

- .1 Install pipework in accordance with manufacturer's recommendations and Section 23 05 05 - Installation of Pipe Work.
- .2 All ferrous pipe field joints shall be welded by competent workmen and hammer tested under hydrostatic pressure of 1035 kPa [150 psig] or twice the working pressure whichever is greater, unless otherwise specified.
- .3 Piping grade shall be continuous to enable air venting.
- .4 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.
- .5 Alarm Wiring:
 - .1 Follow manufacturer's instructions and recommended procedures. Contractor's installation and test procedure for Alarm Wiring shall be reviewed by Departmental Representative and manufacturer prior to start of Work.
 - .2 The alarm wires that are embedded in the polyurethane insulation consist of two copper wires, one clean and one tinned.
 - .3 Verify alarm wires are installed and operating in each pipe and component correctly prior to performing any work on that piece.
 - .4 When placing the pipes in the trench, ensure that the alarm wires are located as per pipe supplier's recommendations and indicated on alarm drawing if available or as directed by the Departmental Representative.
 - .5 Connect both end wires in all joints and piping ends by certified electrician.
 - .6 Solder each joint and use jointing clamps as supplied by the manufacturer and 2.0 mm square copper wire.
 - .7 Check each pipe and joint connections for continuity, with an ohm meter.
 - .8 Ensure continuity of system as work progresses by means of high voltage tester (Megger).
 - .9 Check the resistance of the connections and the resistance between the wire and steel pipe.

- .10 The alarm system shall be complete. Provide an alarm panel in Boiler Room. Alarm panel shall include leads for testing for leaks.
- .11 Do not weld any piping when leak detection units are connected to the system.
- .6 Install the piping to the alignment and grades indicated on the drawings or as required by the Departmental Representative. Support each pipe on bedding and insulation material as indicated on drawings and have firm bearing along its entire length. It is of the utmost importance that the bedding is thoroughly compacted to specification and completely surrounding the pipes. The sand bedding and surround is designed to act as a friction anchor for the system and it shall be the responsibility of the Contractor to instruct his labor in the proper backfilling procedures accordingly.
- .7 Temporary supports may be used to raise the piping or to allow rotating the pipe to facilitate welding joints. If temporary supports are utilized, they shall consist of sandbags or 4"x 4" cushioned boards and be placed in the trench with a maximum spacing of 12'.
- .8 All temporary supports to be furnished by the Contractor and removed prior to backfilling.
- .9 As necessary and in order to provide clearance for welding and jointing, bedding material and insulation shall not initially be put in place in the trench at the pipe joints.
- .10 Prior to welding the steel pipe, the Contractor shall ensure that shrink sleeves and collars are in place on the straight pipes for each joint. Protect shrink sleeves from undue heat caused by sun
- .11 Steel pipe end shall have flat ends or be properly beveled and aligned and spaced for welding. All welding on pipes, fittings, and valves to be done by personnel who have passed an approved competence test and have been certified. Gas welding or electric arc welding may be used and the type of rods and filler used shall be selected to match the base metal alloy analysis.
- .12 Removal of a portion of pipe to facilitate welding of the joint and then replacing the cut out section, sometimes called "fish mouth" or "Window" welding, shall not be permitted.
- .13 The ends of the pipe in the trench not being fitted or welded shall be securely capped at all times to prevent the entrance of foreign matter.
- .14 All cuts of the exterior polyethylene jacket to be made as per manufacturers recommendations so that no indications of fracture arise.
- .15 All polyethylene foam must be removed from the steel pipe, in the region of the weld, before welding is started.
- .16 Pipes required to be cut to length shall be cut and thoroughly cleaned from pipes leaving 11 inch free steel pipe end left for joining.
- .17 Keep exposed PUR foam dry and covered during installation.
- .18 Make branch connections only with fittings supplied by the pipe supplier.
- .19 The welds on the exterior piping shall be hydrostatically tested prior to foam and jacket sealing.
- .20 After acceptance of hydraulic tests, the piping shall be cleaned.

- .21 The Contractor shall provide for all bends, fittings, valves and cross over connections for the execution of the flushing of the system.
- .22 Install expansion foam cushions strictly as indicated on drawings.
- .23 The Contractor shall ensure the pre-insulated pipe is properly protected before insertion into steel or PVC buried casings. Submit procedure for protection of pipe to Departmental Representative prior to commencement of operation.
- .24 Application of Shrink Sleeves to Buried Piping
 - .1 The contractor shall install the shrink sleeves to the heating pipelines strictly in accordance with the manufacturer's specifications.
 - .2 Follow all Manufacturers' recommended procedures for all jointing.
 - .3 Place the shrink sleeve (and the shrink collars if applicable) on one of the pipes to be welded. Weld the steel pipes. (Joint can be pressure tested at this point if in contractor's procedure).
 - .4 Carefully trim expanded insulation foam from the pipe ends. Ensure no damage is done to alarm wires.
 - .5 Ensure alarm wires are carefully placed outside the foam insulation insert portion.
 - .6 Cut the insulation half shells to suit in order to make them fit tightly between the jacket pipes.
 - .7 Fit the insulation shells tightly between the jacket pipes. The pipe ends must be clean and dry.
 - .8 Clean the jacket pipes at least 150mm from both pipe ends. The surface must be clean and dry.
 - .9 Crimp and solder alarm wires, lay them along outside of the insulation half shells. Ensure they are not trapped between end of insert and/or touching steel pipe.
 - .10 Activate the jacket pipes with the "tiger" torch at least 150mm from both sides of the pipe ends, until the surface has a matt, silky look.
 - .11 Place the shrink film so that the marking line goes around the pipe. Pull the paper off and take the film loosely around the pipe.
 - .12 Heat the whole film from the centre outwards ensuring the mastic becomes visible at the edges and that the shrink film is tightly fitted.
 - .13 Remove packing from main shrink sleeve and ensure sleeve is clean and dry inside and out. Centre shrink sleeve on the joint. Heat shrink from the middle outwards towards one end then from the middle to the other.
 - .14 Remove packing from shrink collars. Centre shrink collars over the ends of the in place shrink sleeve and then proceed to heat shrink collars from the middle towards the ends.
 - .15 The Manufacturer's Technicians will be available to train the contractor's work force in the correct procedures for installation of all components of the heating pipes. Coordinate with Manufacturer. Each new crew shall be trained by the Manufacturer's representative – be responsible for the cost of training.

- .25 Valves
 - .1 Install isolating ball valve vent-valve-vent manufactured assembly as indicated on drawings and in the specification.
 - .2 Install in accordance with manufacturer's recommendations.
 - .3 Welding to ball valves shall be done in accordance with the manufacturers recommendations. This will include the valve being opened as the welding is carried out and using wet fabric to protect the valve seat from excess heat during the welding.
 - .4 Provide concrete sleepers, manhole and Standard Cast Iron Frame and Cover, as per drawings.
 - .5 Valved Drains
 - .1 At low points off top of pipe in mains and branches as indicated on drawings.
 - .2 Check operation after system is under full charge and under full pressure.
 - .6 Air Vents
 - .7 Install at high points and elsewhere as indicated on drawings.
 - .8 Provide schedule 40 PVC enclosure for exterior high point air releases where indicated on the drawings.
- .26 Inspections
 - .1 Leave all joints in piping systems uncovered, free from paint and insulation, until all tests are completed and system inspected and approved by Departmental Representative and local authority having jurisdiction.
- .27 Identification
 - .1 Buried pre-insulated pipes to be identified with warning tape as per detail.
- .28 Piping shall be tested in accordance with section 23 05 05 - Installation of Pipe Work.
- .29 Flush and clean mains in accordance with Section 23 05 05 - Installation of Pipe Work.
- .30 Test the leak detection system – follow manufacturer's recommendations.

3.6

WELDING INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review all weld quality requirements and defect limits of applicable codes and standards with Owners Representative before any work is started.
- .2 Formulate "Inspection and Test Plan".
- .3 Each welder shall be tested prior to commencing work on site or at the Contractors Fabrication Shop. Welders shall produce welding samples on 3 pipe coupons 10" dia or larger on similar material to the main EN253 pipe being installed in this project. Each coupon shall be fully radiographed, and all shall pass. Each coupon shall be stamped with the welders recognition number. Tests shall be carried out at the Contractor's expense.
- .4 The qualification tests shall be conducted by the testing agent.
- .5 Do not conceal welds until they have been inspected, tested and approved by inspector.

- .6 Welders shall have experience in welding of similar pipe sizes and materials to those used on this project.
- .7 Provide for inspector to visually inspect all welds during early stages of welding procedures in accordance with AWS W1. Repair or replace all defects as required by codes and as specified herein.

3.7 WELDING SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified in accordance with ASNT SNT TC-1A and approved by Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, and requirements of authority having jurisdiction.
 - .3 Costs for the X-ray service for work shall be paid by the Contractor.
 - .4 Visual examination: include entire circumference of each weld externally and wherever possible internally.
 - .5 Air tests shall be conducted on all pipe welds.
 - .6 After the air test is completed successfully, the trench may be backfilled.
 - .7 Hydrostatic test shall be completed on the entire supply and return piping with the connection at the tie-in points exposed and blanked off.
 - .8 An in-service test shall be conducted at the tie-in points after the final welds are made at each tie-in.
- .2 Design:
 - .1 Welding shall be done in accordance with ASME B31.1.
 - .2 Submit to Departmental Representative for approval welding procedures that have been registered and approved by the testing agency.
 - .3 Contractor shall have a separate welding procedure for each method it intends to employ during construction.
 - .4 All welders shall be qualified for each procedure to be welded.
 - .5 Departmental Representative may use any method of inspection necessary to establish quality control and assure adherence to proper welding procedures. Departmental Representative shall have the right to reject any weld not meeting the requirements of this specification.
- .3 Radiographic Inspection:
 - .1 Weld quality will be checked by radiographic inspection at the expense of Contractor, unless otherwise specified. Departmental Representative will select up to 10 percent of welds (1 in 10) for radiographic inspection. The welds chosen for radiographic inspection shall be tested 100% circumferentially.
- .4 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality. Type 4 film shall not be used.

- .5 Interpretation of radiographic films:
 - .1 By qualified radiographer in accordance with ASNT SNT TC-1A.
- .6 Failure of radiographic tests:
 - .1 If any weld fails tests, (or leaks in the pressure test) the Departmental Representative shall select another 10% of the welds from the identified welder, for additional X-ray test.
 - .2 If any of the additional welds fail, the Departmental Representative shall select a further 10% of the welds from the identified welder, for X-ray test.
 - .3 If any of the additional welds fail, the Departmental Representative shall select a further 10% of the welds from the identified welder, for X-ray test. (30% of the welds).
 - .4 If any of the additional welds fail, all welds from the identified welder shall be tested. The welder shall not be permitted to make further welds on the project without the approval of the Departmental Representative and having been re-tested as to the welder's competence. ALL TESTS AND RE-TESTS SHALL BE AT THE CONTRACTOR'S EXPENSE.
- .7 Leak indication using a low pressure (20 psi) air and liquid soap test, prior to the hydrostatic test with water, shall be approved at the discretion of the Departmental Representative. Written procedures shall be submitted to the Departmental Representative for review and any such test shall not be considered a substitute for the hydrostatic test. Test shall be in accordance with ANSI/ASME B31.1.

3.8 WELDING DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

3.9 REPAIR OF WELDS WHICH FAILED INSPECTION

- .1 Re-inspect repaired or re-worked welds at Contractor's expense as per Clause 3.5 above.

3.10 CLAIMS AGAINST OWNER FOR DELAYS

- .1 Claims against Owner for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.

3.11 JOINT FIT-UP

- .1 The geometry of pipe weld joints (i.e. joint preparation and root opening) shall be in accordance with the tolerance specified by the weld joint sketches contained in the welding procedures submitted to the Owner's representative.
- .2 In cases where the internal misalignment exceeds 1/16 inch, the component with the wall extending internally shall be trimmed internally so that the adjoining internal surfaces are approximately flush. This trimming shall not result in a piping component wall thickness less than the minimum design thickness and the change in contour shall not exceed 30 degrees.

3.12 EXPANSION OF PIPING

- .1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building.
- .2 Refer to manufacturer's recommendations and installation methods. Include expansion cushions.
- .3 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections
- .4 Expansion loops shall be of all welded construction with long radius elbows.
- .5 Install expansion loops, cold sprung 50% of the calculated expansion.

3.13 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.14 TESTING

- .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
- .2 Hydrostatic test shall be twice the working pressure, but no less than 1000 kPa [150 psi] for 24 hours.
- .3 Before testing piping, isolate all equipment, which cannot withstand the test pressure.
- .4 Do not insulate, backfill or conceal until tests have been completed and approved by the inspection authorities.
- .5 Examine all systems under test for leaks.
- .6 Joints shall remain dry during the test. A general sweating around a weld shall be reason for rejection.
- .7 Remake all leaking connections and joints.

3.15 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems.

3.16 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 for 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.

3.17

PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation, and where connected to existing systems.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Close-out Submittals
- .6 Section 21 05 05 – Common Work Results for Fire Suppression
- .7 Section 22 05 00 – Common Work Results for Plumbing
- .8 Section 23 05 00 – Common Work Results for HVAC
- .9 Section 23 05 05 – Installation of Pipe Work
- .10 Section 23 05 23.01 – Valves – Bronze
- .11 Section 23 05 49.01 – Seismic Restraint Systems (SRS) – Type P2 Buildings
- .12 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .13 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping System

1.2 REFERENCES

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-[2014].
- .2 ASTM International
 - .1 ASTM A47/A47M-[99(2014)], Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-[01(2011)], Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M-[10], Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-[84(2009)], Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62-[15], Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group
 - .1 CSA B51-[14], Boiler, Pressure Vessel, and Pressure Piping Code.

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 expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

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 hydronic specialties for incorporation into manual.

1.5 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 AIR SEPARATOR - IN-LINE

- .1 Working pressure: 860 kPa.
- .2 Size: line size – refer to drawings.

2.2 COMBINATION SEPARATORS/STRAINERS

- .1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with [5] mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.3 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 to 12: T type with ductile iron body to ASTM A536, flanged connections.
- .3 Blowdown connection: NPS [1].
- .4 Screen: stainless steel with [1.19] mm perforations.
- .5 Working pressure: 860 kPa.

2.4 SUCTION DIFFUSER

- .1 Body: cast ductile iron with flanged (for NPS-2 ½ and over), and screwed (for NPS 2 and under) connections.
- .2 Strainer: with built-in, disposable [1.19] mm mesh, low pressure drop screen and NPS [1] blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure gauge tappings.
- .6 Adjustable support leg.

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 hydronic specialties 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 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 GENERAL

- .1 Run drain lines to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.

- .4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.5 AIR VENTS

- .1 Install at high points of systems.
- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.

3.6 EXPANSION TANKS

- .1 Adjust expansion tank pressure as indicated and to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

3.7 PRESSURE SAFETY RELIEF VALVES

- .1 Run discharge pipe to terminate above nearest drain.

3.8 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 50.

3.9 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 for 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 RELATED REQUIREMENTS

- .1 Section 01 11 00 – Summary of Work
- .2 Section 01 14 00 – Work Restrictions
- .3 Section 01 35 00 – Special Procedures
- .4 Section 01 45 00 – Quality Control
- .5 Section 01 61 00 – Common Product Requirements
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 13 - Common Motor Requirements for HVAC
- .8 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
- .9 Section 25 05 00 – EMCS General Requirements

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME).
 - .1 ANSI/ASME B16.5-[2009], Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- .2 American National Standards Institute/International Electrical Commission (ANSI/IEC).
 - .1 IEC 60529-[2004], Degrees Of Protection Provided By Enclosures (IP Code).
- .3 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-11, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .4 ASTM International (ASTM).
 - .1 ASTM A48/A48M-[2003 (2008)], Standard Specification for Gray Iron Castings.
 - .2 ASTM A536-[1984 (2009)], Standard Specification for Ductile Iron Castings.
 - .3 ASTM A582/A582M-[2005], Standard Specification for Free-Machining Stainless Steel Bars.
 - .4 ASTM B584-[2011], Standard Specification for Copper Alloy Sand Castings for General Applications.

- .5 CSA International (CSA).
 - .1 CAN/CSA C22.2 No.108-[2001 (R2010)], Liquid Pumps.
- .6 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .7 German Institute for Standardization (DIN).
 - .1 DIN EN 61800-3-[2004], Adjustable Speed Electrical Power Drive Systems - Part 3: EMC Requirements And Specific Test Methods.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .9 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE 519-[1992], Recommended Practices And Requirements For Harmonic Control In Electrical Power Systems.
- .10 National Electrical and Manufacturers Association (NEMA).
 - .1 NEMA MG-1 Standard-[2009, Revision 2010], Motors and Generators, Revision 1.

1.3 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Product Data: Submit product data including manufacturer's literature for hydronic pump, controls, components and accessories, indicating compliance with specified requirements and material characteristics.
 - .1 Submit list on pump manufacturer's letterhead of materials, components and accessories to be incorporated into Work.
 - .2 Include pump performance curves indication where project pumps appear in curve range.
 - .3 Include product names, types and series numbers.
 - .4 Include contact information for manufacturer and their representative for this Project.
 - .5 Include information on costs for wiring of pump to motor, and wiring pump mounted (internal/external) or remotely mounted differential pressure sensor.
- .3 Submit shop drawings of pump curves with operating points indicated. Include NPSH curve when applicable.

- .4 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
- .5 Submit motor efficiencies for all motors 1H.P. and over. Refer to Section 23 05 00 for minimum efficiencies.
- .6 Submit pump and control enclosure dimensions on shop drawings.

1.5 QUALITY ASSURANCE

- .1 Ensure pumps operate at specified system fluid temperatures without binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.
- .2 Where pumps are operated in conjunction with others such as parallel pumps, show all operating points on the pump curve.
- .3 All grooved joint piping components used in pump drops and connections shall be the products of a single manufacturer, and shall be rated to full system working pressure. Grooving tools shall be of the same manufacturer as the grooved components.

1.6 WARRANTY

- .1 Manufacturer's warranty: Submit manufacturer's standard warranty document executed by authorized company official.
- .2 Warranty period: Two2 years, parts and labour, commencing on Date of Substantial Performance of Work.

1.7 GENERAL

- .1 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have a 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. The motor manufacturer shall submit in writing confirmation that the motors are designed to withstand voltage peaks of 1400 volts and a voltage rate of rise of 2000 volts / microsecond at a frequency of 20 kHz.

Part 2 Products

2.1 GENERAL

- .1 Statically and dynamically balance rotating parts.
- .2 Construction shall permit complete servicing without breaking piping or motor connections.
- .3 Pumps shall operate at 1750 r/min. unless specified otherwise.

- .4 Domestic water pumps shall be all bronze construction.

2.2 IN-LINE CIRCULATOR PUMPS

- .1 Suitable for a maximum working pressure of 860 kPa [125 psig] and maximum temperature of 107°C [225°F].
- .2 Casing: Cast iron radially split, with flanged connections. Supplied with matching companion flanges.
- .3 Impellor: Corrosion resistant cadmium plated steel.
- .4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.
- .5 Seal Assembly: Mechanical.
- .6 Coupling: Flexible self-aligning.
- .7 Motor: Resilient mounted, drip proof, sleeve bearing.

2.3 VERTICAL IN-LINE CENTRIFUGAL PUMPS

- .1 Description: Single stage, single suction type, vertical inline design pump with integrated controls. Pumps designed for variable volume applications and selected for hydraulic design conditions and minimum pressure with sensorless load control re-settable by pressure sensor across most remote load.
 - .1 Seals: Mechanical seals, serviceable without disturbing motor or piping connections.
 - .2 Include casing drain plug and 1/4 inch suction and discharge ports.
- .2 Meet or exceed requirements of ASHRAE 90.1.
- .3 Suitable for a maximum working pressure of 1210 kPa [175 psig] and maximum temperature of 107°C [225°F].
- .4 Casing: Cast iron radially split, single stage, flanged suction and discharge connections, separate tapped openings for venting, draining and gauge connections.
 - .1 Cast iron to ASTM A48, Class 30 or Ductile iron ASTM A536.
 - .2 Test casing to 150 % maximum working pressure.
 - .3 Ensure casing is radially split to allow for removal of rotating element without disturbing pipe connections.
 - .4 Drill and tap casing for gauge ports on both suction and discharge connections.
 - .5 Drill and tap casing on bottom for drain port.

- .5 Impellor: Bronze, to ASTM B584, dynamically balanced to ANSI G6.3, keyed drive with locking nut.
 - .1 Use two-plane balancing when installed impeller diameter is less than 6 times impeller width.
- .6 Shaft: Stainless steel on split coupled pumps and carbon steel with bronze sleeve on close coupled pumps.
- .7 Seal Assembly: Inside unbalanced mechanical seal with factory installed seal flushing line.
- .8 Install vent flush line in factory.
 - .1 Ensure vent flush line runs from seal chamber to pump discharge.
- .9 Pump Controls:
 - .1 Install integrated controls on each pump for use with EMCS for energy logging to ASHRAE 189.1P.
 - .1 Pre-program integrated controls for each pump before pump leaves factory.
 - .2 Mark pumps and controls with co-ordinated identification.
 - .2 Control: Integrated, sensorless controls complete with fused disconnect switch and menu-driven graphical interface.
 - .3 Provide near unity displacement power factor ($\cos \emptyset$) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls
 - .1 Incorporate DC link reactors for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.
 - .2 Fit RFI filters as standard to ensure integrated controls meets low emission and immunity requirements.
 - .3 Ensure additional 3 % AC line reactor is available for controls with saturating (non linear) DC link reactors.
- .10 Protocol: BACnet™ MS/TP, and optionally Modbus RTU
- .11 Sensorless override for EMCS control signal.
- .12 Closed loop PID control
- .13 Enclosure: UL Type 12 or 4X.
- .14 EMI/RFI Control: Integrated filter designed to DIN EN61800-3.
- .15 Harmonic suppression: Dual DC-link reactors (Equivalent: 5% impedance AC line reactor) to mitigate harmonics to support IEEE 519 system requirements.

- .16 Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
- .17 Cooling: Fan cooled through back panel.
- .18 Ambient working conditions: -10°C to 45°C [14°F to +113°F], up to 1000 m [3300 feet] above sea level.
- .19 Analog I/O: 2 Current or voltage inputs minimum, 1 current output.
- .20 Digital I/O: 6 programmable inputs minimum with 2 minimum able to be configured as outputs.
- .21 Pulse inputs: 2 programmable minimum.
- .22 Relay outputs: 2 programmable minimum.
- .23 Communications ports: 1- RS485, 1- USB minimum.
- .24 One volt free contact.
- .25 Auto alarm reset.
- .26 Software: Ensure software for sensorless control includes automatic speed control in variable volume systems without need for pump mounted or remotely mounted differential pressure sensor.
 - .1 1. Operating mode under sensorless control: Quadratic Pressure Control (QPC).
 - .1 Ensure head reduction with reducing flow conforms to quadratic control curve.
 - .2 Head flow: [40] % minimum of design duty head.
 - .2 Linear or Proportional Pressure Control without sensor is unacceptable.
 - .3 Ensure control mode setting and minimum/maximum head set-points are user adjustable using built-in programming interface.
 - .4 Ensure integrated control software is capable of controlling pump performance for non-overloading power at every point of operation.
 - .5 Ensure integrated control software is capable of flow rate data output of $\pm 5\%$ accuracy to EMCS.
- .27 Include energy monitoring log function to ASHRAE 189.1P.
- .28 Pump Motor and Controls Protection
 - .1 Include protection as follows:
 - .1 Motor phase to phase fault.

- .2 Motor phase to ground fault.
- .3 Loss of supply phase.
- .4 Over voltage.
- .5 Under voltage.
- .6 Motor over temperature.
- .7 Inverter overload.
- .8 Over current.
- .29 Pre-program integrated controls for each pump before pump leaves factory.
 - .1 Install vent flush line in factory.
 - .1 Ensure vent flush line runs from seal chamber to pump discharge.
 - .2 Mark pumps and controls with co-ordinated identification.
- .30 Accessories
- .31 Pipe Flanges: To ANSI/ASME B16.5, Class 125.
- .32 Supports: in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment, details on drawings and manufacturer’s recommendations.
- .33 Vibration isolators, neoprene isolation pads in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
- .34 Seismic restraint in accordance with Section 23 05 49.01 – Seismic Restraint Systems (SRS) – Type P2 Buildings.
- .35 Suction Guides: For ANSI 150 flange and ANSI 125 pump flange; alternatively grooved pipe and ANSI 125 pump flange.
- .36 Triple Duty Valve: Ductile iron valve body, tight shut-off, spring -closure type silent non-slam check valve with effective throttling design capability.
 - .1 Valve stem: Stainless steel with flat surfaces for adjustment with open-end wrench.
 - .2 Suitable and recommended for variable flow systems.
- .37 Pressure Gauges: 4-1/2 inch diameter sized to meet system pressure requirements.

Part 3 Execution

3.1 GENERAL

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

- .3 Ensure that pumps are installed such that no piping or equipment loads are imposed on the pump body. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .4 Ensure suction and discharge pipe flanges are aligned and square to pipe.
- .5 Install pumps level in accordance with pump manufacturer's written recommendations.

3.2 VERTICAL IN-LINE CENTRIFUGAL PUMPS

- .1 Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.
 - .1 Support pump using floor mounted saddle as required.
 - .2 Ensure no pipe strain is imposed on pump flanges.
- .2 Follow manufacturer's recommended length of spool piece on discharge connection from pump before valves and fittings.
- .3 Install suction guides on pump suction connection.
- .4 Install pressure gauges on strainer, suction and discharge pump connections – refer to drawing details.
- .5 Align pipe flanges with pump flanges and bolt together in accordance with pump manufacturer's written recommendations.
- .6 Connect pumps and integrated control system to electrical distribution system to IEE regulations and with authority having jurisdiction in accordance with Section 26 05 00 – Common Work Results for Electrical.
 - .1 Include wiring to most remote sensor in system where applicable.
- .7 Pumps shall be aligned by qualified millwright and alignment certified.
- .8 Check pump rotation. Do not run pumps dry to check rotation.
- .9 Pipe drain tapping to floor drain.
- .10 "Start-up" strainer baskets in strainer/suction guides must be removed prior to commissioning of systems.
- .11 Provide air cock and drain connection on horizontal pump casings.
- .12 Decrease from line size, with long radius reducing elbows or reducers.
- .13 Shave or replace pump impellers to meet actual operating conditions.
- .14 Where remote control panels are used, this contractor shall allow for wiring from panel

to pumps.

- .15 Provide seismic restraints for pumps.
- .16 Secure control panels for seismic loads.
- .17 Manufacturer's Field Services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for product installation review in accordance with manufacturer's instructions. Coordinate manufacturer's services with Section 01 45 00 - Quality Control.
 - .1 Have manufacturer review work involved in handling, installation, protection, and cleaning of hydronic pumps and components, and submit written reports in acceptable format to verify compliance of Work with Contract conditions.
 - .2
 - .3 Report any inconsistencies from manufacturer's recommendations immediately to Departmental Representative.
 - .4 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of pumps, controls and components, and when preparatory work on which Work of this Section depends is complete, but before installation begins.
 - .2 Upon completion of Work, after cleaning is carried out.
 - .3 Obtain reports within three days of review and submit immediately to Departmental Representative.

3.3 IN-LINE CIRCULATORS

- .1 Install as indicated by flow arrows.
- .2 Support at flanges on outlets of unit.
- .3 Install with bearing lubrication points accessible.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedure
- .2 Section 01 61 00 – Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Closeout Submittals
- .6 Section 22 05 00 – Common Work Results for Plumbing
- .7 Section 23 05 00 – Common Work Results for HVAC
- .8 Section 23 05 05 – Installation of Pipe Work
- .9 Section 23 05 23.01 – Valves – Bronze
- .10 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .11 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping System

1.2 REFERENCES

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-[2013].
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Worksafe BC Regulations.

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 HVAC water treatment systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two (2) copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Shop Drawings:
 - .1 Submit drawings per Section 01 33 00 – Submittal Procedures.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 HVAC water treatment systems for incorporation into maintenance manual.
- .3 Include following:
 - .1 Log sheets as recommended by manufacturer and Departmental Representative.

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 off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect HVAC water treatment systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 CONNECTIONS TO EXISTING SYSTEMS

- .1 New systems shall connect to existing systems and the water will be common to both systems.
- .2 All chemicals will be compatible with the existing water treatment. Coordinate with Departmental Representative.
- .3 Using same chemicals that the existing systems use is strongly suggested.
- .4 Test the water treatment of existing systems prior to commencing work. Coordinate with Departmental Representative. Submit test results.

Part 2 Products

2.1 MANUFACTURER

- .1 Equipment, chemicals, and service provided by one supplier.
- .2 Confirm with Departmental Representative and match existing chemicals and treatment levels.

2.2 POT FEEDER

- .1 Welded steel, pressure rating 890 kPa. Temperature rating: 90 degrees C.

2.3 CHEMICAL FEED PIPING

- .1 Resistant to chemicals employed. Pressure rating: 890 kPa.

2.4 CHEMICAL FEED PUMPS

- .1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.
- .2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.

2.5 SHIPPING/FEEDING CHEMICAL CONTAINERS

- .1 High density moulded polyethylene, with liquid level graduations, cover.
- .2 Stands: metallic grate with castors.

2.6 CONDUCTIVITY PROBES

- .1 Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

2.7 WATER TREATMENT FOR HYDRONIC SYSTEMS

- .1 Chilled water system: pot feeder, 25 L, operating pressure 890 kPa.
- .2 Micron filter for each pot feeder:
 - .1 Capacity 2% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.8 WATER TREATMENT FOR CONDENSER WATER SYSTEMS, SPRAY WATER SIDE OF CLOSED CIRCUIT COOLERS

- .1 Chemical feed pump:
 - .1 Capacity: 0.05 L/s at 1000 kPa.
 - .2 To provide proportional chemical feed.
- .2 Chemical container:
 - .1 As specified.
 - .2 Capacity: 25 L.
- .3 Bleed-off solenoid and throttling valves.
- .4 Panel: EEMAC type 12 enclosure with enamel-finish, pre-wired, following features:
 - .1 Internal wiring harness, colour-coded, identified, brought to central terminal board.
 - .2 Grounded AC receptacles for feed pumps and utility.
 - .3 Main power switch, indicating light, legend nameplate.
 - .4 Manual-auto selector switches, indicating lights for bleed-off control, chemical feed, with legend plates.
 - .5 Timers pulsed from water metre with contacting register to operate feed pumps and bleed-off solenoid valve.

- .6 Conductivity controller with indicating metre to control bleed-off.
- .5 Flow assembly: consisting of conductivity probe mounted in flow-tee complete with isolating valves.
- .6 Automatic flow switch: to shut down and re-start water treatment system on interruption of water flow.
- .7 Make-up water metre:
 - .1 Capacity: 0.7 L/s, 15 kPa pressure drop.
 - .2 Size: NPS 1.5.
 - .3 Bronze, capacity to meet requirements, non-reset electric cumulative totalizer, electric contacting register.
 - .4 Pulse meter.
- .8 Pot feeder:
 - .1 For addition of biocides.
 - .2 Capacity 25 L minimum, 1200 kPa max. WP.

2.9 CHEMICALS

- .1 Provide [1] years supply.
- .2 Obtain chemicals from manufacturer with existing valid contract with PARC.

2.10 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

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 HVAC water treatment systems 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 Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.4 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.5 CLEANING OF MECHANICAL SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush system[s] until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.6 DOMESTIC WATER SYSTEMS

- .1 Chlorinate and flush domestic water systems in accordance with codes, regulations, and good practice.

3.7 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for period of [1 year] after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every 10 days during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for 1 year operation.
 - .6 Provide necessary laboratory and technical assistance.
 - .7 Provide clear, concise, written instructions and advice to operating staff.

3.8 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
 - .1 Commissioning Agency: to oversee water treatment.
 - .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
 - .3 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of initial water analysis.
 - .4 Required quality of treated water.
 - .4 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
 - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
 - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
 - .7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
 - .5 Commissioning procedures - Water side of closed circuit coolers, Cooling Tower Systems:
 - .1 Verify operation of bleed-off system.
 - .2 Establish bleed-off flow rate.
 - .3 Establish rate of chemical feed - continual and periodic.
 - .4 Test system water for chlorides, TDS, suspended solids, algae, slime, inhibitor level, pH, alkalinity, hardness, other impurities and microbiological organisms.

- .5 Compare with readings of total dissolved and suspended solids metre.
- .6 Read make-up water metre, compare with chiller load summation (ton-hours).
- .7 Test make-up water for chlorides, hardness.
- .8 Compare test results with readings from TDS metre.
- .9 Record quantity of make-up water, compare with summation of chiller load (in ton-hours).
- .10 Record types, quantities of chemicals applied.
- .6 Training:
 - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O M personnel.
 - .2 Train O M personnel in softener regeneration procedures.
- .7 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .8 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .9 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

3.9

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 for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Refer to Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings for required seismic restraint of ductwork.

1.2 REFERENCE STANDARDS

- .1 The construction and installation of ductwork and plenums shall be in accordance with the latest edition of the following referenced SMACNA manuals and ASHRAE handbooks.
 - .1 SMACNA - H.V.A.C. Duct Construction Standards.
 - .2 SMACNA - H.V.A.C. Air Duct Leakage Test Manual.
 - .3 ASHRAE - Handbook - Equipment Volume.

1.3 GENERAL

- .1 Duct sizes on drawings indicate clear inside dimensions. For acoustically lined or internally insulated ducts, maintain inside duct dimensions.
- .2 Where duct sizes are shown in nominal metric sizes, round and oval duct sizes may be supplied in the nearest available sizes in equivalent imperial units.
- .3 Proper sized openings shall be arranged for in the correct locations through all slabs and walls. Openings shall be planned to include for the installation of fire dampers at all rated fire separations.
- .4 Where ducts penetrate roofs, provide roof curbs with flashing and counterflashing.
- .5 Arrange for 100 mm [4"] high by 100 mm [4"] wide concrete curbs around all duct penetrations through floor slabs outside of duct shafts.
- .6 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.
- .7 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.

- .8 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.
- .9 Where welded ductwork is indicated, the welding shall be continuous with Everdur welding. Tack welding is unacceptable except as specifically noted. Paint damaged areas with zinc coating after welding.
- .10 Provide seismic restraints for ductwork in accordance with SMACNA "Guidelines for seismic restraints of mechanical systems and plumbing piping systems".

Part 2 Products

2.1 GALVANIZED STEEL

- .1 Galvanized steel shall have a 380 g/sq.m. [1-1/4 oz/sq.ft] galvanizing coat both sides to ASTM A525 G90.

2.2 DUCTWORK - 500 PA [2" W.G.] STATIC PRESSURE

- .1 Provide galvanized iron ductwork for system operating pressures 500 Pa [2" W.G.] and less. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-1/2 times the working static pressure.
- .2 Construct rectangular ductwork in accordance with Section I including Tables 1-5, 1-10, 1-11, 1-12, 1-13 and Figs. 1-4 through 1-18 of the SMACNA Duct Standards.
- .3 Nomasco "Ductmate System, Lockformer TDC" or Exanno "Nexus System" may be used for rectangular duct joints.
- .4 At least two opposite faces of all rectangular ductwork must be joined together using a type of joint, which cannot pull apart.
- .5 Construct rectangular duct fittings in accordance with Section II including Figs. 2-1 to 2-11 and Figs. 2-16 to 2-18 of the SMACNA Duct Standards.
- .6 Construct round ductwork in accordance with Section III including Table 3-2 and Figs. 3-1 and 3-2 of the SMACNA Duct Standards, but excluding beaded crimp joints and snaplock seams.
- .7 Construct flat oval ductwork in accordance with Section III including Table 3-4 and Fig. 3-6 of the SMACNA Duct Standards. Joints and seams shall be similar to those indicated for round ducts. Flat oval duct to be used for positive pressure application only.
- .8 Construct round and flat oval duct fittings in accordance with Section III including Table 3-1 and Figs. 3-3 through 3-6 of the SMACNA Duct Standards. Round elbows shall have a centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall be not less than the thickness of that specified for longitudinal seam straight duct. Adjustable elbows are not permitted.

2.3 DUCTWORK - ACOUSTICALLY LINED

- .1 Where rectangular ductwork is indicated to be acoustically insulated with flexible acoustic duct liner, liner shall be installed in accordance with instructions and Figures 2-22 through 2-25, SMACNA Duct Standards. Duct sizes shown are inside the duct liner.
- .2 Where round ductwork is indicated to be acoustically insulated, it shall consist of two concentric round ducts with 25 mm [1"] thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be perforated and correspond to the duct diameter noted on the drawings. The outer duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.

2.4 AIR DISTRIBUTION PLATES

- .1 Provide perforated air distribution plates at the discharge of supply fans as shown on the drawings.
- .2 For construction of plates refer to Mechanical Detail MD 21 042, Section 23 06 01.
- .3 Modify and reposition plates as necessary to balance airflow through downstream filters and coils to plus or minus 15%.

2.5 COIL END COVERS

- .1 Provide coil end casings to eliminate coil frame air leakage.
- .2 Provide for cooling coil ends to drip condensate to the coil drain pan. Insulate the inside of the coil end casing to prevent casing condensation and provide closure panels to retain insulation.

2.6 WIRE MESH SCREENS

- .1 Provide wire mesh screens in all air intake openings where noted on the drawings.
- .2 Screens shall be constructed from aluminum wire 1.3 mm diameter [16 ga].
- .3 Screen mesh shall be 12.7 mm [1/2"].
- .4 Mount screens in 0.66 mm thick [20 ga] folded aluminum frames.

2.7 COUNTER FLASHINGS

- .1 Counter flashings - galvanized sheet steel of 0.8 mm [22 gauge] minimum thickness.
- .2 Counter flashings are attached to mechanical equipment and lap the base flashings on the roof curbs.
- .3 All joints in counter flashings shall be flattened and solder double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.
- .4 Vertical flange section of roof jacks shall be screwed to face of curb.

Part 3 Execution

3.1 DUCTWORK & PLENUM INSTALLATION

- .1 Where a duct contains a fire or smoke damper, construct the duct so that the free area of the duct is maintained through the fire or smoke damper.
- .2 Where a duct is to be internally insulated, enlarge the duct so as not to reduce the duct free area.
- .3 Make the taper of diverging transitions less than 20 deg. and the taper of converging transitions less than 30 deg., in accordance with Fig. 2-9 of the SMACNA Duct Standards. Maximum divergence upstream of equipment to be 30 deg. and 45 deg. convergence downstream.
- .4 Make the inside radius of any rectangular duct elbow at least equal to the duct width, measured in the direction of the radius. If space conditions do not permit a full radius elbow to be installed, use square elbows with multi-blade turning vanes.
- .5 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76 mm [22 ga]. Vanes shall be spaced at 40 mm [1-1/2"] centres and shall turn through 90 deg., with a radius of 50 mm [2"]. Vanes shall not include a straight trailing edge. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86 mm thick [18 ga].
- .6 For 500 Pa [2"] pressure systems, install tie rods to limit the maximum unsupported vane length to 914 mm [36"]. Refer to Fig. 2-4 of the SMACNA Duct Standards.
- .7 For 750 Pa [3"] and greater pressure systems, install tie rods to limit the maximum unsupported vane length to 460 mm [18"]. Refer to 2-4 of the SMACNA Duct Standards.
- .8 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions.
- .9 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with Fig. 2-16 of the SMACNA Duct Standards. Adjustment shall be accessible outside the duct with lockable quadrant operator or through the grille or register with key-operated worm gear mechanism.
- .10 Cross-break or bead all metal duct panels unless otherwise noted.
- .11 Do not cross-break duct panels on 750 Pa [3"] and greater static pressure systems.
- .12 Do not cross-break bottom duct panels when ductwork is handling moisture.
- .13 Roof mounted ducts shall have standing seams and shall be sealed weather tight.

- .14 Grade all ductwork handling moisture, a minimum of 1:120 [1" in 10 ft] back to the source or at low points in the ductwork, provide a 150 mm [6"] deep drain sump and 32 mm [1-1/4"] dia. drain connection with deep seal trap and pipe to drain.
- .15 Construct ductwork handling moisture with three sided bottom sections and a separate top panel. Install the three sided bottom sections and internally seal the transverse joints with CGE Silicone Sealant "Silpruf". Then install the top panels and seal the top panel seams and joints.
- .16 Provide floor drains in outside air and humidifier sections with deep seal traps.
- .17 Provide moisture collection sections inside all louvres for outside air and exhaust air.
- .18 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to the structure shall be compatible with the structure and selected for the load of the ductwork. Install ductwork hangers in accordance with Section IV including Tables 4-1 through 4-3 and Figs. 4-1 through 4-9 of the SMACNA Duct Standards.
- .19 Support duct risers at their base and at each floor and at not greater than 3.7 m [12 ft] intervals.
- .20 Prior to the fabrication of ductwork, co-ordinate and field measure all ductwork to ensure a complete installation respecting all other services. Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.
- .21 Arrange ductwork and plenums so that duct and plenum mounted equipment can be easily removed.
- .22 Arrange access doors so that they open against the airflow and static pressure.
- .23 Provide necessary baffling in manufactured or built-up mixed air plenums to ensure good mixed air temperature with variations of not more than \pm minus 5°C [23°F] under all operating conditions.
- .24 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent passage of smoke and/or transmission of sound. (U.L.C. approved fire stop sealant is not a requirement). Where ducts are insulated provide a 0.61 mm [24 ga] thick galvanized steel band tightly fitted around insulation and then caulk to band.
- .25 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps.
- .26 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

- .27 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.
- .28 Provide drip pans under piping and shields for protection of electrical panels and equipment.
- .29 Unless noted otherwise, line all builder's shafts and air plenums used as ducts and plenums with sheet metal.

3.2 DUCT PENETRATIONS IN NEGATIVE/POSITIVE PRESSURE ROOMS

- .1 All ducts passing through walls, floor and ceiling slabs of rooms that are required to be maintained at negative or positive pressure, shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent the transmission of air.

3.3 DUCTWORK LEAKAGE TEST

- .1 Leakage test all 750 Pa [3"] and greater static pressure supply ductwork installed under this contract, as recommended in the SMACNA H.V.A.C. Air Duct Leakage Test Manual, 1985 Standards, to a static pressure 500 Pa [2" W.G.] in excess of the specified ductwork design static pressure.
- .2 Use equipment capable of demonstrating leakage.
- .3 Test the first 30 m [100 ft] of installed ductwork in the presence of the Consultant.
- .4 Test a 30m [100ft] section of 500 Pa [2"] static pressure ductwork, where complete systems over 30m [100 ft] long are installed under this contract to a static pressure of 500 Pa [2" W.G.].
- .5 The total allowable leakage for the entire system shall be not greater than [5] percent of the total system capacity.
- .6 Submit test reports for all ducts tested.

3.4 DUCTWORK AND PLENUM CLEANING

- .1 All ductwork and equipment installed shall be free of scale, debris and dirt.
- .2 Maintain all duct and equipment openings covered with poly or equivalent to prevent the entry of dirt.
- .3 Clean all plenums and buried supply ductwork with an industrial vacuum cleaner on completion of the duct and plenum installation.
- .4 Install air filters of the specified performance.
- .5 Blow out all supply ductwork, (by means of the supply fan) on completion of the duct and plenum installation and prior to installation of air terminals.

- .6 Ductwork shall be considered clean when all foreign material visible to the naked eye has been removed. A random sampling review by the Consultant will be conducted to check for cleanliness.

3.5 DUCTWORK AND PLENUM CLEANING

.1 Responsibility

- .1 This Contractor shall be responsible for and ensure that all ductwork, installed under this contract is internally CLEAN, when handed over to the Owner. This responsibility includes the entire systems, from outdoor air intakes to air terminals and from air terminals to relief outlets. It includes all ductwork, lined and unlined, all plenums and all equipment within or connected to ducts and plenums.
- .2 The surfaces shall be considered clean when all foreign materials capable of particulating and visible to the naked eye are removed.

.2 Installation Procedure

- .1 All ductwork shall be wiped clean prior to installation.
- .2 Close all dampers immediately following installation thus checking the operation and retarding movement of contaminants through the system.
- .3 Seal all openings at the end of each day and at such other time as site conditions dictate.
- .4 Floor openings to be capped with sheet metal or floor grilles plus 0.15 mm [6 mils] thick poly sheet.
- .5 Other openings to be covered with 0.15 mm [6 mils] thick poly sheet taped so as to be air tight.

.3 Cleaning Procedure

- .1 On completion of the duct and plenum installation and prior to the installation of air terminals and prior to balancing of the air systems, but not until the areas are substantially clean (floors have been swept and vacuumed) and all "dirty" construction has been completed, employ an approved Cleaning Agency to vacuum clean the following:
 - .1 All plenums.
 - .2 All supply and return air ducts.
 - .3 All exhaust air ducts.
- .2 All components within each system shall be thoroughly cleaned and shall include but not be limited to the following: coils, fans and motors, silencers, air terminals and mixing boxes / air valves.
- .3 When connecting to existing supply ductwork, clean existing supply ducts upstream from connection back to the filters. Clean existing supply ductwork downstream from new connections to outlets.

- .4 Cleaning shall generally be by high capacity power vacuum. High-pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise. Coils shall be de-scaled.
- .5 The Cleaning Contractor shall be responsible for removing and replacing filter media. This contractor will remove the temporary filters and replace with new after cleaning the systems.
- .6 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is still to be balanced.
- .7 Reinstall any grilles, registers and diffusers, which may have been removed for cleaning purposes.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.06 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A480/A480M-[12], Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-[09b], Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A653/A653M-[11], Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Green Seal Environmental Standards (GS)
 - .1 GS-36-[11], Standard for Adhesives for Commercial Use.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-[12], Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[12], Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, [2005].
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, [2012].
 - .3 IAQ Guideline for Occupied Buildings Under Construction [2007].
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-[A2005], Adhesives and Sealants Applications.

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 metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings submittals to Section 11 33 00 – Submittal Procedures.
- .4 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Sustainable Design Submittals:
 - .1 Construction IAQ Management Plan:
 - .1 Submit Indoor Air Quality (IAQ) Plan for construction and pre-occupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	[C]
250	[C]
125	[C]

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape, or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with gaskets, sealant, tape, or combination thereof. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.2 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: VOC limit 70 g/L maximum.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: standard radius (centreline radius: [1.5] times width of duct).
 - .2 Round: smooth radius or five piece, centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.

- .6 Offsets:
 - .1 As indicated, full radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Fire stopping material and installation must not distort duct.
- .3 Follow ULC rated assembly: submit shop drawing of the assembly used.

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type [304].
- .2 Finish: number [4]; number 2 finishes in exposed occupied areas.
- .3 Thickness, fabrication and reinforcement: to SMACNA.
- .4 Joints: to SMACNA. Welded joints to be continuous inert gas welded.

2.9 ALUMINUM

- .1 To SMACNA. Aluminum type: [3003-H-14].
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.10 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment, following SMACNA guidelines.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500.
 - .2 Hanger configuration: to SMACNA.

- .3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA [as a minimum following table]:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	14
2401 and over	50 x 50 x 6	14

- .4 Upper hanger attachments:
- .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps:

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 metal duct 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 Departmental Representative.

3.2 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, SMACNA, and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct. Ensure diffuser is fully seated.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.

- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.4 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 Minimum [3000] mm from duct mounted humidifier in all directions.
 - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards hoods or connections served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with [150] mm deep drain sump and [32] mm drain connected, with deep seal trap and valve and discharging to open funnel drain, or as indicated.

3.5 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA.
- .2 Bed tape in sealant and recoat with minimum of [1] coat of sealant to manufacturers recommendations.

3.6 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of [30] m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete test before performance insulation or concealment Work.

3.7 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 for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.06 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, [2013].

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 air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
 - .5 Seismic bracing points.

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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 2 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at minus [40] degrees C to plus [90] degrees C, density of [1.3] kg/m².

2.3 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to [300 x 300] mm: two sash locks complete with safety chain.
 - .2 [301 to 450] mm: four sash locks complete with safety chain.
 - .3 [451 to 1000] mm: piano hinge and minimum two sash locks.
 - .4 Doors over [1000] mm: piano hinge and two handles operable from both sides.
 - .1 Hold open devices.
 - .2 [300 x 300] mm glass viewing panels.

2.4 TURNING VANES

- .1 Factory or shop fabricated single thickness without trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

- .1 [1.6] mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

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 air duct accessories 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 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: [100] mm.
 - .3 Minimum distance between metal parts when system in operation: [75] mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
 - .3 Flexible material shall not reduce flow cross sectional area.
- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 [1200] x [1200] mm for person size entry.
 - .2 [450] x [600] mm for servicing entry.
 - .3 [450] x [450] mm for viewing.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.

- .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
- .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.06 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-[2013].

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

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 dampers for incorporation into manual.

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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

-
- Part 2** **Products**
- 2.1** **GENERAL**
- .1 Manufacture to SMACNA standards.
- 2.2** **SPLITTER DAMPERS**
- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.
- 2.3** **SINGLE BLADE DAMPERS**
- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.
- 2.4** **MULTI-BLADED DAMPERS**
- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 150 mm.
- .4 Bearings: pin in bronze bushings.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage : 0.5% at 2500 Pa – low leakage characteristic.
- 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 damper 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 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Departmental Representative.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.6 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems
- .9 Section 23 33 00 – Air Duct Accessories

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-[12], Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[12], Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, [2013].
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction,[2008].
- .4 Underwriters' Laboratories (UL)
 - .1 UL 181-[2013], Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-[2013], Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.

- .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
 - .6 UL or ULC rating.
- .3 Test and Evaluation Reports:
- .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect flexible ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for re-use or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for re-use or recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

- .1 Type 1: spiral wound flexible aluminum with flexible vinyl coated fibreglass cloth membrane, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, [37] mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to [5.0] kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: [3].
 - .3 Thermal loss/gain: 1.15 W/m². degrees C mean.

2.4 NON-METALLIC - UNINSULATED

- .1 Type 3: non-collapsible, coated aluminum foil mylar type, mechanically bonded to, and helically supported by, external stainless steel wire, as indicated.
- .2 Performance:
 - .1 Factory tested to [2.5] kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: [3].

2.5 NON-METALLIC - INSULATED

- .1 Type 4: non-collapsible, coated aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, [37] mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to [5.0] kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: [3].
 - .3 Thermal loss/gain: 1.15 W/m². degrees C mean.

2.6 METALLIC ACOUSTIC INSULATED - MEDIUM PRESSURE

- .1 Type 5: spiral wound, flexible perforated aluminum with factory applied [37] mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate [Type M] vapour barrier, as indicated.
- .2 Performance:
 - .1 Factory tested to [2.5] kPa without leakage.

- .2 Maximum relative pressure drop coefficient: [3].
- .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

	Frequency (Hz)				
Duct Diam:	125	250	500	1000	2000
[100]	[0.6]	[3]	[12]	[27]	[0]
[150]	[1.2]	[3]	[12]	[22]	[27]
[200]	[2.0]	[5]	[12]	[19]	[20]
[300]	[2.4]	[5]	[12]	[16]	[15]

2.7 METALLIC - ACOUSTIC INSULATED - HIGH PRESSURE

- .1 Type 6: spiral wound, flexible perforated aluminum with factory applied [37] mm thick flexible mineral fibre thermal insulation and encased in spiral wound flexible aluminum jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to [2.5] kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: [3].
 - .3 Acoustical performance: minimum attenuation (dB/m) to following table:

	Frequency (Hz)				
Duct Diam:	125	250	500	1000	2000
[100]	[0.6]	[3]	[12]	[27]	[0]
[150]	[1.2]	[3]	[12]	[22]	[27]
[200]	[2.0]	[5]	[12]	[19]	[20]
[300]	[2.4]	[5]	[12]	[16]	[15]

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 flexible ducts 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 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.

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 Waste Management: separate waste materials for 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 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.06 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C423-[09a], Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916-[85(2007)], Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071-[12], Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338-[14], Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21-[13], Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-[12], Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[12], Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .3 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA AH116-[2002], Fibrous Glass Duct Construction Standards.
- .4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible-[2005].
 - .2 SMACNA IAQ Guideline for Occupied Buildings Under Construction-[2008].
- .5 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-[10], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

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 [duct liners] and include product characteristics, performance criteria, physical size, finish and limitations.

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 [duct liners] for incorporation into manual.

1.5 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect duct liners from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A, and NFPA 90B.
 - .3 Fungi resistance: to ASTM C1338.
- .2 Rigid:
 - .1 Use on flat surfaces where indicated.
 - .2 [25] mm thick, to ASTM C1071 Type [2], fibrous glass rigid board duct liner.
 - .3 Density: [48] kg/m³ minimum.
 - .4 Thermal resistance to be minimum 1.15 (m².degrees C)/W for 38 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on faced air side: 20.3 m/s.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.

- .3 Flexible:
 - .1 Use on round or oval surfaces.
 - .2 [25] mm thick, to ASTM C1071 Type [1], fibrous glass blanket duct liner.
 - .3 Density: [24] kg/m³ minimum.
 - .4 Thermal resistance to be minimum 1.11 (m².degrees C)/W for 38 mm thickness and 1.41 (m².degrees C)/W to 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on coated air side: 25.4 m/s.
 - .6 Minimum NRC of [0.65 at 25 mm] thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

- .1 Adhesive: to NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3 Water-based, fire retardant type.

2.3 FASTENERS

- .1 Weld pins [2.0] mm diameter, length to suit thickness of insulation. Metal retaining clips, [32] mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane [50] mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

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 duct liner 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 GENERAL

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standard except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.3 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive (to ASTM C916).
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMACNA HVAC Duct Construction Standard.
 - .2 In systems, where air velocities exceeds [20.3] m/s, install galvanized sheet metal nosing to leading edges of duct liner.
 - .3 Do not expose raw edges to air stream.

3.4 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply [2] coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having [15] mm overlap and fastened to duct.

3.5 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 for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 QUALITY ASSURANCE

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

1.3 SUBMITTALS

- .1 Fan shop drawings shall include sound rating data and fan curves showing operating point plotted on curves.
- .2 Fan shop drawings shall include motor efficiencies. Refer to Section 23 05 13 for minimum motor efficiencies.

1.4 GENERAL

- .1 Motors powered by variable speed drive controllers shall be EEMAC class B with Type F "inverter duty" insulation, shall have a 1.15 service factor on sine wave power, 1.0 service factor on PWM power and meet NEMA Code MG-1, 1993 Part 31.

Part 2 Products

2.1 FANS - GENERAL

- .1 Provide fans selected for maximum efficiency and generating noise levels on site not exceeding the level calculated from the ASHRAE Guide (1987* Systems, Ch. 52, Table 5). If fans are not specified at maximum efficiency, advise mechanical consultant before tendering and submit alternate price for maximum efficiency fans. If approval to supply noisier fans is not obtained prior to tendering, provide equipment meeting ASHRAE levels on site without loss in efficiency.
- .2 Submit fan sound power levels with shop drawings measured to applicable AMCA standards, or other data acceptable to the engineer. Provide test data, if requested. Indicate on shop drawings the test configuration, including ductwork, and any end reflection corrections applied to the data and / or if such corrections have been omitted.
- .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA-99-83. Dynamically balance fans to 1.5-mm/s vibration amplitude, maximum measured on bearing housings. Provide fan shafts with critical speed at least 1.5-times operational speed.
- .4 Ratings: based on tests performed in accordance with AMCA 210, and ASHRAE 51-85. Units shall bear AMCA certified rating seal.

- .5 Refer to Section 23 05 13 for high efficiency motor requirements.
- .6 Refer to drawings for motor position, rotation and discharge arrangements.
- .7 For motors less than 10 H.P. provide standard adjustable pitch drive sheaves having +/- 10% range. Use mid-position of range for specified RPM.
- .8 For motors 10 H.P. and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.
- .9 Match drive and driven sheaves.
- .10 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.
- .11 Minimum drive rating shall be 150% of nameplate rating of motor
- .12 Not less than a 2-belt configuration is required for each drive for motors 3/4 H.P. and larger.
- .13 Provide belt guard with tachometer ports for all belt drive fans.
- .14 Where fans are used for smoke exhaust, the motor, bearings, operators, etc. shall be capable of three (3) hours of operation at 250°C [482°F].
- .15 Bearings shall have a minimum L-10 life of 100,000 hours based on the maximum safe speed of the fan class.
- .16 Where required, fans shall be treated to suit the airstream in which they are used.
- .17 Provide secure attachment points for seismic restraints. Mounting brackets shall be suitable for seismic loading.

2.2 FANS - MOTORS AND VARIABLE SPEED DRIVES

- .1 Provide motors and variable frequency drive / motor assemblies generating noise levels which are imperceptible in the occupied space, and outside building, relative to fan noise. Provide acoustical data confirming required performance prior to tendering. If approval is not obtained prior to tendering, provide equipment meeting specified imperceptible requirement without loss in efficiency.

2.3 FANS - CABINET

- .1 Minimum Requirements:
 - .1 Steel cabinet arranged for ducted inlet and outlet connections c/w duct collars (where shown) or ceiling exhaust opening c/w exhaust grille (where shown).
 - .2 Acoustically insulated cabinet.
 - .3 Centrifugal fan on rubber isolators.
 - .4 Backdraft damper.

- .5 Access panel.
- .6 Integral motor thermal overload protection.
- .7 Motor disconnect plug and integral receptacle.
- .2 Accessories:
 - .1 Solid state speed control - where scheduled.

2.4 FANS - CEILING EXHAUST

- .1 Minimum Requirements:
 - .1 Centrifugal blower, motor vibration isolated.
 - .2 Built-in backdraft damper.
 - .3 White plastic exhaust grille.
 - .4 Adjustable hanger bracket.
 - .5 Pre-wired outlet box, plug-in receptacle.
- .2 Accessories:
 - .1 Solid state speed control - where scheduled.

Part 3 Execution

3.1 FANS

- .1 Install fans as indicated, complete with vibration isolators and seismic restraints as specified in Sections 23 05 48 and 23 05 49.
- .2 Install fans with flexible connections on inlet ductwork and on discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25 mm [1"] flex between ductwork and fan during running.
- .3 Install connectors such that connectors are clear of the air stream. Provide flange extensions as necessary. Ensure accurate alignment of duct to fan.
- .4 Provide safety screens where fan inlet or outlet is exposed.
- .5 Provide belt guards on belt driven fans.
- .6 Provide and install sheaves and belts required for final air balance.
- .7 Assist the Balancing Agency in altering blade pitch angles as required for final air balance. Provide access to fan wheel for blade adjustment.
- .8 Mount floor mounted fans on 100 mm [4"] thick concrete housekeeping bases (bases under Division 3).
- .9 Mount roof mounted fans on curbs 200 mm [8"] minimum above roof.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.06 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .8 Section 23 05 94 – Pressure Testing of Ducted Air Systems

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 diffusers, registers, and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.4 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect diffuser, registers, and grilles from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity [as indicated].
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board and as specified.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as directed by Departmental Representative.

2.3 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 Type SA: aluminum, 25 mm border, double deflection with airfoil shape, horizontal face and vertical rear bars. Finish: baked enamel, to resemble clear anodized finish.
- .3 Type SB: aluminum, 25 mm border, double deflection with airfoil shape, vertical face and horizontal rear bars. Finish: T-bar white. Volume damper.
- .4 SC: square ceiling plaque diffuser, T-bar white, with sectional baffles.

2.5 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 Type RA: steel, 19 mm border, single 45 degrees deflection, horizontal face bars. Finish: grid white. Volume damper.

- .3 Type RB: aluminum, 19 mm border, single, 45 degrees deflection, vertical face bars. Finish: grid white. Volume damper.

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 diffuser, register and grille 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 Install in accordance with manufacturer's instructions.
- .2 Install with flat head stainless steel screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place.
- .4 Provide concealed safety chain on each grille, register and diffuser in compliance with seismic requirements.

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 Waste Management: separate waste materials for 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 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 FILTERS – QUALITY ASSURANCE

- .1 Filters shall be product of and supplied by one manufacturer.
- .2 Filter media shall be ULC listed and labelled, Class I or Class II.
- .3 Filters suitable for air at 100% RH and air temperatures between 3°C [37°F] and 50°C [122°F].
- .4 Dust holding capacity: Air Filter Institute (AFI) Test.
- .5 Efficiency: based on ASHRAE 52-76, atmospheric dust spot efficiency. "Absolute filter" efficiency shall be tested with 0.3 Poly-alpha-olefin (P.A.O.) smoke.
- .6 Representative filters shall have been tested by an independent test laboratory and test results shall be made available on request.

Part 2 Products

2.1 FILTERS - GENERAL

- .1 Filter identification shall be clearly marked on each filter.
- .2 Provide two (2) sets of filter media (for each filter) - one for initial installation and one for handover to the owner as a spare. This does not apply to HEPA filters. Obtain signed receipt.
- .3 All filters sizes shall conform to the existing V.G.H. - Physical Plant Standard. 600x600 [24"x24"], 600x500 [24"x20"], 600x300 [24" x12"], or 300x300 [12"x12"].
- .4 Roll type filters, automatic advance or otherwise will not be considered as an acceptable means of filtration.
- .5 The use of permanent washable type impingement filters is generally not acceptable.

2.2 FILTERS - PANEL TYPE

- .1 Minimum Requirements:
 - .1 50 mm [2"] thick disposable pleated cotton media.
 - .2 Enclosing frame shall be constructed from rigid, heavy-duty high wet strength beverage board with diagonal support members bonded to both sides of each pleat.

- .3 Efficiency: MERV 8 15 per ASHRAE Standard 52.2 and an average dust spot efficiency of 25% to 30% per ASHRAE Standard 52.1.
- .2 Standard of Acceptance:
 - .1 AAF AM-AIR 300, Farr 30/30.

2.3 FILTER - HOLDING FRAMES

- .1 Built-up Frames:
 - .1 Provide separate holding frames for each bank of panel filters and each bank of final filters.
 - .2 Provide combined holding frames for panel/final filters.
 - .3 Factory fabricated from 1.6 mm [16 ga] galvanized steel with spring retaining clips and neoprene gaskets.
- .2 Slide-in-Frames:
 - .1 Provide slide-in-channels for filters mounted in ductwork where noted. Provide hinged and gasketed access doors.

Part 3 Execution

3.1 FILTERS

- .1 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Provide new filters at handover to the Owner. Replace filters used during construction.
- .2 Provide filter banks in arrangement shown with removal and access indicated. Demonstrate removal of filters prior to substantial completion.
- .3 Provide and install Dwyer filter pressure gauges across each filter installation.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCE STANDARDS

- .1 Do installation of in accordance with CSA B52 except where specified otherwise.

1.3 QUALITY ASSURANCE

- .1 Cooling tower shall be product of manufacturer regularly engaged in production of units of type and size specified, who issues complete catalogue data, operation and maintenance instructions on such products.

1.4 GENERAL

- .1 Motors powered by variable speed drive controllers shall be EEMAC class B with Type F "inverter duty" insulation, shall have a 1.15 service factor on sine wave power, 1.0 service factor on PWM power and meet NEMA Code MG-1, 1993 Part 31.
- .2 Refer to Section 23 05 13 for minimum motor efficiencies. Shop drawings to include motor efficiencies.

1.5 INSTALLATION START-UP AND INSTRUCTION

- .1 Manufacturer's representative shall inspect tower after installation is complete and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturer's recommendations.
- .2 Manufacturer's representative shall instruct Owners maintenance personnel in operation.

Part 2 Products

2.1 COOLING TOWERS – FORCED DRAFT

- .1 General:
 - .1 Provide as indicated factory assembled forced draft counterflow vertical discharge cooling tower. Maximum drift loss not to exceed 0.05% of water circulated.
- .2 Casing and Frame Work:
 - .1 Hot-dip galvanized steel casing, angles and channels.
 - .2 Access panels for servicing and maintenance.

- .3 Assembly suitable for outdoor installation.
- .3 Cold Water Basin:
 - .1 Self-cleaning, depressed sump with drain and cleanout connections, anti-vortexing device, strainer, overflow, float operated brass makeup valve.
 - .2 Materials: galvanized steel.
- .4 Water Distribution:
 - .1 Galvanized steel or Schedule 40 PVC header and spray branches with plastic distribution nozzles designed for quick nozzle and branch removal for servicing.
- .5 Fill and Eliminators:
 - .1 Fill: vertical sheets of PVC or chevron configuration of film type PVC.
 - .2 Eliminators: Hot-dip galvanized sheet steel.
 - .3 PVC: flame spread rating of 10 to ULC-S102.
- .6 Fans:
 - .1 Forward curve centrifugal type, statically and dynamically balanced. Housing: inlet ring and four sided discharge cowl extended into pan.
 - .2 Fan drive: V-belt designed for not less than 150% of motor nameplate reading.
 - .3 Motor: drip proof, ball bearings, weather protected.
 - .4 Drives, fans, and moving parts protected by galvanized wire guards.
 - .5 Each fan will have a weatherproof disconnect with early break auxiliary switch.
- .7 Spray Pump
 - .6 Spray pump with distribution piping – secured to the tower housing/
 - .7 Pump will have a weatherproof disconnect with early break auxiliary switch.
- .8 Accessories:
 - .1 Capacity control dampers (in fan discharge). Electric damper control package, including transformer, temperature controller, motor actuator, linkage and end-switch.
 - .2 Driven by variable frequency drives. Provide weatherproof control panel for variable frequency drives and line and load side filters, mounted on cooling towers, or for independent mounting adjacent to cooling towers. Panel will include required cooling and heating.
 - .3 Factory mounted electric pan heater and thermostat and low water cut-out to maintain sump at 4.4°C [40°F] at outdoor winter design temperature.
 - .4 Permanent galvanized steel ladder.
 - .5 Solid bottom.
 - .6 “Baltibond” corrosion protection finish shall be applied to all external and internal galvanized steel.

.9 Control Panel

- .1 Enclosure shall be NEMA 4X, with internal heater and cooling for the environmental conditions and free standing installation outdoors.
- .2 Panel will include single point power connection, splitting into two feeds with disconnects: one for the fans and pumps, and the second for the sump heater. In addition, a 120V control circuit feed with service switch (with pilot light), and a 120V feed for panel (enclosure) AC system and auxiliary receptacle.
- .3 Fans and pumps will have VFD-s and required starters.
- .4 Controls for discharge damper and sump heater.
- .5 Terminal strips for power and control wiring.
- .6 Provide wiring diagram with shop drawings.

.10 Variable Speed Drive Controller

- .1 Minimum Requirements:
 - .1 Unit to operate with an input, line side power factor of 0.94 or better at all speeds and loads.
 - .2 All units supplied to the project must be of the same manufacturer and model type.
 - .3 Factory C.S.A. certified.
 - .4 Unit to operate in ambient temperatures ranging from 0o C to +40o C.
 - .5 Unit to operate at full load with a variation of -15% and +10% of rated building voltage.
 - .6 Unit to operate at full load with a variation of +5% of rated frequency.
 - .7 Printed circuit board design using the latest "state of the art" components including microprocessor control of protective circuits.
 - .8 Suitable for use with the standard or high efficiency EEMAC Design B motors used on this project.
 - .9 VSD module and all additional peripheral components as specified herein, to be integrated and mounted in one common EEMAC 1 (use EEMAC 3R for outdoor units) wall or floor mounted enclosure.
 - .10 Transformers shall not be used on either the input or output of unit.
 - .11 The VSD shall have an adjustable PWM carrier/switching frequency from nominal 1 through 12 kHz. Units unable to adjust to a minimum upper level of 12 kHz are not acceptable. Maximum switching frequency of 16 kHz.
 - .12 The VSD shall include reactors or LRC filters as necessary to protect the motor from PWM - IGBT voltage spikes and limit the voltage rise times and maximum peak voltages throughout the specified building voltage range and for all operating conditions at the related motor connections as follows:
 - .1 Maximum peak voltage 1000 volts.
 - .2 Maximum voltage rate of rise: 500 volts/microsecond.

- .2 Unit shall be provided with protection against:
 - .1 Stalls caused by overcurrent.
 - .2 Stalls caused by regenerative overvoltage.
 - .3 Overcurrent protection.,
 - .4 Regenerative overvoltage protection.
 - .5 Overload protection (thermal type).
 - .6 Ground fault protection.
 - .7 Instantaneous power failure protection.
 - .8 Alarm against overload.
 - .9 Overtemperature of heat sink.
 - .10 Input power under voltage, over voltage and phase loss.
 - .11 DC bus over voltage.
- .3 The unit shall have the following features:
 - .1 Adjustable acceleration and deceleration. Across the line starting shall not be possible. A ramp up time from 0 RPM to 1800 RPM of 30 seconds shall be the minimum possible ramp up time.
 - .2 Dynamic breaking for acceleration and stopping.
 - .3 Critical speed avoidance will allow for the selection of two skip speeds and a rejection band of 0 – 10Hz around each speed.
 - .4 Voltage/frequency ratio and adjustment.
 - .5 Power failure restart to be selectable and programmable for number of attempt's & time interval between attempt's. Unit also to have circuits to permit a start into a rotating motor, in either direction without trip or failure.
 - .6 Frequency range (output) 2 - 60 Hz minimum.
 - .7 Frequency resolution of 0.5 Hz or better.
 - .8 Frequency accuracy of +/-0.5% at 25°C.
 - .9 Able to accept a 4-20 milliamp, 0 to 5 vdc or 0 to 10 vdc external control signal for speed control.
 - .10 Able to accept a remote start / stop control.
 - .11 Minimum of 3 programmable preset speeds to facilitate operation of the unit from interlocks, at fixed speeds.
- .4 Provide EMI filters to reduce EMI to FCC acceptance levels.
- .5 The units shall have the following components:
 - .1 Run and Stop pushbuttons or switch.
 - .2 Hand-Off-Auto selector switch.
 - .3 Manual speed adjusting potentiometer.
 - .4 Fused disconnect switch rated for the full connected load and complete with lockable, through door operator, defeatable with screw driver. Fuses to be suitable semi-conductor rated.
 - .5 Trip relay with light.
 - .6 Run relay with light.

- .7 Analogue speed indicator, 0 - 110%, 50mm [2"] bezel minimum.
- .8 110 volt control transformer, fused in the primary and secondary.
- .9 Auto reset thermal overload - relay interlocked in run circuit.
- .10 Terminal strip to accept N.C. safety contacts such as freeze stats and smoke alarms to safety shut down VSD when in Hand or Auto position.
- .11 N2 Interface card for interface with BMS to provide full control, status and alarm interface.
- .12 Form C contacts to indicate run mode.
- .13 Form C contacts to indicate fault or alarm mode.
- .14 0 to 10 VDC output signal directly proportional to controller's speed.
- .15 Provide integral factory wired and mounted bypass provisions, where scheduled, such that the controlled motors can be manually put into operation bypassing the VSD. Bypass to consist of a motor contactor and overload relay rated for the connected load. The bypass must have its own isolating device to allow corrective work on the VSD whilst operating in the bypass mode. Bypass contactor and VSD must be fully interlocked to prevent both outputs being enabled simultaneously. Control of the bypass will be by means of an enclosure door mounted VSD Bypass selector and Start Stop pushbuttons. Two door mounted lamps shall be provided to indicate operating mode (VSD or Bypass).
- .6 Units shall be equipped with a 5% line reactor and a harmonic filter on the power input side to prevent the backfeeding of harmonics into the power system. Filters should control the THD within the values specified by IEEE 519.
- .7 All power wiring connections shall be by Division 26 and all control wiring by the Controls Contractor.
- .8 The manufacturer's representative shall be present at start-up and shall supervise the start-up and test the voltage at the motor connection with the Commissioning Agency present with a digital oscilloscope with storage capacity and with a sufficiently fast sample time to accurately measure voltage rate of rise to confirm that the voltage spikes and rate of rise are within the specified level. Submit the results to the Consultant including the input voltage on all three phases to the VSD at the time of measurement.
- .9 The manufacturer's representative shall be present for a minimum of 1/2 day to instruct the building maintenance personnel in the correct use and operation of the VSD units following the commissioning of the systems.
- .10 Provide a parts and labour warranty for three years subsequent to Substantial Completion for the Variable Speed Drives.
- .11 Provide a three year parts and labour warranty against VSD related failure for each motor connected to a VSD power output.
- .12 Shop drawings shall include:
 - .1 Dimensional drawings.
 - .2 All connection points.
 - .3 Power circuit diagrams.

- .4 Installation and maintenance manuals.
 - .5 Warranty description.
 - .6 Certification of agency approvals.
 - .7 Conformance to each specified requirement.
 - .8 Placement of input and output reactors / filters, EMI filters, semi-conductor rated fuses (where required).
 - .9 Harmonic analysis indicating the level of harmonic distortion that the drives will cause.
- .13 Variable speed drives shall be configured with hand-off-auto override capability. For applicable fans, the hand position shall override the normal EMCS control output. When the VSD is bypassed for maintenance or due to failure the controlled motor shall operate as if in hand position such that the FFPC control output and the freeze protection interlock (if applicable) are not overridden.

Part 3 Execution

3.1 TOWER INSTALLATION

- .1 Unit to be installed as indicated and to manufacturers recommendations, ensuring adequate clearances for servicing and maintenance.
- .2 Provide steel frame under cooling tower(s). Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .3 Elevate tower to maintain maximum possible positive suction head on condenser pump.
- .4 Unless otherwise noted, all wiring between the respective disconnect switch and the electrical device shall be by cooling tower manufacturer.
- .5 Ensure manufacturers field service representative approves installation and is present to supervise start up and to instruct operators.
- .6 Mount the control panel, and wire to devices. Provide independent support for the control panel.
- .7 The following shall be provided and installed under other divisions/sections.
 - .1 All power wiring between fan disconnect switch, starter and fan motor - Division 26.
 - .2 Control wiring between damper end switches and fan motor starter holding coils - Division 26.
 - .3 Power wiring for the 575/3/60 power to the sump heater, the two pole magnetic contactors in the power circuit, the disconnect switch for 115/1/60 power to sump heater controls and the power wiring to the sump heater - Division 26.
 - .4 Control wiring for the sump heater control.
 - .5 Power wiring to discharge hood dampers - Division 26.

- .6 Wiring from disconnect switch to damper actuators and spray pump motor holding coil.
- .7 Vibration isolation and seismic restraints - Section 23 05 49.

3.2 PERFORMANCE

- .1 Control electric sump heaters from sump-mounted thermostat and interlock with float control so heaters will operate only when there is water in sump.
- .2 Provide time delay relay to limit fan motor starts to maximum of six (6) per hour.
- .3 Capacity control for unit suitable for stable operation down to 10% of rated cooling.

END OF SECTION

1 Halocarbons

- .1 Comply with all of:
 - .1 Federal Halocarbon Regulations, 2003;
 - .2 *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems* (the Environment Canada "Refrigeration Code of Practice") Report EPS 1/RA/2. March, 1996.
- .2 Work on Halocarbon Systems includes installation, servicing, leak testing or charging of a refrigeration system or an air-conditioning system or doing any other work on the system that may result in the release of a halocarbon.
- .3 All work on Halocarbon Systems shall be carried out only by a "Certified Person" as defined by the Federal Halocarbon Regulations 2003.
 - .1 Provide copies of all technicians' certificates to the Departmental Representative.
- .4 Halocarbons listed under Item 1 through 10 of Schedule 1 of Federal Halocarbon Regulations, 2003 (SOR/2003-289) are not acceptable refrigerants.
- .5 Document **all** work on Halocarbon Systems using CFCs halocarbon form "**Information Required for Refrigeration Systems at Federal Facilities**". Obtain the latest form from Departmental Representative. Affix the completed form to equipment, and submit a copy of the form to Departmental Representative.
- .6 Comply with the following timelines:
 - .1 Upon delivery of halocarbon-containing equipment to site, submit the following information to Departmental Representative within 24 hours of service;
 - .1 Make
 - .2 Model
 - .3 Serial number
 - .4 Type of halocarbon
 - .5 Halocarbon charging capacity of system (kg or lbs)
 - .6 Factory Halocarbon Charge (kg or lbs)
 - .7 Cooling capacity (kW, Btuh, or Tons)
 - .2 Leak-test factory-charged halocarbon-containing equipment containing over 10kg of refrigerant in accordance with the Refrigeration Code of Practice within one week of equipment delivery to site.
 - .3 Leak-test field-charged halocarbon-containing equipment in accordance with the Refrigeration Code of Practice immediately following field charge of system.
 - .4 For all work on Halocarbon Systems, submit forms to Departmental Representative within 48 hours of work.

- .5 For release of halocarbons >10 kg and <100 kg, submit forms to Departmental Representative within 24 hours of discovery of release.
- .6 For release or potential release of halocarbons > 100 kg, submit forms to Departmental Representative **immediately**.
- .7 Conduct annual leak tests of halocarbon-containing equipment with 19kW (5.4 tons) or greater cooling capacity in accordance with the *Federal Halocarbon Regulations, 2003* until such time as Interim Certificate of Completion is issued.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 35 29.6 – Health and Safety Requirements
- .3 Section 01 61 00 – Common Product Requirements
- .4 Section 01 74 11 – Cleaning
- .5 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .6 Section 23 05 00 – Common Work Results for HVAC
- .7 Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .8 Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- .9 Section 23 05 94 – Pressure Testing of Ducted Air Systems
- .10 Section 23 73 12 – Halocarbon Management.

1.2 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 210/240-[2008], Unitary Air Conditioning and Air-Source Heat Pump Equipment.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
 - .1 ANSI/ASHRAE Standard 15-[2010], Safety Standard for Refrigeration Systems.
- .3 Air-Conditioning and Refrigeration Institute (ARI)
 - .1 ARI 320-[1998], Standard for Water-Source Heat Pumps.
 - .2 ARI 325-[98], Standard for Ground Water - Source Heat Pumps.
- .4 CSA International
 - .1 CAN/CSA-C656-[2014], Performance Standard for Split-System and Single Package Central Air Conditioners and Heat Pumps.
 - .2 CAN/CSA-C13256-[2001(R2015)], Water-Source Heat Pumps-Testing and Rating for Performance, Part 1 Water-to-Air and Brine-to-Air Heat Pumps.
- .5 Environment Canada, (EC) / Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2-[1996], Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada-[1994], Ozone-Depleting Substances Alternatives and Suppliers List.
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-[2012], Standard for Installation of Air Conditioning and Ventilating Systems.

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 heat pumps and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings per Section 01 33 00 – Submittal Procedures.

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 heat pumps for incorporation into manual.

1.5 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 off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat pumps from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 WARRANTY

- .1 For computer room air conditioning 12 months warranty period is extended to [60] months.
- .2 Contractor hereby warrants that computer room air conditioning will not spall or show visible evidence of cracking, except for normal hairline shrinkage cracks, in accordance with CCDC 2 General Conditions [GC 12.3], but for [5] years.

Part 2 Products

2.1 DESCRIPTION

- .1 Heat pumps: to EPS 1/RA/2, CSA approved and with ARI or CSA certification seal.

2.2 REFRIGERANTS

- .1 Type of Refrigerant: not subject to phase out protocols. Refer to Section 23 73 12 – Halocarbon Management.

2.3 DRAIN PANS

- .1 Design and construct condensate drain pans under indoor coils so that no water can accumulate and install to allow for easy cleaning.
 - .1 Corrosion resistant (air quality) drain pans.
 - .2 Condensate pump package.

2.4 INCREMENTAL WATER SOURCE HEAT PUMP

- .1 General:
 - .1 Horizontal type, as indicated, consisting of factory-assembled package containing fan, air-to-refrigerant coil, compressor, 4-way reversing valve, water-to-refrigerant heat exchanger, controls for use with environmentally friendly refrigerant.
 - .2 Factory packaged, self-contained and pre-wired.
 - .3 The unit and all refrigeration components shall be rated for use with an environmentally friendly refrigerant (R-134a, R-407C, R-410A). CFC and HCFC refrigerants, subject to Montreal Protocol, are not acceptable. Field conversion of refrigerants will not be acceptable.
- .2 Performance: as indicated.
 - .1 Certified in accordance with CAN/CSA-C13256.
 - .2 Ratings in accordance with CAN/CSA-C13256.
 - .3 A.R.I. 320-85 certification, U.L. And C.S.A. Approvals.
 - .4 All heat pumps shall be guaranteed to produce an average Energy Efficiency Ratio (EER) of 16.0 or better and a weighted average Coefficient of Performance (COP) of 3.4 or better when tested in accordance with ARI/ISO Standard 13256-1.
- .3 Basic unit:
 - .1 Compressor: welded hermetic type with internal vibration isolation. Controls to prevent compressor short cycling.
 - .2 Air-to-refrigerant coil: aluminum plate fins mechanically bonded to copper tubing with joints brazed and with controls factory installed.
 - .3 Water-to-refrigerant heat exchanger: circular tube-in-tube type with steel outer tube or brazed plate, cupro-nickel 2 MPa.
 - .4 Refrigerant piping: factory assembled, tested charged with refrigerant sealed, with metering device, thermal expansion valve, pilot operated refrigerant reversing valve, high pressure and low temperature safety cut-outs.
 - .5 Water piping within unit: factory assembled and tested to [1.4] MPa minimum.
 - .6 FPT connections: gate valve tested to 1.4 MPa minimum WOG (on supply line) and ball valve tested to 2.8 MPa minimum WOG (on return line), flexible hose with threaded swivel connections on supply and return lines to heat exchanger.
 - .7 Piping connections: arranged so that only one supply and return connections to hydronic system is required on site.

- .8 Fan: centrifugal forward curved with double inlet, statically and dynamically balanced direct or belt driven from multi-speed, factory lubricated motor.
- .9 Filters: 25 mm thick throw away type, MERV 13.
 - .1 Provide spare filter for each unit.
- .10 Unit cabinet: constructed of heavy gauge die-formed galvanized steel with welded corner bracing, complete with provision for connection to return ductwork, hanger brackets and vibration isolators.
 - .1 Cabinet acoustically insulated.
 - .2 Finish: oven baked enamel.
- .11 Provide for field connection of water and electrical services.
- .12 Condensate drain: manufactured from stainless steel pan and piping designed to ensure complete removal of water.
 - .1 Drain connections: minimum NPS 3/4.
- .13 Controls: wall mounted with OFF-COOL-HEAT and HIGH-LOW fan speed selectors, manually adjustable thermostat with remote bulb in return air. BACnet interface with EMCS.
- .14 Unit will operate with continuous fan operation.
- .15 Outside air connection: complete with foam type gasketting.

.4 Noise and vibration requirements:

- .1 Sound ratings: measured from unit casing at unit inlet while in cooling mode.
- .2 Maximum permissible outlet Sound Power Levels (DB re 10-12 Watts): [as indicated] [as follows]:

Unit no:	Octave Band Centre Frequencies:						
	2	3	4	5	6	7	8
1:	[65]	[60]	[56]	[51]	[44]	[40]	[39]

- .3 Where manufacturer cannot meet specified Sound Power Levels, provide downstream or upstream silencer. Where radiated noise level exceeds specified PWL, provide special enclosure around entire unit, designed to fit in allotted space and still allow full access to unit for operations and maintenance.

.5 Accessories:

- .1 Hanger/vibration isolator kit c/w brackets.
- .2 Thermostats and controls interface as specified.
- .3 Hose kits - all hose kits shall include two 300 mm [12"] long flexible reinforced rubber hoses (rated at 1380 kPa [200 psi] working pressure) with brass pipe connections (swivel on one end).
- .4 One spare set of filters for each unit.

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 heat pumps 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 Install where indicated and in accordance with manufacturer's instructions.
- .2 Provide acoustically insulated return air boot – see drawings.
- .3 Secure with hold-down bolts in accordance with manufacturer's recommendations.
- .4 Make duct connections through flexible connections.
- .5 Level unit with fans running. Align duct work. flexible connections. Misalignment with fan stopped not to strain or damage flexible connection.
- .6 Make piping connections. P/T plugs shall be provided on the supply and return piping connections to each unit.
- .7 Install temporary bypass piping arrangement, using flexible hoses, before piping is chemically cleaned. Replace permanent connections after piping has been flushed out.
- .8 Nothing to obstruct ready access to components or to prevent removal of components for servicing.

3.3 DRAIN PANS

- .1 Install so that no water can accumulate. Arrange easy access for cleaning.
- .2 Include internal or external trap for proper draining.
- .3 The inlet leg of the traps should be a minimum of 25 mm [1"] higher than the outlet leg.
- .4 Condensate drain piping should be graded towards the plumbing drain at minimum 1:200 [1/16 inch per foot].

3.4 START-UP AND COMMISSIONING

- .1 Have manufacturer certify installation.
- .2 Have manufacturer present during tests and start up units and certify performance.
- .3 Submit written start-up and commissioning reports to Departmental Representative.

3.5 CLOSEOUT ACTIVITIES

- .1 Manufacturer to deliver verbal, video, and written instructions to operating personnel.

3.6 CLEANING

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

3.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
 - .1 Start-up testing and verification of systems.
 - .2 Check out demonstration or proper operation of components.
 - .3 On-site operational tests.
 - .2 Related Requirements
 - .1 Section 01 11 00 – Summary of Work
 - .2 Section 01 45 00 – Quality Control
 - .3 Section 01 61 00 – Common Product Requirements
 - .4 Section 01 74 11 – Cleaning
 - .5 Section 01 78 00 – Close-out Submittals
 - .6 Section 09 91 23 – Interior Painting
 - .7 Section 23 05 00 – Common Work Results for HVAC
 - .8 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .9 Section 25 05 01 – EMCS: General Requirements
 - .10 Section 26 05 00 – Common Work Results – Electrical
 - .11 Section 26 27 10 – Modular Wiring Systems
 - .12 Section 26 27 26 – Wiring Devices

1.2 DEFINITIONS

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.
 - .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.

- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.
 - .3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.3 DESIGN REQUIREMENTS

- .1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01330 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Report format to be approved by Departmental Representative before commissioning is started.
 - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
 - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide documentation, O M Manuals, and training of O M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.6 COMMISSIONING

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative and PWGSC Commissioning Manager.
- .3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.

- .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Load system with project software.
- .7 Perform tests as required.

1.7 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and PWGSC Commissioning Manager.

1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 EQUIPMENT

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Departmental Representative.
- .4 Debug system software.

- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

- .1 Pre-Installation Testing.
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
 - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
 - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
 - .5 Additional instruments to include:
 - .1 DP transmitters.
 - .2 VAV supply duct SP transmitters.
 - .3 DP switches used for dirty filter indication and fan status.
 - .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between [0] and [500] Pa, to hold steady at any setting and with direct output to milli-amp meter at source [and to [BECC]].
 - .7 After setting, test zero and span in [10] % increments through entire range while both increasing and decreasing pressure.
 - .8 Departmental Representative [0.5] to mark instruments tracking within % in both directions as "approved for installation".
 - .9 Transmitters above [0.5]% error will be rejected.
 - .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
 - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
 - .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.

- .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air at [700] kPa.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative. This document will be used in final start-up testing.
- .3 Final Start-up Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and PWGSC Commissioning Manager and provide:
- .1 Two technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final start-up testing.
 - .5 O M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .8 Operate systems as long as necessary to commission entire project.
 - .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
- .1 Prior to beginning of [30]day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
 - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
 - .2 Test to last at least [30] consecutive 24 hour days.

- .3 Tests to include:
 - .1 Demonstration of correct operation of monitored and controlled points.
 - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
- .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
 - .2 Requirements of Contract have been met.
- .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
- .6 Correct defects when they occur and before resuming tests.
- .5 Departmental Representative to verify reported results.

3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

- .1 Demonstrate to Commissioning Manager and Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.
- .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 01 – EMCS: General Requirements
 - .9 Section 26 05 00 – Common Work Results – Electrical
 - .10 Section 26 27 10 – Modular Wiring Systems
 - .11 Section 26 27 26 – Wiring Devices

1.2 DEFINITIONS

- .1 CDL - Control Description Logic.
- .2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative [30 days] prior to anticipated date of beginning of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of Phase 1 and Phase 2 training program that training has been satisfactorily completed.

1.4 QUALITY ASSURANCE

- .1 Provide bilingual, competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

1.5 INSTRUCTIONS

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

1.6 TIME FOR TRAINING

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.7 TRAINING MATERIALS

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
 - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O M).

1.8 TRAINING PROGRAM

- .1 To be in two phases over a 6-month period.
- .2 Phase 1: 2-day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative and PWGSC Commissioning Manager.
 - .1 Train O M personnel in functional operations and procedures to be employed for system operation.
 - .2 Supplement with on-the-job training during 30 day test period.
 - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
 - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: 5-day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.
 - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
 - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with [2] days training within [5] day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
 - .3 Programmers: provide personnel with [2] days training within a [5] day period in following subjects in approximate percentages of total course shown:

Software and architecture: [10]%
Application programs: [15]%
Controller programming: [50]%
Trouble shooting and debugging:[10]%
Colour graphic generation: [15]%

1.9 ADDITIONAL TRAINING

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.10 MONITORING OF TRAINING

- .1 Departmental Representative to monitor training program and may modify schedule and content.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Requirements
 - .1 Section 01 11 00 – Summary of Work
 - .2 Section 01 11 55 – General Instructions
 - .3 Section 01 45 00 – Quality Control
 - .4 Section 01 61 00 – Common Product Requirements
 - .5 Section 01 74 11 – Cleaning
 - .6 Section 01 78 00 – Close-out Submittals
 - .7 Section 01 91 13 – General Commissioning (Cx) Requirements
 - .8 Section 09 91 23 – Interior Painting
 - .9 Section 23 05 00 – Common Work Results for HVAC
 - .10 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .11 Section 26 05 00 – Common Work Results – Electrical
 - .12 Section 26 27 10 – Modular Wiring Systems
 - .13 Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5-[1985], Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 260.1-[2004], American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE STD 135-[R2012], BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-Z234.1-[00(R2011)], Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1-[B-2002], Control Network Protocol Specification.

- .6 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1-[1958], Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 ACRONYMS AND ABBREVIATIONS

- .1 Acronyms used in EMCS:
 - .1 AEL Average Effectiveness Level.
 - .2 AI Analog Input.
 - .3 AIT Agreement on International Trade.
 - .4 AO Analog Output.
 - .5 BACnet Building Automation and Control Network.
 - .6 BC(s) Building Controller(s).
 - .7 BECC Building Environmental Control Center.
 - .8 CAD Computer Aided Design.
 - .9 CDL Control Description Logic.
 - .10 CDS Control Design Schematic.
 - .11 COSV Change of State or Value.
 - .12 CPU Central Processing Unit.
 - .13 DI Digital Input.
 - .14 DO Digital Output.
 - .15 DP Differential Pressure.
 - .16 ECU Equipment Control Unit.
 - .17 EMCS Energy Monitoring and Control System.
 - .18 HVAC Heating, Ventilation, Air Conditioning.
 - .19 IDE Interface Device Equipment.
 - .20 I/O Input/Output.
 - .21 ISA Industry Standard Architecture.
 - .22 LAN Local Area Network.
 - .23 LCU Local Control Unit.
 - .24 MCU Master Control Unit.
 - .25 NAFTA North American Free Trade Agreement.

.26	NC	Normally Closed.
.27	NO	Normally Open.
.28	OS	Operating System.
.29	O M	Operation and Maintenance.
.30	OWS	Operator Work Station.
.31	PC	Personal Computer.
.32	PCI	Peripheral Control Interface.
.33	PCMCIA	Personal Computer Micro-Card Interface Adapter.
.34	PID	Proportional, Integral and Derivative.
.35	RAM	Random Access Memory.
.36	SP	Static Pressure.
.37	ROM	Read Only Memory.
.38	TCU	Terminal Control Unit.
.39	USB	Universal Serial Bus.
.40	UPS	Uninterruptible Power Supply.
.41	VAV	Variable Air Volume.

1.4 DEFINITIONS

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide [25] character field for each point identifier. "System" is system that point is located on.
 - .1 Area descriptor: building or part of building where point is located.
 - .2 System descriptor: system that point is located on.
 - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide [25] character field for each point identifier.
 - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide [32] character field for each point expansion.
 - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

- .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.
 - .2 Refer also to Section 25 05 54- EMCS: Identification.

1.5 SYSTEM DESCRIPTION

- .1 Refer to control schematics and sequence of control to derive system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.
 - .3 OWS(s).
 - .4 Data communications equipment necessary to effect EMCS data transmission system.
 - .5 Field control devices.
 - .6 Software/Hardware complete with full documentation.
 - .7 Complete operating and maintenance manuals.
 - .8 Training of personnel.
 - .9 Acceptance tests, technical support during commissioning, full documentation.
 - .10 Wiring interface co-ordination of equipment supplied by others.
 - .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
 - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
 - .4 Provide utility power to EMCS [and emergency power to EMCS] as indicated.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.

- .4 Language Operating Requirements:
 - .1 Provide English operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
 - .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
 - .5 Include, in English:
 - .1 Input and output commands and messages from operator-initiated functions, field related changes, alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Submit for review:
 - .1 Equipment list and systems manufacturers within 48 h after award of contract.
 - .2 List existing field control devices to be re-used included in bid, along with unit price.
- .4 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.

- .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
- .5 For materials whose compliance with organizational standards / codes / specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
- .6 Permits and fees: in accordance with general conditions of contract.
- .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
- .8 Existing devices intended for re-use: submit test report.

1.7 QUALITY ASSURANCE

- .1 Have local office within [50] km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide [7] year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .5 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within [2] weeks after award of Contract.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for recycling and place in designated containers Steel/Metal/Plastic waste in accordance with Waste Management Plan.
 - .5 Place materials defined as hazardous or toxic in designated containers.
 - .6 Handle and dispose of hazardous materials in accordance with CEPA and Regional and Municipal regulations.

- .7 Label location of salvaged material's storage areas and provide barriers and security devices.
- .8 Ensure emptied containers are sealed and stored safely.
- .9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .10 Fold up plastic banding, flatten and place in designated area for recycling.

1.9 EXISTING- CONTROL COMPONENTS

- .1 Utilize existing control wiring and piping as practical.
- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable standards and current system specifications.
 - .1 Do not modify original design of existing devices without written permission from Departmental Representative.
 - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Inspect and test existing devices intended for re-use within [30] days of award of contract, and prior to installation of new devices.
 - .1 Furnish test report within [40] days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
 - .2 Failure to produce test report will constitute acceptance of existing devices by contractor.
- .4 Non-functioning items:
 - .1 Provide with report specification sheets or written functional requirements to support findings.
 - .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.
- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
 - .1 Be responsible for items repaired or replaced by Departmental Representative.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment.
 - .3 Responsibility for existing devices terminates upon final acceptance of EMCS as approved by Departmental Representative.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

1.10 GENERAL DESCRIPTION

- .1 Connect to and integrate with the existing system. The existing system is by Delta

- controls, and includes several generations of controllers, some installed with the existing building.
- .2 System architecture shall accommodate tie in and integration, without slowing down the network, or data exchange.
 - .3 Provide work covered by sections referred to above consisting of a fully operational EMCS, including, but not limited to, following:
 - .1 Provide new standalone control panel (system), powered by emergency power and UPS. New panel to be connected to existing building control network. Provide all necessary control hardware, wiring, and work to meet design intent.
 - .2 Provide all Control devices as listed or referred to in I/O Summaries and sequence of operation.
 - .3 B-OWS complete with graphics development software . Provide graphics for new & existing systems as necessary.
 - .4 Data communications equipment and or cabling necessary to effect an EMCS data transmission system including connection to existing network. Note connection to remote Chemicals Storage Building as specified further.
 - .5 Provide Back-up UPS power source for new DDC system controllers for a minimum of 15 minutes.
 - .6 All field control end devices.
 - .7 Software complete with full documentation for software and equipment.
 - .8 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.
 - .9 Acceptance tests, technical support during commissioning, full documentation
 - .10 Provide wiring and interface co-ordination of equipment supplied by Division 22 and 23 (i.e. cooling towers, pumps, chemical treatment, etc). Include a point for smoke alarm in Chemical Storage Building (not part of a Fire Alarm System).
 - .11 Miscellaneous work as specified in these sections and as indicated.
 - .12 Software provided shall be of the manufacturer's most recent version available. Provide one copy of an B-OWS graphical operator workstation and programmers tool complete with implemented dynamic graphics and PC workstation as specified. Provide one copy of graphical webserver operator interface complete with webserver PC to be connected to the BAS and the client intranet LAN for operator interface from standard PC's with internet browser software.

1.11 METRIC REFERENCES

- .1 Conform to CAN/CSA-Z234.1.
- .2 Provide required adapters between Metric and Imperial components.

1.12 STANDARDS COMPLIANCE

- .1 All equipment and material to be from manufacturer's regular production, CSA certified where line voltage switching is required, manufactured to standard quoted plus additional specified requirements.

- .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
- .3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.
- .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
- .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.13 EMCS CONTRACTOR

- .1 Qualifications
 - .1 Have local office within 65 km of project for at least 5 years, staffed by trained personnel capable of providing instruction, routine maintenance, and emergency service on systems. Typical emergency response time to be on site shall be no longer than approximately four hours.

1.14 SYSTEM DESIGN

- .1 Responsibility
 - .1 Design and provide all conduit and wiring linking all elements of system, including future capability.
 - .2 Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by Departmental Representative prior to installation.
 - .3 Location of controllers to be approved by Departmental Representative prior to installation.
 - .4 Provide utility and emergency power to controllers.

1.15 LANGUAGE

- .1 Operating Requirements
 - .1 Operator to interface to system in English through operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals. All other information to be in English.
 - .3 Operating system executive: primary hardware-to-software interface (specified as part of hardware purchase) with associated documentation to be in English.
 - .4 System manager software: to include system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency. These functions to be in English.

- .5 EMCS operator: include, in English:
 - .1 All input and output commands and messages from operator-initiated functions and/or field related changes and/or alarms as defined in CDL's or assigned limits (i.e. all commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-refinements).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at all specified OWS and to be able to operate one terminal in English. Point name expansions in both languages.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, and maintenance generated messages.

1.16 PHASED CONSTRUCTION

- .1 Note that the construction is phased.
- .2 Refer to the project phasing requirements outlined in Section 011100 and as noted on drawings.
- .3 At the completion of each phase, Condenser water flow and cooling systems need to be fully tested, balanced, commissioned, and made functional prior to commencing the next phase. Refer to phasing requirements in Section 011100.

Part 2 Products

2.1 EQUIPMENT

- .1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 and ASHRAE STD 135 – native BACnet protocol.
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .3 Acceptable Systems Manufacturers:
 - .1 Delta Controls ORCA BACnet DDC Systems, no substitution. The systems shall fully meet all the technical specification sections under Divisions 22 and 23.
 - .2 Complete list of equipment and materials to be used on project and forming part of bid documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 LOCKABLE PANELS

- .1 Panel to be NEMA 12 for network panels in mechanical penthouse and in service core area.
- .2 To have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

2.3 ADAPTORS

- .1 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation: to manufacturer's recommendations.

3.2 PAINTING

- .1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:
 - .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
 - .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
 - .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
 - .4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

3.3 GENERAL

- .1 Provide EMCS controls to new cooling towers and condenser water system pumps, with control function and operation to match with existing chiller operation.
- .2 Refer to Section 25 90 01 - EMCS: Site Requirements, Applications And Systems Sequences Of Operation.
- .3 Modify existing EMCS controls as required to suit new installation and site conditions, as well as to accommodate phased construction.
- .4 Provide Native BACNet controllers for new cooling towers, condenser system pumps, and controls for the Chemicals Storage Building.. New controllers shall match with and compatible to existing EMCS controllers.
- .5 Provide testing and commissioning to the EMCS systems for each phase, prior to enabling the new equipment to serve the building and existing equipment. Provide test and commissioning report for review prior to operational change.
- .6 Provide test and commissioning report for review prior to substantial performance inspection.
- .7 Provide EMCS shop drawings for the new and upgraded equipment for review prior to new installation.
- .8 Provide identification to all new/modified EMCS components and systems to match with existing base building EMCS system.
- .9 Provide power supply to new/relocated control devices, controllers and components. Provide all control devices, components, relays, transformers, E/P switches, wirings and conduits as required for this renovation work.

- .10 Coordinate with the balancing testing agent (TAB) for testing and commissioning work.
- .11 Re-commission existing chillers to ensure their operation and control sequences meet the requirements of the Departmental Representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).
- .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 01 – EMCS: General Requirements
 - .9 Section 26 05 00 – Common Work Results – Electrical
 - .10 Section 26 27 10 – Modular Wiring Systems
 - .11 Section 26 27 26 – Wiring Devices

1.2 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.3 DESIGN REQUIREMENTS

- .1 Preliminary Design Review: to contain following contractor and systems information.
 - .1 Location of [local]office.
 - .2 Description and location of installing and servicing technical staff.
 - .3 Location and qualifications of programming design and programming support staff.
 - .4 List of spare parts.
 - .5 Location of spare parts stock.
 - .6 Names of sub-contractors and site-specific key personnel.
 - .7 Sketch of site-specific system architecture.
 - .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
 - .9 Descriptive brochures.
 - .10 Sample CDL and graphics (systems schematics).
 - .11 Response time for each type of command and report.
 - .12 Item-by-item statement of compliance.

- .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within [5] working days after tender closing and before contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of [3] hard copies and [1] soft copy of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in AutoCAD - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.5 PRELIMINARY SHOP DRAWING REVIEW

- .1 Submit preliminary shop drawings within [30] working days of award of contract and include following:
 - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
 - .2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.
 - .3 Spare point capacity of each controller by number and type.
 - .4 Controller locations.
 - .5 Auxiliary control cabinet locations.
 - .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
 - .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
 - .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
 - .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.
 - .10 Compressor schematic and sizing data.

1.6 DETAILED SHOP DRAWING REVIEW

- .1 Submit detailed shop drawings within [60] working days after award of contract and before start of installation and include following:
 - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
 - .2 Wiring diagrams.
 - .3 Piping diagrams and hook-ups.
 - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
 - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
 - .1 Sensing element type and location.
 - .2 Transmitter type and range.
 - .3 Associated field wiring schematics, schedules and terminations.
 - .4 Pneumatic schematics and schedules.
 - .5 Complete Point Name Lists.
 - .6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
 - .7 Software and programming details associated with each point.
 - .8 Manufacturer's recommended installation instructions and procedures.
 - .9 Input and output signal levels or pressures where new system ties into existing control equipment.
 - .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
 - .7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
 - .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
 - .9 Listing and example of specified reports.
 - .10 Listing of time of day schedules.
 - .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
 - .12 Type and size of memory with statement of spare memory capacity.
 - .13 Full description of software programs provided.
 - .14 Sample of "Operating Instructions Manual" to be used for training purposes.
 - .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.7 QUALITY ASSURANCE

- .1 Preliminary Design Review Meeting: Convene meeting within [45] working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes.
 - .1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.
- .2 Related Requirements
 - .1 Section 01 33 00 – Submittal Procedures
 - .2 Section 01 45 00 – Quality Control
 - .3 Section 01 61 00 – Common Product Requirements
 - .4 Section 01 74 11 – Cleaning
 - .5 Section 01 78 00 – Close-out Submittals
 - .6 Section 09 91 23 – Interior Painting
 - .7 Section 23 05 00 – Common Work Results for HVAC
 - .8 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .9 Section 25 05 01 – EMCS: General Requirements
 - .10 Section 26 05 00 – Common Work Results – Electrical
 - .11 Section 26 27 10 – Modular Wiring Systems
 - .12 Section 26 27 26 – Wiring Devices

1.2 DEFINITIONS

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2 Submit As-built drawings and Operation and Maintenance Manual to Departmental Representative in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
 - .1 Binders to be 2/3 maximum full.
 - .2 Provide index to full volume in each binder.
 - .3 Identify contents of each manual on cover and spine.
 - .4 Provide Table of Contents in each manual.
 - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 AS-BUILTS

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
 - .1 Changes to contract documents as well as addenda and contract extras.
 - .2 Changes to interface wiring.
 - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
 - .4 Locations of obscure devices to be indicated on drawings.
 - .5 Listing of alarm messages.
 - .6 Panel/circuit breaker number for sources of normal/emergency power.
 - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
 - .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
 - .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance [4] hard and [1] soft copy incorporating changes made during final review.

1.5 O M MANUALS

- .1 Custom design O M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide [2] complete sets of hard and soft copies prior to system or equipment tests
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4 Functional description to include:
 - .1 Functional description of theory of operation.
 - .2 Design philosophy.
 - .3 Specific functions of design philosophy and system.
 - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
 - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
 - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

- .5 System operation to include:
 - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
 - .2 Operation of computer peripherals, input and output formats.
 - .3 Emergency, alarm and failure recovery.
 - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 Software to include:
 - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
 - .2 Detailed descriptions of program requirements and capabilities.
 - .3 Data necessary to permit modification, relocation, reprogramming and to permit [new and existing]software modules to respond to changing system functional requirements without disrupting normal operation.
 - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
 - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
 - .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
 - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
 - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes.
 - .1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.
- .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 01 – EMCS: General Requirements
 - .9 Section 26 05 00 – Common Work Results – Electrical
 - .10 Section 26 27 10 – Modular Wiring Systems
 - .11 Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.1-[02], The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

- .1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

- .1 Language Operating Requirements: provide identification for control items in English.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

- .1 Identify by Plastic laminate, [3] mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

- .2 Sizes: 25 x 67 mm minimum.
- .3 Lettering: minimum [7] mm high, black.
- .4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum [5] mm high produced from laser printer in black.
- .4 Data to include: point name and point address.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative.

2.5 WIRING

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

- .1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

- .1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

- .1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).
 - .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 01 – EMCS: General Requirements
 - .9 Section 26 05 00 – Common Work Results – Electrical
 - .10 Section 26 27 10 – Modular Wiring Systems
 - .11 Section 26 27 26 – Wiring Devices
 - .3 References
 - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
 - .2 Canadian Standards Association (CSA International).
 - .1 CSA Z204-[94(R1999)], Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:

- .1 Point name and location.
 - .2 Device type and range.
 - .3 Measured value.
 - .4 System displayed value.
 - .5 Calibration detail
 - .6 Indication if adjustment required,
 - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
 - .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Maintain records and logs of each maintenance task on site.
 - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
 - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
 - .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 DEFERRED WORK

- .1 Provide assistance to PARC for start-up of the cooling season to re-verify performance of the chiller system control.

1.5 MAINTENANCE SERVICE DURING WARRANTY PERIOD

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
 - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

- .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
- .5 Provide system modifications in writing.
 - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 hrs to 1630 hrs, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
 - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
 - .2 Calibrate each field input/output device in accordance with Canada Labour Code - Part I, CSA Z204.
 - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
 - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
 - .2 Check equipment cooling fans as required.
 - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

- .4 Review system performance with Departmental Representative to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
 - .1 Minor inspection.
 - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
 - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
 - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
 - .5 Provide mechanical adjustments, and necessary maintenance on printers.
 - .6 Run system software diagnostics as required.
 - .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
 - .1 Perform network analysis and provide report as described in Submittal article.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
 - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).
- .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 01 – EMCS: General Requirements
 - .9 Section 26 05 00 – Common Work Results – Electrical
 - .10 Section 26 27 10 – Modular Wiring Systems
 - .11 Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA T529-[95(R2000)], Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
 - .2 CSA T530-[99(R2004)], Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
 - .1 IEEE Std 802.3TM-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-568-[March 2004], Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
 - .2 TIA/EIA-569-A-[December 2001], Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
 - .1 TBITS 6.9-[2000], Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS - General Requirements.

1.4 SYSTEM DESCRIPTION

- .1 The existing system is a Delta Controls System, and includes several generations of controllers. The new system shall connect into, and be integrated with the existing system. The new system shall be Delta Controls System, current generation.
- .2 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A, and TBITS 6.9.
 - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
 - .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .3 Data communication network to include, but not limited to:
 - .1 EMCS-LAN.
 - .2 Modems.
 - .3 Network interface cards.
 - .4 Network management hardware and software.
 - .5 Network components necessary for complete network.
- .4 Remote Chemical Storage Building
 - .1 Division 26 will provide media converters at main building and the chemical storage building, as well as fibre-optic connection between two buildings.
 - .2 Establish common network using this connection.

1.5 DESIGN REQUIREMENTS

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
 - .2 EMCS-LAN to: BACnet, Proprietary Protocol.
 - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
 - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
 - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be [10] Megabits per second minimum.
 - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
 - .7 Commonly available, multiple sourced, networking components and protocols to

allow system to co-exist with other networking applications including office automation.

- .2 Dynamic Data Access.
 - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
 - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
 - .1 Network medium: twisted cable, shielded twisted cable, fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Modify existing Operator Work Station (OWS), including primary, secondary, portable and remote OWS's, to make sure the OWSs will be capable and suitable to the upgraded Building EMCS system. This including and not limited to the required hardware and software upgrades.
- .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 25 05 03 – EMCS: Project Record Documents
 - .8 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .9 Section 25 05 01 – EMCS: General Requirements
 - .10 Section 25 30 01 – EMCS: Building Controllers
 - .11 Section 25 90 01 – EMCS: Site Requirements, Applications, and System Sequence of Operation.
 - .12 Section 26 05 00 – Common Work Results – Electrical
 - .13 Section 26 27 10 – Modular Wiring Systems
 - .14 Section 26 27 26 – Wiring Devices
 - .15 Colour graphics printer.
 - .16 Modem and network interface.

1.2 Operator Interface

- .1 Basic Interface Description
 - .1 Command Entry/Menu Selection Process: Operator Work station interface software shall be of current version, and will interface and integrate with the existing control system at PARC Summerland lab.
 - .2 Operator Work station interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set-points from graphical displays through the use of a mouse or similar pointing device.

- .3 Graphical and Text-Based Displays: At the option of the user, Operator Work stations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all work stations.
- .4 Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the controls contractor shall provide at least two operator stations.
- .5 Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit work station control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - .1 Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.
 - .2 A minimum of four levels of access shall be supported.
 - .3 A minimum of 50 passwords shall be supported at each DDC panel.
 - .4 Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.
 - .5 User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
 - .6 It shall be possible to limit which points in the system that a particular operator has access to.
- .6 Operator Commands: The operator interface shall allow the operator to perform all commands required to operate or program the entire system.
- .7 Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - .1 A general listing of all points in the network.
 - .2 Individual lists of all points currently in alarm, off-line, in override status, disabled, or locked out.
 - .3 List all Weekly Schedules.
 - .4 List all Holiday Programming.

- .5 List of Limits and Deadbands.
- .6 Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
- .8 Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and boiler systems, shall be provided as specified herein to optimize system performance analysis and speed alarm recognition.
 - .1 System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 - .2 Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 - .3 Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 - .1 Libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols shall be provided.
 - .2 The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
 - .1 Define symbols
 - .2 Position and size symbols
 - .3 Define background screens
 - .4 Define connecting lines and curves
 - .5 Locate, orient and size descriptive text
 - .6 Define and display colors for all elements
 - .7 Establish correlation between symbols or text and associated system points or other displays.
- .9 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including Terminal Unit Controllers used for DDC unitary or VAV terminal unit control.

- .1 Pre-Constructed Graphics
 - .1 Provide a complete set of pre-constructed graphics for use with the system at time of hand-over.
 - .2 Provide, at minimum the following dynamic graphics.
 - .1 All supply air systems.
 - .2 All return air systems.
 - .3 All exhaust air systems.
 - .4 All air handling ventilation units.
 - .5 Domestic cold and hot water and domestic hot water heating systems.
 - .6 Chilled water systems.
 - .7 Chiller control
 - .8 Condenser water systems (serving chilled water systems).
 - .9 Product refrigeration condenser water system.
 - .10 Heat recovery systems.
- .10 System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
 - .1 The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
 - .1 Add/Delete/Modify SAPs, Modify Operator Work stations, TUCs.
 - .2 Add/Delete/Modify points of any type, and all associated control loops, point parameters, and tuning constants.
 - .3 Add/Delete/Modify Totalization, Historical Data Trending for every point.
 - .4 Add/Delete/Modify custom control processes and all graphic displays, symbols, and cross-references to point data.
 - .5 Add/Delete/Modify dial-up telecommunication definition, operator passwords and Alarm Messages.
 - .2 System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.
 - .3 Database Save/Restore/Back-Up: Back-up copies of all standalone panel databases shall be stored in at least one personal computer operator work station. Continuous supervision of the integrity of all SAP data bases shall be provided. In the event that any SAP on the peer bus experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective data base to restore proper operation. Data base back-up / download shall occur over the peer bus

without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of a SAP data base.

- .11 Personal Computer Operator Work station Description:
 - .1 Primary Personal Computer Operator Work Station shall be provided for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the SAPs to facilitate greater fault tolerance and reliability.
 - .1 Work station shall be general purpose, commercially available, personal computer with sufficient memory and processor capacity to perform all functions described in this specification. At minimum, provide IBM or compatible dual core based processor, 3 Ghz clock speed. Minimum ram memory shall be 16 Gb with a high resolution, fast acting video card to take advantage of windowed operating environment with 3rd party software such as AutoCAD, Windows, D.base, etc. Unit shall have a CD/DVD RW drive, and minimum 4 USB ports.
 - .2 Sufficient proprietary bulk storage shall be provided to accommodate all fully configured point data bases, all application databases, all graphics data bases, all user-defined reports, and all historical data archival as described in this specification. Provide at minimum 1 TB drive.
 - .3 The display provided for system operation shall have a diagonal screen measurement of no less than 17", and a minimum display resolution of no less than 1024 x 768 pixels. The screen shall be non-reflective.
 - .4 Standard, wireless, ASCII keyboard with a 10-key numeric keypad and dedicated function keys and mouse.
 - .5 Provide a printer appropriate for printing alarms, using current laser printer technology available at time.
 - .6 Network card and modem to allow the system to dial out on alarm and to provide the capability for remote access (internet and intranet) to the system.
 - .7 Provide a CD/DVD RW drive.
 - .8 OWS shall support Lync and video conferencing.
 - .2 The primary Operator Work Station shall be located in the maintenance office - confirm exact location with the Departmental Representative. Provide control over the complete communication system and monitor all connected SAPs throughout the system for change-of-state, change-of-value, or no response conditions. Centrally resident software shall be provided for the operator interface, temporary scheduling, control of holiday programming, definition process programming, automatic initialization routines, real-time logs, historical storage, reporting, trend logging, and full on-line dynamic graphics.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Materials and installation for building automation controllers including:
 - .1 Master Control Unit (MCU).
 - .2 Local Control Unit (LCU).
 - .3 Equipment Control Unit (ECU).
 - .4 Terminal Control Unit (TCU).
 - .2 Related Requirements
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 74 11 – Cleaning
 - .4 Section 01 78 00 – Close-out Submittals
 - .5 Section 09 91 23 – Interior Painting
 - .6 Section 23 05 00 – Common Work Results for HVAC
 - .7 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .8 Section 25 05 00 – EMCS: General Requirements
 - .9 Section 25 05 01 – EMCS: General Requirements
 - .10 Section 25 05 02 – EMCS: Shop Drawings, Product Data, and Review Process
 - .11 Section 25 05 03 – EMCS: Project Record Documents
 - .12 Section 26 05 00 – Common Work Results – Electrical
 - .13 Section 26 27 10 – Modular Wiring Systems
 - .14 Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE [2013], Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
 - .1 C22.2 No.205-[12], Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1-[12], Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
 - .1 MD13800-[September 2000], Energy Management and Control Systems (EMCS) Design Manual. English: <ftp://ftp.pwgsc.gc.ca/rps/doccentre/mechanical/me214-e.pdf>

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 DESCRIPTION

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
 - .1 Provide sufficient controllers to meet intents and requirements of this section.
 - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
 - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
 - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
 - .3 Capable of interfacing with operator interface device.
 - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
 - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
 - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.
 - .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

1.5 DESIGN REQUIREMENTS

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least [25] % of each point type distributed throughout the MCUs and LCUs.

- .3 Field Termination and Interface Devices:
 - .1 To: CSA C22.2 No.205.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:
 - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
 - .2 Power supplies for operation of logics devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring (if remote units).
 - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
 - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
 - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
 - .4 AI interface equipment to:
 - .1 Convert analog signals to digital format with [10] bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 [4 - 20] mA;
 - .2 [0 - 10] V DC;
 - .3 100/1000 ohm RTD input;
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .4 Have common mode signal rejection greater than [60] dB to [60] Hz.
 - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
 - .5 AO interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using [8] bit digital-to-analog resolution.
 - .2 Provide for following output signal types and ranges:
 - .1 [4 - 20] mA.
 - .2 [0 - 10] V DC.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .6 DI interface equipment:
 - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
 - .2 Meet IEEE C37.90.1 surge withstand capability.
 - .3 Accept pulsed inputs up to [2] kHz.

- .7 DO interface equipment:
 - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to [0.5] amps at [24] V AC.
 - .2 Switch up to [5] amps at [220] V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
 - .1 Provide for conduit entrance from top, bottom or sides of panel.
 - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
 - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
 - .1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

Part 2 Products

2.1 MASTER CONTROL UNIT (MCU)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
 - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
 - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
 - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
 - .1 Processor to consist of minimum [16] bit microprocessor capable of supporting software to meet specified requirements.

- .2 CPU idle time to be more than [30] % when system configured to maximum input and output with worst case program use.
- .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
- .4 Include uninterruptible clock accurate to plus or minus [5] secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum [72] hour operation in event of power failure.
- .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.
 - .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
 - .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
 - .3 Display simultaneously minimum of [16] point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.
 - .4 Functions to include, but not be limited to, following:
 - .1 Start and stop points.
 - .2 Modify setpoints.
 - .3 Modify PID loop parameters.
 - .4 Override PID control.
 - .5 Change time/date.
 - .6 Add/modify/start/stop weekly scheduling.
 - .7 Add/modify setpoint weekly scheduling.
 - .8 Enter temporary override schedules.
 - .9 Define holiday schedules.
 - .10 View analog limits.
 - .11 Enter/modify analog warning limits.
 - .12 Enter/modify analog alarm limits.
 - .13 Enter/modify analog differentials.

- .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
- .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
- .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
 - .1 Include minimum [2]interface ports for connection of local computer terminal.
 - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
 - .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
 - .4 Include power supplies for operation of LCU and associated field equipment.
 - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
 - .6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
 - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

- .3 VAV Terminal Controller.
 - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
 - .2 Controller to support point definition; in accordance with Section [25 05 01 - EMCS: General Requirements].
 - .3 Controller to operate independent of network in case of communication failure.
 - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

- .1 General.
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
 - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
 - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
 - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
 - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
 - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Operator Terminal interface.
 - .1 Operating and control functions include:
 - .1 Multi-level password access protection to allow user/manager to limit workstation control.
 - .2 Alarm management: processing and messages.
 - .3 Operator commands.
 - .4 Reports.
 - .5 Displays.
 - .6 Point identification.

- .5 Pseudo or calculated points.
 - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
 - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .6 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
 - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
 - .3 Perform changes to CDL on-line.
 - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
 - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
 - .6 MCU to be able to perform following pre-tested control algorithms:
 - .1 Two position control.
 - .2 Proportional Integral and Derivative (PID) control.
 - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
 - .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 - .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported.

Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

- .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
 - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
 - .1 Time of day scheduling.
 - .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start stop.
 - .6 Night setback control.
 - .7 Enthalpy (economizer) switchover.
 - .8 Peak demand limiting.
 - .9 Temperature compensated load rolling.
 - .10 Fan speed/flow rate control.
 - .11 Cold deck reset.
 - .12 Hot deck reset.
 - .13 Hot water reset.
 - .14 Chilled water reset.
 - .15 Condenser water reset.
 - .16 Chiller sequencing.
 - .17 Night purge.
 - .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
 - .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
 - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
 - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
 - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
 - .4 Totalization routine to have sampling resolution of [1] min or less for analog inputs.

- .5 Totalization to provide calculations and storage of accumulations up to [99,999.9] units (eg. kWh, litres, tonnes, etc.).
- .6 Store event totalization records with minimum of [9,999,999] events before reset.
- .7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
 - .1 Display analog values digitally to [1] place of decimals with negative sign as required.
 - .2 Update displayed analog values and status when new values received.
 - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
 - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

- .1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

- .1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

- .1 Install Controllers in secure locking enclosures as indicated or as directed by Departmental Representative.
- .2 Provide necessary power from local [120] V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

3.3 CHEMICAL STORAGE BUILDING

- .1 Connect the chemical storage building network and the network serving the cooling towers with the main building network.
- .2 Fiber optic communication and fiberoptic-to-copper converters will be provided by Division 26. Connect to the link, and integrate the networks.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, low voltage current transformers.
 - .2 Related Sections:
 - .1 Section 01 45 00 – Quality Control
 - .2 Section 01 61 00 – Common Product Requirements
 - .3 Section 01 73 00 – Execution Requirements
 - .4 Section 01 74 11 – Cleaning
 - .5 Section 01 78 00 – Close-out Submittals
 - .6 Section 07 84 00 – Firestopping
 - .7 Section 09 91 23 – Interior Painting
 - .8 Section 23 05 00 – Common Work Results for HVAC
 - .9 Section 23 05 93 – Testing, Adjusting & Balancing for HVAC
 - .10 Section 23 33 15 – Dampers - Operating.
 - .11 Section 25 01 11 – EMCS: Start-Up, Verification and Commissioning.
 - .12 Section 25 05 01 – EMCS: General Requirements.
 - .13 Section 25 05 02 – EMCS: Shop Drawings, Product Data and Review Process.
 - .14 Section 25 05 54 – EMCS: Identification.
 - .15 Section 25 90 01 – EMCS: Site Requirements Applications and Systems Sequences of Operation.
 - .16 Section 26 05 00 – Common Work Results for Electrical
 - .17 Section 26 27 10 – Modular Wiring Systems
 - .18 Section 26 27 26 – Wiring Devices

1.2 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C12.7-[2014], Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13-[2008], Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148-[2009], Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
 - .1 NEMA 250-[2011], Enclosures for Electrical Equipment (1000 Volts Maximum).

- .4 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D-[12], Laboratory Method of Testing Dampers For Rating.
- .5 Canadian Standards Association (CSA International).
 - .1 CSA-C22.1-[15], Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

- .1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Pre-Installation Tests.
 - .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.5 EXISTING CONDITIONS

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

Part 2 Products

2.1 GENERAL

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.
- .3 Operating conditions: [0] - [32] degrees C with [10] - [90]% RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA [4] enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of [35]. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
 - .1 Thermocouples: limit to temperature range of [200] degrees C and over.
 - .2 RTD's: 100 or 1000 ohm at [0] degrees C (plus or minus [0.2] ohms) platinum element with strain minimizing construction, [3] integral anchored leadwires. Coefficient of resistivity: [0.00385] ohms/ohm degrees C.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of [10] degrees C.
 - .6 Immersion wells: NPS [3/4], stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Jack connection for plugging in laptop personal computer for access to zone bus.
 - .4 Integral thermistor sensing element [10,000] ohm at [24] degrees.
 - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
 - .6 Stability 0.02 degrees C drift per year.
 - .7 Separate mounting base for ease of installation.
 - .2 Room temperature sensors.
 - .1 Wall mounting, in slotted type covers having brushed aluminum finish, with guard.
 - .2 Element [10-50]mm long RTD with ceramic tube or equivalent protection or thermistor, [10,000] ohm, accuracy of plus or minus [0.2] degrees C.
- .3 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length [460] mm [as indicated].

- .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length [6000] mm. Bend probe at field installation time to [100] mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:
 - .1 Outside air type: complete with probe length [100 - 150] mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to [13] mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at [0] degrees C, platinum resistance detector type sensors.
 - .2 Power supply: [24] V DC into load of [575] ohms. Power supply effect less than [0.01] degrees C per volt change.
 - .3 Output signal: [4 - 20] mA into[500] ohm maximum load.
 - .4 Input and output short circuit and open circuit protection.
 - .5 Output variation: less than [0.2] % of full scale for supply voltage variation of plus or minus [10] %.
 - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus [0.5] % of full scale output.
 - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed [25] mA.
 - .8 Integral zero and span adjustments.
 - .9 Temperature effects: not to exceed plus or minus [1.0] % of full scale/ [50]degrees C.
 - .10 Long term output drift: not to exceed [0.25] % of full scale/ [6] months.
 - .11 Transmitter ranges: select narrowest range to suit application from following:
 - .1 Minus [50] degrees C to plus [50] degrees C, plus or minus [0.5] degrees C.
 - .2 [0 to 100] degrees C, plus or minus [0.5] degrees C.
 - .3 [0 to 50] degrees C, plus or minus [0.25] degrees C.
 - .4 [0 to 25] degrees C, plus or minus [0.1] degrees C.
 - .5 [10 to 35] degrees C, plus or minus [0.25] degrees C.

2.4 PRESSURE TRANSDUCERS

- .1 Requirements:
 - .1 Combined sensor and transmitter measuring pressure.
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.

- .3 Output variations: less than [0.2] % full scale for supply voltage variations of plus or minus [10] %.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus [0.5] % of full scale output over entire range.
- .5 Temperature effects: not to exceed plus or minus [1.5] % full scale/ [50] degrees C.
- .6 Over-pressure input protection to at least twice rated input pressure.
- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus [1]% of Full Scale.

2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .3 Output variations: less than [0.2] % full scale for supply voltage variations of plus or minus [10] %.
 - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus [0.5] % of full scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effects: not to exceed plus or minus [1.5] % full scale/ [50] degrees C.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.6 STATIC PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint element with self-averaging manifold.
 - .1 Maximum pressure loss: [160] Pa at [10] m/s. (Air stream manifold).
 - .2 Accuracy: plus or minus [1] % of actual duct static pressure.

2.7 STATIC PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed [150] % of duct static pressure at maximum flow.
 - .3 Accuracy: [0.4] % of span.
 - .4 Repeatability: within [0.5] % of output.
 - .5 Linearity: within [1.5] % of span.
 - .6 Deadband or hysteresis: [0.1]% of span.

- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.8 VELOCITY PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
 - .2 Maximum pressure loss: [37]Pa at [1000] m/s.
 - .3 Accuracy: plus or minus [1] % of actual duct velocity.

2.9 VELOCITY PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed [125] % of duct velocity pressure at maximum flow.
 - .3 Accuracy: [0.4] % of span.
 - .4 Repeatability: within [0.1] % of output.
 - .5 Linearity: within [0.5] % of span.
 - .6 Deadband or hysteresis: [0.1]% of span.
 - .7 External exposed zero and span adjustment.
 - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.10 LIQUID FLOW METERS

- .1 Requirements:
 - .1 Pressure rating: as specified in I/O summaries.
 - .2 Temperature rating: as specified in I/O summaries.
 - .3 Repeatability: plus or minus [0.2] %.
 - .4 Accuracy and linearity: plus or minus [1.0] %.
 - .5 Flow rangeability: at least [10:1].
 - .6 Insertion turbine type

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
 - .2 Adjustable setpoint and differential.
 - .3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.

- .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
- .5 Accuracy: within [2]% repetitive switching.
- .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
- .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.12 TEMPERATURE SWITCHES

.1 Requirements:

- .1 Operate automatically. Reset automatically, except as follows:
 - .1 Low temperature detection: manual reset.
 - .2 High temperature detection: manual reset.
- .2 Adjustable setpoint and differential.
- .3 Accuracy: plus or minus [1]degrees C.
- .4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
- .5 Type as follows:
 - .1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.
 - .2 Duct, general purpose: insertion length = [460] mm.
 - .3 Thermowell: stainless steel, with compression fitting for NPS [3/4] thermowell. Immersion length: [100] mm.
 - .4 Low temperature detection: continuous element with [6000] mm insertion length, duct mounting, to detect coldest temperature in any [30] mm length.
 - .5 Strap-on: with helical screw stainless steel clamp.

2.13 WIND VELOCITY TRANSMITTERS

.1 Requirements:

- .1 3-cup anemometer and airfoil vane mounted on common vertical axis, designed for mast mounting.
- .2 Anemometer:
 - .1 Range: 0-160 km/h.
 - .2 Threshold: 3.0 km/h.
 - .3 Accuracy: +/- 2%.
- .3 Airfoil vane
 - .1 Range: 0-360 degrees with infinite resolution potentiometer with no loss of reading at transition point.

- .2 Starting threshold: 1,1 M/s.
- .3 Accuracy: +/- 0.5%.
- .4 Output signals: 4 - 20 mA into 500 ohm load.
- .5 Provide two output signals: velocity, direction.
- .6 Mast: aluminum, size and height as indicated.
 - .1 Provide at least 3 stainless steel guys, turnbuckles, anchor bolts. Follow manufacturers installation guidelines.
 - .2 Lightning protection as indicated on electrical drawings.

2.14 AIR PRESSURE GAUGES

- .1 Diameter: [38] mm minimum.
- .2 Range: zero to two times operating pressure of measured pressure media or nearest standard range.

2.15 ELECTROMECHANICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
 - .3 Contacts: rated at [5] amps at [120] V AC.
 - .4 Relay to have visual status indication

2.16 SOLID STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
 - .5 Relays to be CSA Certified.
 - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
 - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.
 - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output:
 - .1 AC or DC Output Model to suit application.

2.17 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-1 volt DC.
 - .3 0-10 volts DC.
 - .4 0-20 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.18 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
 - .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
 - .7 Adjustable latch level.

2.19 CONTROL DAMPERS

- .1 Construction: blades, [152] mm wide, [1219] mm long, maximum. Modular maximum size, [1219] mm wide x [1219] mm high. Three or more sections to be operated by jack shafts.
- .2 Materials:
 - .1 Frame: [2.03] mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
 - .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
 - .3 Bearings: maintenance free, synthetic type of material.
 - .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
 - .5 Seals: synthetic type, mechanically locked into blade edges.
 - .1 Frame seals: synthetic type, mechanically locked into frame sides.

- .3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
 - .1 Size/Capacity: refer to damper schedule
 - .2 [25] L/s/m² maximum allowable leakage against [1000] Pa static pressure for outdoor air and exhaust air applications.
 - .3 Temperature range: minus 40 degrees C to plus 100 degrees C.
- .4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.
- .5 Jack shafts:
 - .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
 - .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
 - .3 Install using manufacturers installation guidelines.
 - .4 Use same manufacturer as damper sections.

2.20 ELECTRONIC CONTROL DAMPER ACTUATORS

- .1 Requirements:
 - .1 Direct mount proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
 - .4 Power requirements: [5] VA maximum at 24 V AC.
 - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
 - .6 For VAV box applications floating control type actuators may be used.
 - .7 Damper actuator to drive damper from full open to full closed in less than [120] seconds.

2.21 CONTROL VALVES

- .1 Body: globe style or characterized ball.
 - .1 Flow characteristic as indicated on control valve schedule: linear, equal percentage, quick opening.
 - .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
 - .3 Normally open or normally closed, as indicated.
 - .4 Two or three port, as indicated.
 - .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
 - .6 Packing easily replaceable.
 - .7 Stem, stainless steel.
 - .8 Plug and seat, stainless steel.

- .9 Disc, replaceable, material to suit application.
- .10 NPS 2 and under:
 - .1 Screwed National Pipe Thread (NPT) tapered female connections.
 - .2 Valves to ANSI Class [250], valves to bear ANSI mark.
 - .3 Rangeability [50:1] minimum.
- .11 NPS 2 and larger:
 - .1 Flanged connections.
 - .2 Valves to ANSI Class 150 or 250 to meet system rating, valves to bear ANSI mark.
 - .3 Rangeability [100:1] minimum.
- .2 Butterfly Valves NPS 2 and larger:
 - .1 Body: for condenser water ANSI Class 150 cast iron lugged body or wafer body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel lugged body or wafer body.
 - .2 End connections to suit flanges that are ANSI Class 150.
 - .3 Extended stem neck to provide adequate clearance for flanges and insulation.
 - .4 Pressure limit: bubble tight sealing to [170] kilopascals.
 - .5 Disc/vane: 316 stainless steel.
 - .6 Seat: for service on chilled water EPDM (ethylene propylene diene monomer).
 - .7 Stem: 316 stainless steel.
 - .8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
 - .9 Flow characteristic: linear.
 - .10 Maximum flow requirement as indicated on control valve schedule.
 - .11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.
 - .12 Normally open or normally closed, as indicated.
 - .13 Valves are to be provided complete with mounting plate for installation of actuators.

2.22 ELECTRONIC / ELECTRIC VALVE ACTUATORS

- .1 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal: 0-10V DC or 4-20 mA DC.
 - .3 Positioning time: to suit application. [90] sec maximum.
 - .4 Fail to normal position as indicated.
 - .5 Scale or dial indication of actual control valve position.
 - .6 Size actuator to meet requirements and performance of control valve specifications.
 - .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

- .8 Minimum shut-off pressure: refer to control valve schedule.

2.23 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:

- .1 Include three phases, test and terminal blocks for watthour meter connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour meter use. Accuracy: plus or minus [0.25] % of full scale. For condenser water applications: to have instantaneous indicator with analog or digital display.
- .2 Watthour meter sockets: to ANSI C12.7.
- .3 Potential and current transformers: to ANSI/IEEE C57.13.
- .4 Potential transformers: provide two primary fuses.
- .5 Demand meters: configure to measure demand at [15] minute intervals.

2.24 SURFACE WATER DETECTORS

.1 Requirements:

- .1 Provide alarm on presence of water on floor.
- .2 Expendable cartridge sensor.
- .3 Internal waterproof switch.
- .4 One set of dry contacts 2 amps at 24 V.
- .5 Unaffected by moisture in air.
- .6 Self-powered.

2.25 PANELS

- .1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

2.26 WIRING

- .1 In accordance with Section 26 27 10 - Modular Wiring System and Section 26 27 26 - Wiring Devices.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
 - .1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
 - .2 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.

Part 3 Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.
- .6 Electrical:
 - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .3 Refer to electrical control schematics included as part of control design schematics on drawings and in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.
 - .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .5 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Maximum conduit fill not to exceed 40%.
 - .4 Design drawings do not show conduit layout.
 - .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.
 - .7 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
 - .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .2 Wire multiple sensors in series for low temperature protection applications.
 - .3 Wire multiple sensors separately for temperature measurement.
 - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
 - .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

3.3 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

- .1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.
- .2 Locations: as indicated and for differential pressure.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
 - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.6 I/P TRANSDUCERS

- .1 Install air pressure gauge on outlet.

3.7 AIR PRESSURE GAUGES

- .1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.
- .2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.8 IDENTIFICATION

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.9 AIR FLOW MEASURING STATIONS

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.10 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Provide shop drawings to include:
 - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
 - .1 Control Description Logic (CDL) for each system.
 - .2 Input/Output Point Summary Tables for each system.
 - .3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS); System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 REFERENCES

- .1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
 - .1 MD13800-[September 2000], Energy Management and Control Systems (EMCS) Design Manual. English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.3 SEQUENCING

- .1 Present sequencing of operations for system[s], in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
- .2 Sequencing of operations for system[s] as follows:

1.4 A/C UNIT

- .1 Heat pump operates continuously.
- .2 Room temperature is monitored on BMS.
- .3 Room temperature provides modulating signal and re-set for supply air temperature for A/C unit.
- .4 A/C unit modulates to maintain room temperature setpoint.

1.5 COOLING TOWER CONTROL

- .1 Condenser loop temperature set-point is set on EMCS.
- .2 Cooling towers modulate (open dampers, modulate fan speed) to maintain supply water temperature set-point.
- .3 During cold weather, cooling towers modulate basin heater to prevent freezing water condition.
- .4 When a cooling tower is not active or does not require air movement, discharge control dampers close.

1.6 COOLING TOWER WATER QUALITY CONTROL

- .1 Pulse water meters record make-up water used.
- .2 When a given amount of make-up water is supplied to the cooling tower, a chemical dosing package energizes for a set cycle. The parameters are set during testing and balancing in accordance with manufacturer's recommendation.
- .3 A separate counter monitors the blowdown cycle, time and make-up water-based. The cycle energizes the blowdown solenoid and drains a balanced amount of water from the basin.

1.7 CONDENSER WATER FLOW

- .1 Condenser water flow is a result of operation of pumps P-5, P-6, and P-7 (process flow) and pumps P-8, P-9, and P-10 (chiller condenser flow).
- .2 Process flow is continuous (24-7) and pumps P-5, P-6, and P-7 in lead-lag-lag configuration modulate to maintain return water temperature to cooling towers from process 1°C (adjustable) below return water temperature from the probes (loop of pumps P-1, P-2, and P-3).
- .3 Exception is during cold weather (outdoor air temperature less than 1°C (adjustable)): during this period, flow shall be maintained at 12.5 2/3 [200 USGPM] per cooling tower; temperature of the water shall be adjusted using existing heat exchanger HE-01 to ensure non-freezing temperature of the condenser loop water (returning from cooling towers).
- .4 When chillers are activated, chiller condenser water pumps P-8, P-9, and P-10 maintain chiller loop flow required.

1.8 CHILLER CONDENSER LOOP FLOW

- .1 Chiller condenser loop pumps P-8, P-9, and P-10 are arranged so that one pump serves each chiller and one pump is common spare.
- .2 Control valves at chiller condenser pumps accommodate the active arrangement. The pumping arrangement changes weekly (adjustable). On failure of any pump, the arrangement is to serve the chillers with active pumps; operators can lock an arrangement from EMCS.
- .3 Each pump modulates from minimum to maximum flow to maintain condenser water loop temperature differential for its respective chiller at 8.5°C [15°F] (adjustable).

1.9 CHEMICAL STORAGE BUILDING

- .1 Building is continuously in unoccupied mode, manually overridden into timed occupied mode (when operators are in the building).

1.10 EQUIPMENT MONITOR ROOM

- .1 Unoccupied mode: temperature range is maintained between 12°C (non-condensing) and 27 °C (adjustable) in unoccupied mode and between 18 °C and 24 °C in occupied mode.
- .2 Ventilation operates continuously (for building pressurization) – air is transferred to service room.

- .3 Heat pump fan operates continuously.
- .4 Heating mode: outdoor air damper is at minimum flow (matching flow of exhaust fan EF-2). Heat pump modulates to maintain room temperature set-point. Unit heater UH-3 operates to supplement the heating as required.
- .5 Free cooling mode: outdoor damper modulates to maintain room temperature set-point. (Motorized control damper on outdoor louvre in service room opens.)
- .6 Cooling mode: control damper is at minimum outdoor air position; heat pump modulates to maintain room temperature set-point.
- .7 When heat pump is modulating, the pump P-2B is activated.

1.11 SERVICE ROOM

- .1 Low ventilation rate is maintained continuously (EF-2).
- .2 High ventilation rate is initiated:
 - .1 Manually by operators,
 - .2 Room high temperature (summer mode),
 - .3 Future auxiliary sensor.
- .3 When EF-1 is cycled, EF-2 stops and outdoor louvre motorized damper opens.
- .4 Unit heater (UH-1 and UH-2) cycle to maintain room temperature (low) set-point.

1.12 ADDITIONAL MONITORING AND CONTROL

- .1 Monitor smoke sensors in Chemicals Storage Building – not part of a Fire Alarm System.
- .2 Monitor and record water makeup.
- .3 Control and monitor chemical treatment systems (cooling tower; condenser water loop).

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 TEMPERED WATER SYSTEM

- .1 Tempered water set-point is set on the tempering valve (Emergency Shower).
- .2 Self-activated valve operates to maintain temperature setpoint.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 This section covers items common to sections of Division 26. This section supplements requirements of Division 01.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 Safety Standard for Electrical Installations latest version.
 - .2 CSA C22.2 No. 0-10 (R2015), General requirements-Canadian electrical code, part II latest version.
 - .3 CAN/CSA-C22.3 No. 1-01(Update March 2005), Overhead Systems.
 - .4 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.

1.3 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.

1.4 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235-83.
- .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 for control items in English.

1.5 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials.

- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, 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 co-ordinated 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 If changes are required, notify Engineer Consultant of these changes before they are made.
- .4 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
- .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.

1.6 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 Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification].
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Site Meetings:
 - .1 In accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM). Section 01 32 16.07 - Construction Progress Schedule - Bar (GANNT) Charts.

- .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, in appropriate NMS Section, 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 29.06 - Health and Safety Requirements.

1.7 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.

1.8 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel 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.

1.9 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.

- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

2.2 MATERIALS AND EQUIPMENT

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

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 23 and as shown on mechanical drawings.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Departmental Representative.
- .2 Porcelain enamel decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

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

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: Lamicoid 3 mm thick plastic engraving sheet black face, white core. Lettering accurately aligned and engraved into core mechanically attached with self-tapping screws.

.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 to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. " as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

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

2.8 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
Telephone	Green	

	Prime	Auxiliary
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency	Red	Blue
Other Security Systems	Red	Yellow

2.9 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 indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1-1958.

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 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 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 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 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 where applicable.

- .5 Systems: fire alarm system and 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 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.

3.8 CLEANING

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 General requirements related to existing buildings.

1.2 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results

Part 2 Sequencing, Phasing And Scheduling of Work

- .1 Refer to Section 26 05 00 - Electrical Common Work Results and ensure that all work on existing buildings, facilities, services and utilities is coordinated, sequenced, phased, and scheduled with all other work. Refer to specification documents for phasing and scheduling.

Part 3 Existing Conditions

- .1 Examine the site and existing conditions prior to tendering on this work and make due allowance for these conditions in the tender. Confirm all locations and routings of any existing services, above and below grade, which might be affected by this installation and allow in the tender for such additional work.
- .2 Indication on the drawings of existing conduit, outlets and other electrical apparatus is based on casual field observations and records of past contracts. As such, this information represents the best data available but is not guaranteed to be full or accurate. Verify that field measurements and circuiting diagrams as indicated on Drawings and that abandoned wiring and equipment serve only abandoned facilities. Report discrepancies to Departmental Representative before disturbing existing installation. Disregard types of existing light fixture shown on the demolition drawings, as they represent mosaic of types retrieved from the past projects and observations, and do not relate to the light fixture schedule of the new design. Confirm existing circuiting on site, disregard circuiting shown on demolition drawings, unless verified by Contractor.
- .3 Submission of a tender for this work shall indicate that the Contractor has made a thorough examination of the site and has accepted the existing conditions.
- .4 Where alterations and/or additions to existing equipment or apparatus are required to be made by these documents, it shall be assumed that any existing CSA certification may be in jeopardy. Ensure that all changes are made in accordance with the current edition of the Canadian Electrical Code, Part 2, obtain re-certification, and include re-certification costs in the tender.
- .5 Permit no interruptions to the electric power, fire alarm, telephone, security or other similar systems in the existing building during normal working hours. Advise the Departmental Representative in writing of any intended interruptions outside of these normal hours, including the time and duration of outage. Obtain permission from Departmental Representative at least 24 hours before partially or completely disabling any of the systems. The Departmental Representative may cancel such permission in emergencies at the last minute without penalty or extra cost. Contractor may be required to work in evenings and weekends as required for the existing main building or to minimize duration of outage with no extra cost to the project.

- .6 Assume full responsibility for any disruption to existing services and systems. Provide all necessary material and equipment and provide all labour at no extra cost for any temporary connections be required to maintain services during work in the existing buildings. Include the removal of such temporary connections at completion of the work in the tender price.
- .7 Provide new breakers for all additional circuits as required. Update and retype panel schedules. Where existing panels are affected by the scope of work, provide all necessary blank covers and filler pieces: under no circumstances breaker spaces shall be left open.
- .8 All systems such as power, lighting, security, CCTV, door control, alarm, sound system, fire alarm system, shall be fully operational during renovation and after renovation and be accepted by the Departmental Representative.
- .9 Contractor shall remove all surplus electrical equipment, F.A. devices, speakers, security sensors, wiring, conduits, etc. from renovated areas and return to the Departmental Representative unless otherwise noted.
- .10 Contractor shall relocate, rewire or reroute all wiring which passes through renovated areas, or is in line or on the same circuit as the existing device to be removed to ensure continuity of proper operation of all electrical, fire alarm, security systems, etc. in areas which are not renovated, or devices which are to remain operational. Provide blank covers on all removed devices as required.
- .11 All equipment shown dotted is existing and shall remain in its present location (unless otherwise noted) or shall be relocated as required as per drawings. Rewire, extend wiring, conduits as required.
- .12 Contractor shall allow for adequate removal (without damage) of all fixtures, wiring devices, wires, etc. to facilitate renovation.
- .13 Any fixtures, wiring devices, etc. damaged during and after removal shall be replaced with new approved equipment at Contractor's cost.
- .14 Contractor is responsible for adequate protection of equipment, furniture, etc. (plastic covers, etc.) during the execution of the work.
- .15 Contractor is responsible for cleaning up working area each day before leaving the job site.
- .16 Allow for multiple verifications for fire alarm system and other electrical systems dictated by phasing and scheduling as required for partial building occupancy or substantial performance.

Part 4 Installation

- .1 Examine drawings of all other trades and allow for all work such as the removal, temporary relocation, and re-installation of electrical fixtures, equipment, devices, wiring, raceways, etc., where such work is required due to alterations in or about existing buildings.

- .2 Where work requires modification, extension, and additions to power and low tension services within the existing building, the wiring required for this work shall be installed concealed wherever possible. In certain cases (e.g., where it is necessary to clear obstructions, or to avoid damage to existing structure and/or finish materials), concealed wiring may not be possible. In such cases, special wiring methods such as mineral-insulated cable or wiremold surface mounted raceway, shall be used, provided that, for each specific instance, approval for same is requested from and granted in writing by the Departmental Representative.
- .3 Chisel and patch concrete for conduits feeding new pedestal-mounted floor outlets in existing building.
- .4 Remove abandoned wiring to source. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- .5 Disconnect abandoned outlets and remove devices. Remove abandoned outlets when servicing conduit is abandoned and removed. Blank off all unused outlet boxes.
- .6 Disconnect and remove abandoned panelboards and distribution equipment.
- .7 Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- .8 Clean and repair existing materials and equipment which remain or are to be reused, as described elsewhere in these Specifications.
- .9 Refer to Division 01, Division 23 and Section 26 05 00 Electrical Common Work Results - Phasing of the Work.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-93(R1999), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.4 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 paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer.

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Clamp for stranded aluminum conductors.
 - .4 Stud clamp bolts.
 - .5 Bolts for copper conductors.
 - .6 Bolts for aluminum conductors.

- .7 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 34 – Conduit, Conduit fastenings and fittings.

1.2 REFERENCES

- .1 CSA C22.2 No.0.3-96, Test Method for Electrical Wires and Cables.
- .2 CAN/CSA C22.2 No.131-M89(R1994), Type TECK 90 Cable.

1.3 PRODUCT DATA

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600V insulation of cross-linked thermosetting polyethylene material rated RW90 or RWU90 Jacketed.
- .3 Neutral supported cable: 3 phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated.

2.2 TECK 90 CABLE

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
 - .1 Grounding conductor: copper as indicated.
 - .2 Circuit conductors: copper as indicated, size as indicated.
- .3 Insulation: Chemically cross-linked thermosetting polyethylene rated type RW90XLPE, 600V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: flat galvanized steel
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

- .2 Channel type supports for two or more cables.
- .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
 - .1 Watertight, explosion-proof approved for TECK cable.

2.3 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90, 600V XLPE RW90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Connectors: anti short connectors.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

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

3.2 GENERAL CABLE INSTALLATION

- .1 Install cable in trenches in accordance with Section 33 71 73.02 - Underground Electrical Service.
- .2 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .4 Cable Colour Coding: to Section 26 05 00 Common Work Results for Electrical.
- .5 Conductor length for parallel feeders to be identical.
- .6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .8 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
 - .2 Perform insulation resistance testing on all cable and wiring, submit results to the department representative.
 - .3 Perform continuity test on all new cable and wiring; submit results to the department representative.
 - .4 Check each conductor tested for unintentional grounds.
 - .5 Check if wire and cable are properly tightened to manufacturer's recommendations.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification is to be read, coordinated and implemented in conjunction with all other parts of the Contract Documents.

1.2 REGULATORY REQUIREMENTS

- .1 Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.
- .2 The Seismic Consulting Engineer should be able to provide a proof of professional insurance and the related practice credentials if requested by the Departmental Representative. The Seismic Consulting Engineer should be familiar with SMACNA, ECABC & NFPA guidelines as well as BCBC requirements.
- .3 The Contractors Seismic Consultant shall submit original signed BC Building Code "Letters of Assurance" (Schedules B and C-B) to the Departmental Representative.
- .4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

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

- .8 The Seismic Consultant shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.
- .9 Include all costs associated with the Seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

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

Part 2 Products

1.5 SLACK CABLE SYSTEMS

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

Part 3 Execution

1.6 GENERAL

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

1.7 CONDUITS

- .1 Provide restraint installation information and details on conduit and equipment as indicated below:
 - .2 Vertical Conduit:
 - .1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.

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

1.8 FLOOR MOUNTED EQUIPMENT

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

1.9 LIGHT FIXTURES

- .1 Fluorescent fixtures in suspended ceilings shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by at least two taught cables which are connected to the fixture at diagonal points.

- .2 Surface and recessed style fixtures shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by taught cables.
- .3 Fixtures which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the fixture. Seismic restraint cables shall be secured into the concrete or structural deck above.
- .4 Cables shall be corrosion resistant and approved for the application.
- .5 Fixtures which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
 - .1 ANSI/IEEE 837-1989 (R1996), Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)
 - .1 CAN/CSA Z32-1999, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

1.3 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 paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as indicated as required to electrically conductive underground water pipe.
- .2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.
- .3 Rod electrodes: copper clad steel 19 mm dia by 3 m long.
- .4 Plate electrodes: copper, surface area 0.2 m², 1.6 mm thick.
- .5 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .6 Insulated grounding conductors: green.
- .7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

- .8 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 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, 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 bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .13 Ground secondary service pedestals.

3.2 MANHOLES

- .1 Install conveniently located grounding stud, electrode, size #6 stranded copper conductor in each manhole.
- .2 Install ground rod in each manhole so that top projects through bottom of manhole. Provide with lug to which grounding connection can be made.

3.3 ELECTRODES

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.
- .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Install rod electrodes and make grounding connections.
- .5 Bond separate, multiple electrodes together.
- .6 Use size 4/0 AWG copper conductors for connections to electrodes.
- .7 Make special provision for installing electrodes that will give [acceptable] resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.4 EQUIPMENT GROUNDING

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

3.5 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size #6 AWG.

3.6 COMMUNICATION SYSTEMS

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 Sound, fire alarm, intercommunication systems as indicated.

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 Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.2 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 paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SUPPORT CHANNELS

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

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .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 two (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 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .12 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 SHOP DRAWINGS AND PRODUCT DATA

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

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 JUNCTION AND PULL BOXES

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

2.2 CABINETS

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, two (2) keys, containing 19 mm G1S plywood backboard for surface mounting.

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

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

3.2 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1-1998, Canadian Electrical Code, Part 1.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

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.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V 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. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

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

2.6 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 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 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.

2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56 liquid-tight flexible metal conduit.

2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 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.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

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

- .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 in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .4 Use epoxy coated conduit underground in corrosive areas].
- .5 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .6 Use rigid PVC conduit underground in corrosive areas.
- .7 Use flexible metal conduit for connection to motors in dry areas, connection to surface or recessed fluorescent fixtures, and work in movable metal partitions].
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .9 Use explosion proof flexible connection for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .11 Minimum conduit size for lighting and power circuits.
- .12 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .17 Dry out conduits before installing wire.

3.3 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 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.

3.4 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.

3.5 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

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.4 STANDARDS

- .1 Use transformers of one manufacturer throughout the project.
- .2 Transformers to be built in accordance with CSA standard C9-M1981(R2001) for dry-type transformers and tested in accordance with this standard.

1.5 TESTS

- .1 Submit full certified performance test data including noise levels for review prior to manufacture.

1.6 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00.

2 Products

2.1 STANDARD TRANSFORMERS (TYPE I)

- .1 Type: ANN, 600 volts, 3 phase delta primary.
- .2 Primary taps: 2x 2 1/2% full capacity taps above and 2x 2 1/2% taps below the nominal voltage.
- .3 Secondary: 3 phase, 60 Hz 120V/208V 4 wire Y (see drawings for kVA rating). Electrostatic shielded grounded star secondary.
- .4 Class H, 220°C insulation with temperature rise not exceeding 150°C maximum in 40°C ambient.

- .5 Efficiency: Energy Star rating
- .6 Basic Impulse Level (BIL): standard.
- .7 Hipot: standard.
- .8 Windings: High grade aluminum or copper windings, double dipped, vacuum impregnated high temperature non hygroscopic silicon varnish.
- .9 Impedance: Sizes 225 kVA and below to be between 4.5 and 5%. Sizes 225 kVA up to 450 kVA to be between 5 and 6%.
- .10 Average Sound Level: Noise emission shall not exceed 50 dB at full-load
- .11 Impedance at 17 degrees C: standard.
- .12 Enclosure: air ventilated EEMAC 1, removable metal front panel "sprinkler-proof" design. Provide angled louvres for ventilation slots to prevent entrance of water from the sprinkler fire protection system. Air cooled type, natural circulation in ventilated enclosure.
- .13 Mounting: provide external vibration isolator kit. Provide "Super W Pads" Neoprene.

2.2 VIBRATION AND SEISMIC CONTROL

- .1 Vibration and Seismic control shall meet the requirements of current BC Building Code and Supplements, and the seismic consultant.
- .2 Vibration and Seismic hardware to control static deflection.
- .3 Transformer equipment to be vibration isolated from the building structure by means of approved Neoprene isolators. Isolation system to have a mutual frequency no higher than one-third of the fundamental frequency.
- .4 Provide inspection services by a qualified isolator manufacturer's representative during and after installation. Provide concise written reports accepting the installation and stating any deficiencies. Correct any deficiencies noted. Include all costs associated with the above in the base tender

3 Execution

3.1 MOUNTING

- .1 Mount dry type transformers on floor unless otherwise noted on drawings.
- .2 Provide 100 mm [4"] concrete house-keeping base pad unless otherwise detailed.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.

3.2 CONNECTIONS

- .1 Make primary and secondary connections in accordance with the manufactures diagrams.
- .2 Check all factory connections for correct tightness before energization.
- .3 Torque the building system wiring transformer connections using a torque wrench set to the manufacturers recommended settings. Note the torque setting on the equipment identification label for future maintenance reference.
- .4 All external wiring connections to transformer casing shall be enclosed in flexible conduit. Typically minimum 900mm [36"] flex to minimize vibration transmission to building structure.
- .5 Conduit to only enter transformers within the bottom third of the transformer casing. (to minimize heat transfer to conduit).
- .6 Energize transformers immediately after installation is completed, where practicable.

3.3 EQUIPMENT IDENTIFICATION

- .1 Size 7 label in accordance with Section 20 05 00.
- .2 Include the transformer identification (as indicted on the project drawings), primary power source equipment designation, equipment served and torque setting of connections (e.g. Transformer T1, served from CDPH-1, serving CDPL-1, Cable Connection Torque x Nm).

3.4 GROUNDING

- .1 Provide a ground conductor with all feeder runs to dry type transformer installations. The ground shall be either green insulated or identified and connected as a ground to the ground pad in the transformer enclosure and thence to the secondary neutral of the transformer. From the transformer ground pad make cable connection to non-current carrying ground of the distribution centre or panel supplied from transformer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 06 10 00.01 - Rough Carpentry - Short Form: Plywood Backboard.
- .4 Section 26 05 00 - Common Work Results - Electrical.
- .5 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2No.29-M1989 (R2000), Panelboards and Enclosed Panelboards.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

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 packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and 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 approved by Departmental Representative.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 Panelboards: bus and breakers rated for 18kA (symmetrical) interrupting capacity or as indicated.

- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two (2) keys for each panelboard and key panelboards alike.
- .6 Tin plated aluminum bus with full size neutral.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank filler for all spaces.

2.2 BREAKERS

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Circuit breaker ratings and interrupting capacity as shown and to match existing breaker kA rating. 347/600V circuit breakers to have minimum of 18,000 A IC symmetrical rms interrupting capacity rating. 120/208V circuit breakers to have minimum of 10,000 A IC symmetrical rms interrupting capacity rating

2.3 EQUIPMENT IDENTIFICATION

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

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

- .2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 00 - Rough Carpentry. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results - Electrical or as indicated.
- .4 Check for breaker installed correspond to short circuit ratings and trip setting in accordance with coordination study, provide coordination study for review prior to field installation.
- .5 Provide *lamicoid* identification for all new breakers.

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide data for incorporation into maintenance manual specified in Division one and Section 26 05 00.
- .2 Include operation and maintenance data for each type and style of starter.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 26 05 00.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 2 contacts, stationary.
 - .2 2 contacts, movable.
 - .3 1 contact, auxiliary.
 - .4 1 control transformer.

- .5 1 operating coil.
- .6 2 fuses.
- .7 4 indicating lamps.

1.7 HOUSE KEEPING PADS

- .1 Provide 100mm [4"] high (nominal) concrete housekeeping pads under all floor mounted MCC's.

2 Products

2.1 MATERIALS

- .1 Starters: to CSA C22.2 No.14.
- .2 Half size starters not acceptable.

2.2 MANUAL MOTOR STARTERS

- .1 Single phase manual motor starters of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One overload heater, manual reset, trip indicating handle.
 - .3 Flush mounted in finished areas.
 - .4 Pilot light.
- .2 Accessories:
 - .1 Toggle switch labelled as indicated.
 - .2 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Three pole adjustable overload relay(s) with single phase protection feature
 - .3 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .4 Wiring and schematic diagram inside starter enclosure in visible location.
 - .5 Provide a fixed 10 point terminal strip for all controls.
 - .6 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - .7 Control transformers to be line voltage to 120 V of sufficient VA to handle operating coil and associated auxiliary controls. Provide primary and secondary HRC fusing.
 - .8 Provide fused circuit and terminal blocks.

- .9 Provide the following accessories:
 - .1 Hand-off-auto selector switches, start/stop/reset buttons or on/off control as indicated.
 - .2 Loads served labelled as indicated.
 - .3 Indicating lights: standard type and colour as indicated.
 - .4 2-N/O and 2-N/C spare auxiliary contacts in addition to the holding contacts unless otherwise indicated.
 - .5 Support facilities for load sensing ring type CT on Phase C of motor circuit
- .2 Two (2) sets of auxiliary contacts - normally Open in addition to standard auxiliary holding contacts supplied with each contactor making a total of three (3) auxiliary contacts. One (1) set of auxiliary contacts to be convertible to normally closed.
- .3 CEMA 1 enclosure unless otherwise indicated.

2.4 COMBINATION STARTERS

- .1 In addition to "Full Voltage Magnetic Starters" above, provide 3 pole magnetic trip moulded case breaker (MCP) and operating handle with lock-off facility.
- .2 Enclosure "opening" to be restricted by use of a defeater screw unless switch is in "off" position.

2.5 MCC ASSEMBLIES

- .1 Unit motor control centres to be of the dead front, assembly of vertical stacks with each stack containing necessary cubicles to provide equipment required including space as specified or shown on the drawings. Minimum height for one module to be 300mm [12"] and each module to house a combination starter MCP, relays and/or transformer as indicated. Motor control centres to be for 600V, 3 phase, 3 wire, 60 Hz application. Motor control centres to have horizontal copper bussing across top and vertical copper bussing down each stack. Main bus capacity to be as indicated on drawing, having bracing and supports suitable to withstand short circuit current up to 50,000 amps symmetrical unless otherwise specifically noted in MCC schedules. Each module of each motor control centre to be connected to the common bus by plug-in style connection stabs.
- .2 Enclosures shall be drip-proof. Provide "sprinkler-proof" design where equipment is located in areas where sprinkler fire protection is installed. All ventilation slots to be provided with angled louvres to prevent entrance of water from the sprinkler fire protection system.
- .3 Each starter or disconnect switch assembly in MCC assembly to be mounted in tub or rack assembly of removable plug-in type with necessary bus connection stabs. Provide hinged section(s) with full copper bussing to receive future rack assemblies where blank starter connections are indicated.
- .4 Provide wiring gutter across top and bottom and vertically down each stack of MCC. Wireways to be barriered from bussway compartments. Motor control centre components to be designed and constructed for ease of servicing and connection.

Connection and terminal blocks to be accessible from the front (not to be at back or rear). Overload devices to be interchangeable and to clearly indicate heater rating from exterior of device.

- .5 Motor control centres to be constructed in accordance with NEMA standards for construction of Class I, modified Type B centres with control wiring and control terminals on each module and control wiring extended to control terminal section of MCC.
- .6 Provide separate hinged door over vertical wire gutter along each stack of starters.
- .7 Each motor control centre to have a separate control terminal section unless otherwise indicated, barriered from adjacent line voltage section(s). Control terminal section not to contain any bus work or bus supports. Control terminal section to be complete with solid backpan at rear of MCC stack for installation of control terminals. Control terminal section to be full depth of motor control centre.
- .8 Where indicated, provide front mounted single phase manual motor protection switches with red pilot light, adjacent HOA selector switch, auxiliary relay and terminal block interface.
- .9 Provide feeder breakers for particular loads not requiring starters as indicated.
- .10 Provide adequately sized terminal compartment to facilitate incoming feeder cables. Compartment to contain fully rated main bus extensions with cable lugs. Provide lamicoid nametag labeled "INCOMING TERMINAL COMPARTMENT".
- .11 Floor mounting, free standing, enclosed dead front.

2.6 WALL MOUNTED GROUPED MOTOR CONTROL

- .1 Wall mounted "4Plex" assemblies are an acceptable alternative to floor mounted MCC assemblies for grouping of up to 4 full size combination starters or sections are in one location.
- .2 Wall mounted Grouped Motor Control may include sections allocated to main disconnect, multiple manual starter assemblies, control sections or load centres.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.
- .4 MCC designation label, white plate, black letters, size 7 engraved as indicated.

3 Execution

3.1 INSTALLATION

- .1 Install starters and MCC assemblies.
- .2 Connect power and control as indicated.
- .3 Provide interlocking between starters where required.
- .4 Provide relays for fire alarm shutdown. Relays to be approved by Fire Alarm manufacturer and to be powered by the fire alarm panel or approved 24VDC source.

- .5 In finished areas, provide flush mounted remote controls and manual motor protection starters complete with stainless steel coverplates and pilot lights unless otherwise indicated. Provide key operated motor protection starters where indicated or in normally accessible areas where unauthorized operation could be a functionality issue.
- .6 Select overload settings to suit full load current of motors installed that may differ from the design loads. Confirm with other Divisions.
- .7 Ensure correct control fuses and overload devices elements installed.
- .8 Provide disconnects at all equipment.

3.2 MOTOR CONTROL CENTRES

- .1 Each motor control centre to contain starters and spaces as indicated. Arrange starter units and circuit breakers in groupings shown. Certain alterations will be accepted to suit a particular manufacturer's standard unit layout, however, layout of units per stack to follow that indicated. Starter units are numbered with equipment unit number identification system. All cubicles to be complete with lamicooid engraved nametag (screw attached) giving motor designation or load controlled, voltage and horsepower.

3.3 CONTROL TERMINAL SECTION

- .1 Extend control wiring as indicated on typical wiring diagram from each motor control module to control terminal section. All terminals to be number coded and otherwise suitably identified to indicate which section or module of motor control centre they are associated with and their function. Control wiring diagrams of each typical type with conductor identification clearly shown to be affixed to interior cover of control terminal section.
- .2 Control terminal section to house all controls, relays and time delay relays associated with the mechanical control systems and control systems such as fire alarm.
- .3 Relays for fire alarm shutdown to be approved by Fire Alarm manufacturer and be powered by the fire alarm panel or approved 24VDC source. Relays not powered by the fire alarm panel shall be wired as fail-safe to supervise power source.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 and manufacturer's instructions.
- .2 Operate controls, switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42-99 (R2002), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.
 - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and 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 paper, plastic, polystyrene, corrugated cardboard and 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 Consultant.

Part 2 Products

2.1 SWITCHES

- .1 20 A, 120 V, single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.

- .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 Ivory toggle.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Acceptable materials:
 - .1 Hubbell HBL.1221 20A series
 - .2 Leviton 1221-20A 120V series – 18221 347V
 - .3 Pass & Seymour PS20AC1 120V series – PS37201(3)0 347V

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable materials:
 - .1 Hubbell 5252 heavy duty, construction series
 - .2 Leviton 5262 series
 - .3 Pass & Seymour 5262 series

2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

- .4 Stainless steel, vertically brushed, 1 mm thick cover plates.
- .5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

Part 3 Execution

3.1 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results - Electrical.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

- .1 Materials for moulded-case circuit breakers, circuit breakers, ground-fault circuit-interrupters, fused circuit breakers, and accessory high-fault protectors.

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. 5-[02], Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.5 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 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

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

- .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers of panel 6A1 to have minimum 18 KA symmetrical rms interrupting capacity rating.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.
- .2 Supply and install matching circuit breaker to match the existing CDP and panelboards.
- .3 Check circuit breaker operation in accordance with the manufacturer's requirements.
- .4 Check for breaker installed correspond to short circuit ratings and trip setting in accordance with coordination study, provide coordination study for review prior to field installation.
- .5 Provide *lamicoid* identification for all new breakers.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for fused and non-fused disconnect switches.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 35 29.06 - Health and Safety Requirements
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .4 Section 26 05 00 - Common Work Results - Electrical
- .5 Section 26 28 13.01 - Fuses - Low Voltage

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-[M89 (R2000)], Enclosed Switches.
 - .2 CSA C22.2 No.39-[M89 (R2003)], Fuseholder Assemblies.

1.4 SUBMITTALS

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

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - 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 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible, non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 size as indicated.
- .2 Provision for padlocking in off switch position.

- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplate..

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C82.1-[04], Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
 - .2 ANSI C82.4-[02(R2007)], Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-[1991], Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ASTM International Inc.
 - .1 ASTM F1137-[00(2006)], Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA International)
- .5 ICES-005-[07], Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

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.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval by Departmental Representative.
 - .3 Photometric data to include: VCP Table where applicable and spacing criterion.
- .3 Quality assurance submittals: provide following 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 Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .3 Packaging Waste Management: remove or reuse and return to manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.
- .5 Disposal and recycling of fluorescent lamps as per local regulations.
- .6 Disposal of old PCB filled ballasts.

Part 2 Products

2.1 LAMPS

- .1 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80; or as indicated.
- .2 Compact fluorescent lamps to be - 18 Watt, G24q-2 base, 12,000 hour lamp life, 12,000 initial lumens, 4100 K, CRI 80; or as indicated.
- .3 LED lamps to be – High efficiency LED source, minimum 50,000 hours rated life, 4100K colour temperature, compliance with IES LM-79 standards; or as indicated.

2.2 BALLASTS

- .1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic, IC electronic dimmable.
 - .1 Rating: 60 Hz, voltage as indicated, for use with 2-32W, rapid start lamps.
 - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
 - .3 Power factor: minimum with 95% of rated lamp lumens.
 - .4 Current crest factor: 1.7 maximum.
 - .5 Harmonics: 10 % maximum THD.
 - .6 Operating frequency of electronic ballast: 20 kHz minimum.
 - .7 Total circuit power: 64 Watts.
 - .8 Ballast factor: greater than 0.90.
 - .9 Sound rated: Class A.
 - .10 Mounting: integral with luminaire.
- .2 LED Drivers:
 - .1 RLED drivers with 0-10 volt dimming shall be supplied as a standard.
 - .2 Housing protection against moisture, dust, and vibrations.
 - .3 Minimum 50,000 hours life.
 - .4 Module temperature control
 - .5 Constant light output.
 - .6 Compliance with IES LM-80 Standards.

2.3 FINISHES

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.4 OPTICAL CONTROL DEVICES

- .1 As indicated in luminaire schedule.

2.5 LUMINAIRES

- .1 As indicated in luminaire schedule.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 WIRING

- .1 Connect luminaires to lighting circuits:
 - .1 Install flexible or rigid conduit for luminaires as indicated.

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires independently of ceiling support luminaires from ceiling grid in accordance with local inspection requirements.

3.4 LUMINAIRE ALIGNMENT

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

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 33 65 76 - Direct Buried Underground Cable Ducts.
- .3 Section 26 05 39 - Underfloor Raceways for Electrical Systems.
- .4 Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .5 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .6 Section 26 05 36 - Cable Trays for Electrical Systems.
- .7 Section 26 05 38 - Cellular Metal Floor Raceway Fittings.
- .8 Section 26 27 23 - Indoor Service Poles.

1.2 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 paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal conduit and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 MATERIAL

- .1 Conduits: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.
- .2 Cabletroughs: in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .3 Junction boxes, cabinets type: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes, and Cabinets.
- .4 Outlet boxes type, conduit boxes size, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .5 Indoor service poles: in accordance with Section 26 27 23 - Indoor Service Poles.
- .6 Fish wire: polypropylene.

Part 3 Execution

3.1 INSTALLATION

- .1 Install empty raceway system, including distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletroughs, service poles, miscellaneous and positioning material to constitute complete system.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No. 214-02, Communications Cables (Bi-National standard with UL 444).
 - .2 CSA-C22.2 No. 232-M1988 (R2004), Optical Fiber Cables.
- .2 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-568-B.1-(2001), Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
 - .2 TIA/EIA-568-B.2-(2001), Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
 - .3 TIA/EIA-568-B.3-(2000), Optical Fiber Cabling Components Standard.
 - .4 TIA/EIA-606-A-(2002), Administration Standard for the Commercial Telecommunications Infrastructure.
 - .5 TIA TSB-140-2004, Telecommunications Systems Bulletin - Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
 - .6 TIA-598-C-(2005), Optical Fiber Cable Colour Coding.

1.2 DEFINITIONS

- .1 Refer to TIA/EIA-598-C, Annex A for definitions of terms: optical-fiber interconnect, distribution, and breakout cables.

1.3 SYSTEM DESCRIPTION

- .1 Structured telecommunications wiring system consist of unshielded-twisted-pair and optical fiber cables, terminations, connectors, cross-connection hardware and related equipment installed inside building for occupant's telecommunications systems, including voice (telephone), data, and image.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 As-built Records and Drawings:
 - .1 Provide Microsoft Access database reflecting cable installation and cross-connections.
 - .2 Provide electronic drawings in AutoCAD 2008 format depicting all construction.
 - .3 Provide two (2) bound complete hard-copy sets of as-built records to the Departmental Representative.

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FOUR-PAIR 100 Ω BALANCED TWISTED PAIR CABLE

- .1 Four-pair, 100 ohm balanced unshielded-twisted-pair (UTP) cable, flame test classification FT6 or MPP or CMP to: CSA-C22.2 No. 214, Category 6 (Cat 6).

2.2 UTP CROSS-CONNECT WIRE

- .1 Category 6, 4 pairs to: TIA/EIA-568-B.2.

2.3 UTP PATCH CORDS

- .1 3 metres long, with factory-installed male plug at one end to mate with "RJ-45" jack and with factory-installed male plug at other end to mate with "RJ-45" jack Category 6, 4 pairs to: TIA/EIA-568-B.2.

2.4 OPTICAL-FIBER CABLE

- .1 Distribution Breakout, single mode 50/125, 500 MHz km capacity 62.5/125 micron, 6 strands to: TIA/EIA-568- B.3, flame test classification FT6 or OFNR, each end terminated with duplex SC connectors.

2.5 OPTICAL-FIBER PATCH PANEL

- .1 Mounted in rack 19" wide, 12 ports, equipped with duplex SC compatible adapters.

2.6 OPTICAL-FIBER PATCH CORDS

- .1 Interconnect cable, 2 strands, 3 metres long, each end equipped with duplex SC connectors. Single mode 50/125, 500 MHz km capacity to: TIA/EIA-568-B.3.

2.7 MEDIA CONVERTER

- .1 Provide two sets of media converters to extend the network over fiber at distances up to 5 kilometers on single-mode fiber cable. The converter should both sends and receives over one or two strands of fiber.
- .2 The media converter should be a Fiber Multi-Power Media Converter to seamlessly and transparently converts 10-/100-/1000-Mbps copper to 1000-Mbps fiber and back at to copper at both ends of the fiber.
- .3 Provide power supplies for all the media converters at both ends.
- .4 Media converters should be rack mountable.

Part 3 Execution

3.1 INSTALLATION OF TERMINATION AND CROSS-CONNECT HARDWARE

- .1 Install termination and cross-connect hardware in rack as indicated and according to manufacturers' instructions. Identify and label as indicated to: TIA/EIA-606-A.
- .2 Install consolidation points, as indicated according to manufacturer's instructions. Identify and label as indicated to: TIA/EIA-606-A.

3.2 INSTALLATION OF BACKBONE CABLES

- .1 Install backbone cables from DDC panel to chemical building as indicated and according to manufacturers' instructions.
 - .1 Identify and label as indicated to: TIA/EIA-606-A.

3.3 INSTALLATION OF EQUIPMENT CABLES

- .1 Install equipment cables from equipment patch panel as indicated.
 - .1 Identify and label as indicated to: TIA/EIA-606-A.

3.4 IMPLEMENT CROSS-CONNECTIONS

- .1 Implement cross-connections using jumper wires as specified.

3.5 FIELD QUALITY CONTROL

- .1 Test horizontal UTP cables as specified below and correct deficiencies provide record of results as hard copy electronic record on CD.
 - .1 Perform tests for Permanent Link on installed cables, including spares:
 - .1 Category 6 using certified level III tester to: TIA/EIA-568-[B.2].
 - .2 Perform tests for Channel on 20% of cross-connected data horizontal cabling installed from each telecommunications room, including shortest and longest drops from each telecommunications room: should more than 5% of tested cables fail, test remaining cross-connected data cables.
 - .1 Category 6 using certified level III tester to: TIA/EIA-568-B.2.
- .2 Test backbone UTP cables as specified below and correct deficiencies: provide record of results as hard copy and electronic record on CD.
 - .1 Perform tests for Permanent Link on 4-pair cables:
 - .1 Category 6 using certified level III tester to: TIA/EIA-568-B.2.
 - .2 Perform Wire Map tests on multi-pair UTP cables to: TIA/EIA-568-B.1.
- .3 Test Optical-fiber strands for attenuation to: TIA/EIA-568-B.1 and correct deficiencies: provide record of results as hard copy electronic record on CD.
 - .1 Test horizontal links need at only one wavelength 850 nm and in one direction.
 - .1 Attenuation to be less than 2.0 dB, unless consolidation point is used.
 - .2 If consolidation point is used, attenuation test result to be less than 2.75

- dB when testing between horizontal cross-connect and telecommunications outlet/connector.
- .2 Test backbone links in both directions. Backbone links:
 - .1 Test multi-mode fiber at both applicable wavelengths 850 nm and 1300 nm.
 - .2 Test single-mode fiber at both applicable wavelengths 1550 nm and 1310 nm.
 - .3 Maximum attenuation: Cable attenuation + Connector loss + Splice loss.
 - .1 Multi-mode-fiber attenuation coefficients:
 - .1 3.5 db/km @ 850 nm; and
 - .2 1.5 db km @ 1300 nm
 - .2 Single-mode fiber attenuation coefficients at both 1310 nm and 1550 nm:
 - .1 1.0 db/km for inside plant cable; and
 - .2 0.5 db/km for outside plant cables.
 - .3 Maximum connector insertion loss: 0.75 db per pair and maximum splice insertion loss: 0.3 db.
 - .4 Perform additional Tier 2 tests using optical time domain reflectometer (OTDR) on backbone fiber pairs to: TSB-140.
 - .1 Correct deficiencies.
 - .2 Provide record of results as described in SUBMITTALS.
 - .5 Provide record of results as hard copy and electronic record on CD to: TIA/TSB-140.

END OF SECTION

1 GENERAL

1.01 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 N/A

1.02 RELATED REQUIREMENTS

- | | | |
|----|----------------------------------------|---------------------|
| .1 | Special Procedures for Traffic Control | Section 01 35 00.06 |
| .2 | Roadway Embankments | Section 31 24 13 |
| .3 | Aggregate Materials | Section 31 05 16 |
| .4 | Roadway Dust Control | Section 32 15 60 |

1.03 MEASUREMENT AND PAYMENT

- .1 Measure granular sub-base in cubic metres measured in place by cross section and calculated by average end area method of material incorporated into Work and accepted by Departmental Representative.
- .2 Measure excavation of sub-base and subgrade materials to correct deficiencies in subgrade discovered during proof rolling as common excavation under Section 31 24 13 – Roadway Embankments.
 - .1 Measure backfill of subgrade with common materials as common excavation and subgrade compaction under Section 31 24 13 – Roadway Embankments.
 - .2 Measure backfill of subgrade with sub-base material and replacement of sub-base material under this Section.
- .3 Measure hauling granular sub-base material in cubic metre-kilometres, computed by taking product of number of cubic metres of material placed multiplied by haul distance in kilometres.
 - .1 Measure haul distance from source of material to centre of volume of material after placing, measured along shortest route determined by Departmental Representative as being feasible and satisfactory.
- .4 Measure water in units of 1000 L for water authorized by Departmental Representative and applied.
- .5 Measure compaction of granular sub-base in hours for particular compaction units employed including operator, fuel and maintenance as shown on approved recording devices.

1.04 REFERENCES

- .1 ASTM International
 - .1 ASTM C 117-[04], Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 131-[06], Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C 136-[06], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D 422-[63(2007)], Standard Test Method for Particle-Size Analysis of Soils.
 - .5 ASTM D 698-[07e1], Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft²) (600kN-m/m²).
 - .6 ASTM D 1557-[09], Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft²) (2,700kN-m/m²).
 - .7 ASTM D 1883-[07e2], Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

- .8 ASTM D 4318-[10], Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
- .3 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.
- .4 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.

1.05 ACTION AND INFORMATIONAL SUBMITTALS

- .1 N/A

1.06 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 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Replace defective or damaged materials with new.
- .3 Develop a Construction Waste Management Plan related to the Work of this Section in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 MATERIALS

- .1 Granular sub-base material: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.
 - .3 Table
Sieve

<u>Designation</u>	<u>% Passing</u>
75 mm	100
25 mm	50-85
0.150 mm	0-15
<u>0.075 mm</u>	<u>0-8</u>
 - .4 Other properties as follows:
 - .1 Liquid Limit: to ASTM D 4318, Maximum 25.
 - .2 Plasticity Index: to ASTM D 4318, Maximum 6.
 - .3 Los Angeles degradation: to ASTM C 131.
 - .1 Maximum loss by mass: 50 %.
 - .4 Particles smaller than 0.02 mm: to ASTM D 422, Maximum 3%.
 - .5 Soaked CBR: to ASTM D 1883, Minimum 40 when compacted to 100% of ASTM D 1557.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for granular sub-base 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.

3.02 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 construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 PLACING

- .1 Place granular sub-base after subgrade is inspected and accepted by Departmental Representative.
- .2 Construct granular sub-base to depth and grade in areas indicated.
- .3 Ensure no frozen material is placed.
- .4 Place material only on clean unfrozen surface, free from snow or ice.
- .5 Begin spreading sub-base material on crown line or high side of one-way slope.
- .6 Place granular sub-base materials using methods which do not lead to segregation or degradation.
- .7 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .8 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
 - .1 Departmental Representative may authorize thicker lifts if specified compaction can be achieved.
- .9 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .10 Remove and replace portion of layer in which material has become segregated during spreading.

3.04 COMPACTION

- .1 Compaction equipment to be capable of obtaining required material densities.
- .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Departmental Representative before use.
- .3 Equipped with device that records hours of actual work, not motor running hours.
- .4 Compact to density of not less than 95% modified proctor density.
- .5 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- .6 Apply water as necessary during compaction to obtain specified density.
- .7 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Departmental Representative.
- .8 Correct surface irregularities by loosening and adding or removing material until surface is within

specified tolerance.

3.05 PROOF ROLLING

- .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm maximum.
- .2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.
- .3 Proof roll at level in sub-base as indicated.
 - .1 If non-standard proof rolling equipment is approved, Departmental Representative will determine level of proof rolling.
- .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove sub-base and subgrade material to depth and extent as directed by Departmental Representative.
 - .2 Backfill excavated subgrade with common material and compact in accordance with Section 31 24 13 – Roadway Embankments.
 - .3 Replace sub-base material and compact.
- .6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

3.06 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 for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.07 SITE TOLERANCES

- .1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.08 PROTECTION

- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Departmental Representative.

END OF SECTION

1 GENERAL

1.01 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 N/A

1.02 RELATED REQUIREMENTS

.1	Special Procedures for Traffic Control	Section 01 35 00.06
.3	Aggregate Materials	Section 31 05 16
.3	Granular Sub-Base	Section 32 11 16.01
.4	Roadway Dust Control	Section 32 15 60
.4	Reference Specifications	Section 01 42 00
.2	Roadway Embankments	Section 31 24 13
.4	Re-shaping Existing Subgrade	Section 31 22 16.1

1.03 MEASUREMENT AND PAYMENT

- .1 Measure granular base in cubic metres measured in place by cross section and calculated by average end area method of material incorporated into Work and accepted in writing by Departmental Representative.
- .2 Measure excavation of base, sub-base and sub-grade materials to correct deficiencies in sub-grade discovered during proof rolling as common excavation under Section 31 24 13 – Roadway Embankments.
 - .1 Measure backfill of sub-grade with common materials as common excavation and sub-grade compaction under Section 31 24 13 – Roadway Embankments.
 - .2 Measure backfill of subgrade with sub-base material and replacement of sub-base material to Section 32 11 16.01 - Granular Sub-base.
 - .3 Measure subsequent replacement of base materials under this Section.
- .3 Measure hauling granular base material in cubic metre-kilometres computed by taking product of number of cubic metres of material placed multiplied by haul distance in kilometres.
 - .1 Measure haul distance from source of material to centre of volume of material after placing, measured along shortest route determined by Departmental Representative as being feasible and satisfactory.
- .4 Measure water in units of 1000L for water authorized by Departmental Representative and applied.
- .5 Measure compaction of granular base in hours for each type of compaction unit employed including operator, fuel and maintenance as shown on recording devices.

1.04 REFERENCES

- .1 ASTM International
 - .1 ASTM C 117-[04], Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 131-[06], Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C 136-[06], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D 698-[07e1], Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft²) (600kN-m/m²).
 - .5 ASTM D 1557-[09], Test Method for Laboratory Compaction Characteristics of Soil

- Using Modified Effort (56,000ft-lbf/ft²) (2,700kN-m/m²).
- .6 ASTM D 1883-[07e2], Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .7 ASTM D 4318-[10], Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
 - .3 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.
 - .4 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.

1.05 ACTION AND INFORMATIONAL SUBMITTALS

- .1 N/A

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements, 31 05 16 - Aggregate Materials and with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
 - .1 Stockpile minimum 50% of total aggregate required prior to beginning operation.
 - .2 Store materials in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.
 - .3 Replace defective or damaged materials with new.
 - .4 Store cement in weathertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 MATERIALS

- .1 Granular base: material in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.

.1 Gradation Method #1 to:	
Sieve Designation	% Passing
19 mm	100
12.5 mm	75-100
9.5 mm	60-90
4.75 mm	40-70

2.36 mm	27-55
1.18 mm	16-42
0.600 mm	8-30
0.300 mm	5-20
0.075 mm	2-8
.2	Material to level surface depressions to meet gradation (2) limits in accordance with Method #1.
.3	Liquid limit: to ASTM D 4318, maximum 25
.4	Plasticity index: to ASTM D 4318, maximum 6.
.5	Los Angeles degradation: to ASTM C 131. Max. % loss by weight: 45
.6	Crushed particles: at least 60% of particles by mass within each of following sieve designation ranges to have at least 1 freshly fractured face. Material to be divided into ranges using methods of ASTM C 136.
<u>Passing</u>	<u>Retained on</u>
50 mm	to 25 mm
25 mm	to 19.0 mm
19.0 mm	to 4.75 mm
.7	Soaked CBR: to ASTM D 1883, minimum 80, when compacted to 100% of ASTM D 1557.

3 EXECUTION

3.01 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 construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.02 PLACEMENT AND INSTALLATION

- .1 Place granular base after sub-base surface is inspected and accepted in writing by Departmental Representative.
- .2 Placing:
 - .1 Construct granular base to depth and grade in areas indicated.
 - .2 Ensure no frozen material is placed.
 - .3 Place material only on clean unfrozen surface, free from snow and ice.
 - .4 Begin spreading base material on crown line or on high side of one-way slope.
 - .5 Place material using methods which do not lead to segregation or degradation of aggregate.
 - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
 - .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
 - .1 Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.

- .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
 - .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
 - .3 **Compaction Equipment:**
 - .1 Ensure compaction equipment is capable of obtaining required material densities.
 - .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Departmental Representative before use.
 - .3 Equipped with device that records hours of actual work, not motor running hours.
 - .4 **Compacting:**
 - .1 Compact to density of not less than 95% modified proctor density.
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved in writing by Departmental Representative.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
 - .5 **Proof rolling:**
 - .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
 - .2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.
 - .3 Proof roll at level in granular base as indicated.
 - .1 If use of non-standard proof rolling equipment is approved, Departmental Representative to determine level of proof rolling.
 - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Departmental Representative.
 - .2 Backfill excavated subgrade with sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-Base.
 - .3 Replace sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-base.
 - .4 Replace base material and compact in accordance with this Section.
 - .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Departmental Representative and replace with new materials in accordance with Section 32 11 16.01 - Granular Sub-base and this section at no extra cost.
- 3.03 SITE TOLERANCES**
- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.04 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 for reuse and 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.
 - .2 Divert unused granular material from landfill to local facility as directed by Departmental Representative.

3.05 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Departmental Representative.

END OF SECTION

1 GENERAL

1.01 RELATED REQUIREMENTS

- .1 Special Procedures for Traffic Control Section 01 35 00.06
- .2 Reshaping Granular Roadbed Section 32 11 17
- .3 Aggregate Base Courses Section 32 11 23
- .3 Asphalt Paving Section 32 12 16

1.02 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- .1 N/A

1.03 MEASUREMENT PROCEDURES

- .1 Asphalt prime will be measured in square metres at 15 degrees C of cutback asphalt.
- .2 Blotter Sand: supply of blotter sand will be measured by weight in tonnes.
- .3 Application of Blotter Sand: application of blotter sand will be measured in cubic metres.

1.04 REFERENCES

- .1 ASTM International
 - .1 ASTM D 140/D 140M-[09], Standard Practice for Sampling Bituminous Materials.
- .2 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-NC-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations 2009.
 - .3 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Commercial Interiors.
 - .4 LEED Canada-EB: O&M-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Existing Buildings: Operations and Maintenance 2009.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-16.1-[M89], Cutback Asphalts for Road Purposes.
 - .2 CAN/CGSB-16.2-[M89], Emulsified Asphalts, Anionic Type, for Road Purposes.

1.05 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 asphalt prime coat and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit two 4L samples of asphalt prime proposed for use in new, clean, air tight sealed, wide mouth plastic containers to Departmental Representative 2 weeks prior to commencing Work.
 - .2 Sample asphalt prime coat materials in accordance with ASTM D 140.
 - .3 Provide access on tank truck for Departmental Representative to sample asphalt material to be incorporated into Work, in accordance with ASTM D 140.

- .4 Sustainable Design Submittals:
 - .1 N/A

1.06 QUALITY ASSURANCE

- .1 Upon request from Departmental Representative, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

1.07 DELIVERY, STORAGE AND HANDLING

- .1 Deliver 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.
 - .1 Arrange points of delivery and quantity to be shipped with vendor
 - .2 Make deliveries during normal work hours.
 - .3 Include copy of orders and instructions respecting shipment upon request by Departmental Representative.
 - .4 Include suitable unloading facilities and unload asphalt as directed Departmental Representative.
 - .5 Provide, maintain and restore asphalt storage area.
- .3 Storage and Handling Requirements:
 - .1 Deliver, store and handle materials to ASTM D 140.
 - .2 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .3 Store and protect asphalt prime coats from nicks, scratches, and blemishes.
 - .4 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 MATERIAL

- .1 Asphalt material: to CAN/CGSB-16.1 grade: RM-20, MC-30, MC-250, or CAN/CGSB-16.2 grade: SS-1.
- .2 Sand blotter: clean granular material passing 4.75 mm sieve and free from organic matter or other deleterious materials.
- .3 Water: clean, potable, free from foreign matter.

2.02 EQUIPMENT

- .1 Pressure distributor:
 - .1 Designed, equipped, maintained and operated so that asphalt material can be:
 - .1 Maintained at even temperature.
 - .2 Applied uniformly on variable widths of surface up to 5 m.
 - .3 Applied at controlled rates from 0.2 to 5.4 L/m² with uniform pressure, and allowable variation from any specified rate not exceeding 0.1 L/m².
 - .4 Distributed in uniform spray without atomization at temperature required.
 - .2 Equipped with meter registering travel distance in metres per minute, visibly located to

- .3 enable truck driver to maintain constant speed required for application at specified rate.
Equipped with pump having flow meter graduated in units of 5 L or less per minute passing through nozzles and readily visible to operator.
 - .1 Pump power unit to be independent of truck power unit.
- .4 Equipped with easily read, accurate and sensitive device which registers temperature of liquid in reservoir.
 - .1 Temperature to be measured to nearest whole number.
- .5 Equipped with accurate volume measuring device or calibrated tank.
- .6 Equipped with nozzles of same make and dimensions, adjustable for fan width and orientation.
- .7 Equipped with nozzle spray bar, with operational height adjustment in increments of 0.6 metres and capable of being raised or lowered.
- .8 Cleaned if previously used with incompatible asphalt material.
- .2 Aggregate Spreader:
 - .1 Apply blotter sand to primed surfaces using roll type spreader, or rotating disc sander capable of applying aggregate at variable widths and at variable rates.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt prime coat 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.

3.02 APPLICATION

- .1 Proceed with application of tack coat only after acceptance of granular base surface from Departmental Representative.
- .2 Cutback asphalt:
 - .1 Heat asphalt prime to between 60 and 70 degrees C for pumping and spraying.
 - .2 Apply asphalt prime to granular base at rate as directed by Departmental Representative, but not to exceed 2 L/m².
 - .3 Apply on dry surface unless otherwise directed by Departmental Representative.
- .3 Anionic emulsified asphalt:
 - .1 Dilute asphalt emulsion with clean water at 1:1 ratio for application.
 - .2 Mix thoroughly by pumping or other method approved by Departmental Representative.
 - .3 Apply diluted asphalt emulsion at rate directed by Departmental Representative, but do not exceed 5 L/m².
 - .4 Apply diluted asphalt emulsion on damp surface unless otherwise directed by Departmental Representative.
- .4 Apply asphalt prime only on unfrozen surface.
- .5 Apply asphalt tack coat only when air temperature is greater than 10 degrees C and when rain is not forecast within 2 hours minimum of application.
- .6 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt prime material.

- .7 Where traffic is to be maintained, treat no more than one-half width of surface in one application.
- .8 Prevent overlap at junction of applications.
- .9 Do not prime surfaces that will be visible when paving is complete.
- .10 Apply additional material to areas not sufficiently covered as directed by Departmental Representative.
- .11 Keep traffic off primed areas until asphalt prime has cured.
 - .1 Control traffic in accordance with Section 01 35 00.06 - Special Procedures for Traffic Control.
- .12 Permit prime to cure before placing asphalt paving.

3.03 USE OF SAND BLOTTER

- .1 If asphalt prime fails to penetrate within 24 hours, spread sand blotter material in amounts required to absorb excess material.
- .2 Allow sufficient time for excess prime to be absorbed as directed by Departmental Representative.
- .3 Apply second application of sand blotter as required.
- .4 Do not roll blotter sand.
- .5 Sweep and remove excess blotter material.

3.04 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 for reuse and 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

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|----------------------------------------|---------------------|
| .1 | Special Procedures for Traffic Control | Section 01 35 00.06 |
| .2 | Aggregate Materials | Section 31 05 16 |
| .3 | Reshaping Granular Roadbed | Section 32 11 17 |
| .4 | Asphalt Prime Coats | Section 32 12 13.23 |
| .5 | Asphalt Tack Coats | Section 32 12 13.16 |
| .6 | Excavating, Trenching and Backfilling | Section 31 23 33.01 |

1.02 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- .1 N/A

1.03 MEASUREMENT AND PAYMENT

- .1 Measure asphalt concrete paving in tonnes of asphalt concrete actually incorporated into Work.
.2 Measure supply of asphalt cement in tonnes.
.3 Measure supply of hydrated lime in tonnes.

1.04 REFERENCES

- .1 American Association of State Highway and Transportation Officials (AASHTO)
.1 AASHTO M320-[10], Standard Specification for Performance Graded Asphalt Binder.
.2 AASHTO R29-[02], Standard Specification for Grading or Verifying the Performance Graded of an Asphalt Binder.
.3 AASHTO T245-[97(2004)], Standard Method of Test for Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus.
.2 Asphalt Institute (AI)
.1 AI MS-2-[1994] [Sixth Edition], Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
.3 ASTM International
.1 ASTM C 88-[05], Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
.2 ASTM C 117-[04], Standard Test Method for Material Finer Than 0.075mm (No.200) Sieve in Mineral Aggregates by Washing.
.3 ASTM C 123-[04], Standard Test Method for Lightweight Particles in Aggregate.
.4 ASTM C 127-[07], Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
.5 ASTM C 128-[07a], Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
.6 ASTM C 131-[06], Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
.7 ASTM C 136-[06], Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
.8 ASTM C 207-[2006], Standard Specification for Hydrated Lime for Masonry Purposes.
.9 ASTM D 995-[-95b(2002)], Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
.10 ASTM D 2419-[09], Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
.11 ASTM D 3203-[94(2005)], Standard Test Method for Percent Air Voids in Compacted

- Dense and Open Bituminous Paving Mixtures.
- .12 ASTM D 4791-[05e1], Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .4 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
- .5 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.
- .6 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.

1.05 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 asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C 4 weeks prior to beginning Work.
- .3 Samples:
 - .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling 4 weeks prior to beginning Work.
 - .2 Submit samples of following materials proposed for use 4 weeks prior to beginning Work.
 - .1 One 5 L container of asphalt cement.
 - .2 1 kg of hydrated lime.
- .4 Test and Evaluation Reports:
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification that asphalt cement meets specification requirements.
 - .2 Submit manufacturer's test data and certification that hydrated lime meets specified requirements.
 - .3 Submit asphalt concrete mix design and trial mix test results to Departmental Representative at least 4 weeks prior to beginning Work.
 - .4 Submit printed record of mix temperatures at end of each day.
- .7 Sustainable Design Submittals:
 - .1 N/A

1.06 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 Deliver and stockpile aggregates in accordance with Section 31 05 16 - Aggregate Materials.

- Stockpile minimum 50% of total amount of aggregate required before beginning asphalt mixing operation.
- .3 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.
 - .4 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.
 - .5 Provide approved storage, heating tanks and pumping facilities for asphalt cement.
 - .6 Submit to Departmental Representative copies of freight and waybills for asphalt cement as shipments are received.
 - .1 Departmental Representative reserves right to check weights as material is received.
 - .7 Stockpile crushed RAP separately in accordance with Section 31 05 16 - Aggregate Materials.
 - .8 Protect and cover stockpiles of crushed RAP from rain to satisfaction of Departmental Representative.
 - .9 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .10 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 MATERIALS

- .1 Performance graded asphalt cement: to AASHTO M320, grade PG 58-28 when tested to AASHTO R29.
- .2 RAP:
 - .1 Crushed and screened to ensure 100% of RAP material passes 50 mm screen before mixing.
- .3 Aggregates: in accordance with Section 31 05 16 - Aggregate Materials and requirements as follows:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1 or CAN/CGSB-8.2.
 - .3 Table:

	<u>Sieve Designation % Passing</u>	
	Lower Course	Surface Course
19 mm	100	-
12.5 mm	84-99	100
9.5 mm	73-88	-
4.75 mm	50-68	55-75
2.36 mm	35-55	38-58
1.18 mm	27-46	28-47
0.600 mm	18-36	20-36
0.300 mm	10-26	10-26
0.150 mm	4-17	4-17
0.075 mm	3-8	3-8
- .4 Coarse aggregate: aggregate retained on 4.75 mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C 136.

- .5 When dryer drum plant or plant without hot screening is used, process fine aggregate through 4.75 mm sieve and stockpile separately from coarse aggregate.
 - .6 Separate stockpiles for coarse and fine aggregates not required for sheet asphalt.
 - .7 Do not use aggregates having known polishing characteristics in mixes for surface courses.
 - .8 Sand equivalent: ASTM D 2419. Min: 50.
 - .9 Magnesium Sulphate soundness: to ASTM C 88. Max % loss by mass:
 - .1 Coarse aggregate surface course: 12 %.
 - .2 Coarse aggregate lower course: 12 %.
 - .3 Fine aggregate, surface course: 16 %.
 - .4 Fine aggregate, lower course: 16 %.
 - .10 Los Angeles degradation: Grading B, to ASTM C 131. Max % loss by mass:
 - .1 Coarse aggregate, surface course: 25 %.
 - .2 Coarse aggregate, lower course: 35 %.
 - .11 Absorption: to ASTM C 127. Max % by mass:
 - .1 Coarse aggregate, surface course: 1.75 %.
 - .2 Coarse aggregate, lower course: 2.00 %.
 - .12 Loss by washing: to ASTM C 117. Max % passing 0.075 mm sieve:
 - .1 Coarse aggregate, surface course: 1.5 %.
 - .2 Coarse aggregate, lower course: 2.0 %.
 - .13 Lightweight particles: to ASTM C 123. Max % by mass less than 1.95 relative density:
 - .1 Surface course: 1.5 %.
 - .2 Lower course: 3.0 %.
 - .14 Flat and elongated particles: to ASTM D 4791, (with length to thickness ratio greater than 5): Max % by mass:
 - .1 Coarse aggregate, surface course: 15 %.
 - .2 Coarse aggregate, lower course: 15 %.
 - .15 Crushed fragments: at least 60 % of particles by mass within each of following sieve designation ranges, to have 1 minimum freshly fractured face. Material to be divided into ranges, using methods of ASTM C 136.

<u>Passing</u>		<u>Retained on</u>
25 mm	to	12.5 mm
12.5 mm	to	4.75 mm
 - .16 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.
- .4 Mineral filler:
- .1 Ensure finely ground particles of limestone, hydrated lime, Portland cement or non-plastic mineral matter are thoroughly dry and free from lumps.
 - .2 Add mineral filler when necessary to meet job mix aggregate gradation or as directed by Departmental Representative to improve mix properties.
 - .3 Ensure mineral filler is dry and free flowing when added to aggregate.
- .5 Anti-stripping agent: hydrated lime to ASTM C 207 type N.
- .1 Add lime at rate of approximately 2-3 % of dry weight of aggregate.
- .6 Water: to be accepted by Departmental Representative.

2.02 EQUIPMENT

- .1 Pavers: mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.

- .2 Rollers: sufficient number minimum of 3 per paver of type and weight to obtain specified density of compacted mix.
- .3 Vibratory rollers:
 - .1 Drum diameter: 1200 mm minimum.
 - .2 Amplitude of vibration (machine setting): 0.5 mm maximum for lifts less than 40 mm thick.
- .4 Haul trucks: sufficient number and of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
 - .1 Boxes with tight metal bottoms.
 - .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
 - .3 In cool weather or for long hauls, insulate entire contact area of each truck box.
 - .4 Use only trucks which can be weighed in single operation on scales supplied.
- .5 Hand tools:
 - .1 Lutes or rakes with covered teeth for spreading and finishing operations.
 - .2 Tamping irons having mass 12 kg minimum and bearing area not exceeding 310 cm² for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Departmental Representative, may be used instead of tamping irons.
 - .3 Straight edges, 4.5 m in length, to test finished surface.
- .6 Plant testing facility: provide laboratory space at plant site for exclusive use of Departmental Representative, for performing tests, keeping records and making reports.

2.03 MIX DESIGN

- .1 Mix design to be reviewed by Departmental Representative.
- .2 Mix design to be developed by testing laboratory accepted by Departmental Representative.
- .3 Mix to contain maximum 50% by mass of RAP. Departmental Representative may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.
- .4 Design of mix: by Marshall method to requirements below.
 - .1 Compaction blows on each face of test specimens: 75.
 - .2 Mix physical requirements:

Property	Lower Course	Upper Course
Marshall Stability at 60 degrees C (kN min)	6.4	5.5
Flow Value (mm)	2-4	2-4
Air Voids in Mixture (%)	3-6	3-5
Voids in Mineral Aggregate (% min)	14	15
Index of Retained Stability (% min)	75	75

- .3 Measure physical requirements as follows:
 - .1 Marshall load and flow value: to AASHTO T245.
 - .2 Compute void properties on basis of bulk specific gravity of aggregate to ASTM C 127 and ASTM C 128. Make allowance for volume of asphalt absorbed into pores of aggregate.
 - .3 Air voids: to ASTM D 3203.
 - .4 Voids in mineral aggregates: to AI MS2.
 - .5 Index of Retained Stability: measure in accordance with Section 32 12 10 - Marshall Immersion Test for Bitumen.

- .4 Do not change job-mix without prior approval of Departmental Representative. When change in material source proposed, new job-mix formula to be approved by Departmental Representative.
- .5 Return plant dust collected during processing to mix in quantities acceptable to Departmental Representative.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt paving 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.

3.02 PLANT AND MIXING REQUIREMENTS

- .1 Batch and continuous mixing plants:
 - .1 To ASTM D 995.
 - .2 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.
 - .1 Do not load frozen materials into bins.
 - .3 Feed cold aggregates to plant in proportions to ensure continuous operations.
 - .4 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .5 Before mixing, dry aggregates to moisture content not greater than 1 % by mass or to lesser moisture content if required to meet mix design requirements. Heat to temperature required to meet mixing temperature as directed by Departmental Representative after combining with RAP.
 - .6 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job-mix requirements.
 - .7 Store hot screened aggregates in manner to minimize segregation and temperature loss.
 - .8 Heat asphalt cement and aggregate to mixing temperature directed by Departmental Representative. Do not heat asphalt cement above 160 degrees C maximum temperature indicated on temperature-viscosity chart.
 - .9 Make available current asphalt cement viscosity data at plant. With information relative to viscosity of asphalt being used, Departmental Representative to accept temperature of completed mix at plant and at paver after considering hauling and placing conditions.
 - .10 Maintain temperature of materials within 5 degrees C of specified mix temperature during mixing.
 - .11 Mixing time:
 - .1 In batch plants, both dry and wet mixing times as directed by Departmental Representative. Continue wet mixing as long as necessary to obtain thoroughly blended mix but not less than 30s or more than 75s.
 - .2 In continuous mixing plants, mixing time as directed by Departmental Representative but not less than 45s.
 - .3 Mixing time as directed by Departmental Representative.
 - .12 Where RAP is to be incorporated into mix:
 - .1 Feed from separate cold feed bin specially designed to minimize

- consolidation of material.
 - .1 Provide 50 mm scalping screen on cold feed to remove oversized pieces of RAP.
 - .2 Ensure positive and accurate control of RAP cold feed by use of hydraulic motor or electric clutch and equip with anti-rollback device to prevent material from sliding backward on feed belt.
 - .3 Combine RAP and new aggregates in proportions as directed by Departmental Representative. Dry mix thoroughly, until uniform temperature within plus or minus 5 degrees C of mix temperature, as directed by Departmental Representative, is achieved prior to adding new asphalt cement.
 - .1 Do not add new asphalt cement where temperature of dried mix material is above 160 degrees C.
- .2 Dryer drum mixing plant:
 - .1 To ASTM D 995.
 - .2 Load aggregates from individual stockpiles to separate cold feed bins. Do not load frozen materials into bins.
 - .3 Feed aggregates to burner end of dryer drum by means of multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.
 - .4 Where RAP is to be incorporated into mix, dryer drum mixer is to be designed to prevent direct contact of RAP with burner flame or with exhaust gases hotter than 180 degrees C.
 - .5 Feed RAP from separate cold feed bin designed to minimize reconsolidation of material.
 - .6 Meter total flow of aggregate and RAP using electronic weigh belt system with indicator that can be monitored by plant operator and which is interlocked with asphalt pump to ensure proportions of aggregate, RAP and asphalt entering mixer remain constant.
 - .7 Allow for easy calibration of weighing systems for aggregates and RAP without having material enter mixer.
 - .8 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .1 Calibrate weigh bridge on charging conveyor by weighing amount of aggregate passing over weigh bridge in set amount of time.
 - .2 Difference between this value and amount shown by plant computer system to differ by not more than plus or minus 2 %.
 - .9 Make provision for conveniently sampling full flow of materials from cold feed.
 - .10 Provide screens or other suitable devices to reject oversize particles or lumps of aggregate and RAP from cold feed prior to entering drum.
 - .11 Provide system interlock stop on feed components if either asphalt or aggregate from bin stops flowing.
 - .12 Accomplish heating and mixing of asphalt mix in approved parallel flow dryer-mixer in which aggregate enters drum at burner end and travels parallel to flame and exhaust gas stream.
 - .1 Control heating to prevent fracture of aggregate or excessive oxidation of asphalt.
 - .2 Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with printing recorder that can be monitored by plant operator.
 - .3 Submit printed record of mix temperatures at end of each day.
 - .13 Ensure mixing period and temperature to produce uniform mixture in which particles are

- thoroughly coated, and moisture content of material as it leaves mixer is 2 % maximum.
- .3 Temporary storage of hot mix:
 - .1 Provide mix storage of sufficient capacity to permit continuous operation and designed to prevent segregation.
 - .2 Do not store asphalt mix in storage bins in excess of 3 hour.
 - .4 While producing asphalt mix for this Project, do not produce mix for other users unless separate storage and pumping facilities are provided for materials supplied to this project.
 - .5 Mixing tolerances:
 - .1 Permissible variation in aggregate gradation from job mix (percent of total mass).

4.75 mm sieve and larger	5.5
2.00 mm sieve	4.5
0.425 mm sieve	3.5
0.180 mm sieve	2.5
0.075 mm sieve	1.5
 - .2 Permissible variation of asphalt cement from job mix: 0.25%.
 - .3 Permissible variation of mix temperature at discharge from plant: 5 degrees C.
 - .6 Addition of anti-stripping agent:
 - .1 Plant to be equipped with pug mill to thoroughly mix aggregates and lime prior to entering the plant.
 - .2 Plant to be equipped with suitable conveyor systems capable of supplying aggregates and lime at constant rate.
 - .3 Plant and equipment used for addition of lime to be equipped with covers to control loss of lime.
 - .4 Plant to be equipped to control rate of lime incorporation to within 1/4%.
 - .5 Add water to aggregate prior to entering pug mill.
 - .6 Add water to lime sufficiently in advance to permit time to slake prior to entering pug mill.

3.03 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 construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Reshape granular roadbed and asphalt pavement in accordance with Section 32 11 17 - Reshaping Granular Roadbed and Section 32 01 16.13 - Reshaping Asphalt Pavement.
- .3 When paving over existing asphalt surface, clean pavement surface in accordance with Section 32 01 11.01 - Pavement Cleaning and Marking Removal.
 - .1 When levelling course is not required, patch and correct depressions and other irregularities as directed by Departmental Representative before beginning paving operations.
- .4 Apply prime coat in accordance with Section 32 12 13.23 - Asphalt Prime Coats prior to paving.
- .5 Prior to laying mix, clean surfaces of loose and foreign material.

3.04 TRANSPORTATION OF MIX

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with limewater, soap or detergent solution, or non-petroleum based commercial product, at least daily or as required.
 - .1 Raise truck bed and thoroughly drain, and ensure no excess solution remains in truck bed.
- .3 Schedule delivery of material for placing in daylight, unless Departmental Representative approves artificial light for night placing.
- .4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation.
 - .1 Do not dribble mix into trucks.
- .5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.
- .6 Deliver loads continuously in covered vehicles and immediately spread and compact.
 - .1 Deliver and place mixes at temperature within range as directed by Departmental Representative, but not less than 135 degrees C.

3.05 TEST STRIP

- .1 Construct and test test strip to acceptance of Departmental Representative.
- .2 For airfield pavement, construct test strip in non-critical area to resolve anticipated problems with equipment, mix behaviour or compaction, prior to starting paving operation.
- .3 Construct test strip with at least 500 tonnes of mix, and involving more than one lane, so that joint finishing techniques can be established.
- .4 During construction of test strip, Departmental Representative will establish optimum rolling pattern by taking nuclear densimeter readings and observations to:
 - .1 Determine sequence and number of passes.
 - .2 Determine correct operating characteristics of vibratory rollers.
 - .3 Determine maximum density of asphalt mix.
 - .4 Ensure smooth surface finish.
 - .5 Establish actual density achieved by coring in order to determine if additional or other rolling equipment is required to achieve density of not less than 98 % of density obtained with Marshall specimens prepared from samples of mix being used.

3.06 PLACING

- .1 Obtain Departmental Representative's approval of base, existing surface and prime coat prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as directed by Departmental Representative.
- .3 Placing conditions:
 - .1 Place asphalt mixtures only when air temperature is 5 degrees C minimum.
 - .2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.
 - .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Place asphalt concrete in compacted lifts of thickness as indicated.
- .5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.
- .6 Place individual strips no longer than 500 m.
- .7 On airport runways and taxiways, aprons and parking lots commence spreading at high side of pavement or at crown and span crowned centerlines with initial strip.

- .8 Spread and strike off mixture with self-propelled mechanical finisher.
 - .1 Construct longitudinal joints and edges true to line markings.
 - .1 Departmental Representative to establish lines for paver to follow parallel to centerline of proposed pavement. Position and operate paver to follow established line closely.
 - .2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver.
 - .1 Work pavers as close together as possible and in no case permit them to be more than 30 m apart.
 - .3 Maintain constant head of mix in auger chamber of paver during placing.
 - .4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
 - .5 Correct irregularities in alignment left by paver by trimming directly behind machine.
 - .6 Correct irregularities in surface of pavement course directly behind paver.
 - .1 Remove excess material forming high spots using shovel or lute.
 - .1 Fill and smooth indented areas with hot mix.
 - .2 Do not broadcast material over such areas.
 - .7 Do not throw surplus material on freshly screeded surfaces.
- .9 When hand spreading is used:
 - .1 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section.
 - .1 Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
 - .2 Distribute material uniformly without broad casting material.
 - .3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes.
 - .1 Reject material that has formed into lumps and does not break down readily.
 - .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
 - .5 Provide heating equipment to keep hand tools free from asphalt.
 - .1 Control temperature to avoid burning material.
 - .2 Do not use tools at higher temperature than temperature of mix being placed.

3.07 COMPACTING

- .1 Roll asphalt continuously using established rolling pattern for test strip and to density of not less than 100 % of maximum density determined for test strip.
- .2 Do not change rolling pattern unless mix changes or lift thickness changes.
 - .1 Change rolling pattern only as directed by Departmental Representative.
- .3 Roll asphalt continuously to density not less than 98 % of 75 blow Marshall density to AASHTO T245.
- .4 General:
 - .1 Provide at least 2 rollers and as many additional rollers as necessary to achieve specified pavement density. When more than 2 rollers are required, 1 roller must be pneumatic tired type.
 - .2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.
 - .3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h

- for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.
- .4 Use static compaction for levelling coarse less than 25 mm thick.
 - .5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
 - .6 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.
 - .7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
 - .8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
 - .9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
 - .10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
 - .1 Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.
 - .11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
 - .12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.
- .5 Breakdown rolling:
- .1 Begin breakdown rolling with static steel wheeled roller or vibratory roller immediately following rolling of transverse and longitudinal joint and edges.
 - .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.
 - .3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by Departmental Representative.
 - .4 Use only experienced roller operators.
- .6 Intermediate rolling:
- .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
 - .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .7 Finish rolling:
- .1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks.
 - .1 If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by Departmental Representative.
 - .2 Conduct rolling operations in close sequence.
- .8 Dust entire area of sheet asphalt pavements with hydrated lime immediately after rolling to eliminate tendency to pick-up under traffic.

3.08 JOINTS

- .1 General:
 - .1 Remove surplus material from surface of previously laid strip.
 - .1 Do not deposit on surface of freshly laid strip.
 - .2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.
 - .3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.
- .2 Transverse joints:
 - .1 Offset transverse joint in succeeding lifts by at least 600 mm.
 - .2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.
 - .3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.
- .3 Longitudinal joints:
 - .1 Offset longitudinal joints in succeeding lifts by at least 150 mm.
 - .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100 degrees C prior to paving of adjacent lane.
 - .1 If cold joint cannot be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.
 - .3 Overlap previously laid strip with spreader by 25 to 50 mm.
 - .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.
 - .5 Roll longitudinal joints directly behind paving operation.
 - .6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.
- .4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix.
 - .1 Place and compact joint to ensure joint is smooth and without visible breaks in grade.
 - .2 Locate feather joints as indicated.
- .5 Construct butt joints as indicated.

3.09 FINISH TOLERANCES

- .1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.
- .2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.

3.10 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.
 - .1 If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.
- .2 Repair areas showing checking, rippling, or segregation.
- .3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

3.11 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 for reuse and 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

1 GENERAL

1.01 RELATED REQUIREMENTS

- .1 Special Procedures for Traffic Control Section 01 35 00.06
- .2 Pavement Cleaning and Marking Removal Section 32 01 11.01

1.02 MEASUREMENT FOR PAYMENT

- .1 Pavement marking: measured by lump sum.
- .2 Pavement marking including reflective glass beads: measured by lump sum.
- .3 Supply of paint: measured in litres.
- .4 Supply of reflective glass beads: measured in kilograms.
- .5 Symbols and letters: measured in units.

1.03 REFERENCES

- .1 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
 - .3 LEED Canada 2009 for Design and Construction-[2010], LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.
 - .4 LEED Canada for Existing Buildings, Operations and Maintenance-[2009], LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.
- .2 Environment Canada (EC)
 - .1 Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations, SOR/2009-264.
- .3 Green Seal (GS)
 - .1 GS-11-[2013], Standard for Paints and Coatings.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - [current edition].
 - .1 MPI #32 Traffic Markings Paint, Alkyd.
- .6 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1113-[13], Architectural Coatings.

1.04 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for pavement markings and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.

- .3 Samples:
 - .1 Submit to Departmental Representative following material sample quantities at least 4 weeks prior to commencing work.
 - .1 Two 1 L samples of each type of paint.
 - .2 One 1 kg sample of glass beads.
 - .3 Sampling to MPI Painting Manual.
 - .2 Mark samples with name of project and its location, paint manufacturer's name and address, name of paint, MPI specification number and formulation number and batch number.
- .4 Sustainable Design Submittals:
 - .1 N/A

1.05 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operations and Maintenance Data: submit information on materials relative to work of this Section for inclusion in operations and maintenance manual.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect specified materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.07 SITE CONDITIONS

- .1 Sustainable Design Provisions:
 - .1 Seasonal restriction for high VOC content traffic marking coatings.
 - .1 Traffic marking coating application between May 1st and October 15th is subject to seasonal use restriction and must not have a VOC concentration in excess of 150 g/L.

2 PRODUCTS

2.01 MATERIALS

- .1 Paint and Markings:
 - .1 To MPI #32, Alkyd zone/traffic marking.
 - .2 Traffic Marking Coatings: maximum VOC limit 450 g/L to SOR/2009-264 Schedule 1 and to GS-11 Standard or SCAQMD Rule 1113
 - .3 Paints: in accordance with MPI recommendation for surface conditions.
 - .4 Colour: to MPI listed, yellow and white.
 - .5 Upon request, Departmental Representative will supply qualified product list of paints

applicable to work. Qualified paints may be used but Departmental Representative reserves right to perform further tests.

- .2 Thinner: to MPI listed manufacturer.
- .3 Glass reflective beads: type suitable for application to wet paint surface for light reflectance.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates and surfaces to receive pavement markings previously installed under other Sections or Contracts are acceptable for product installation in accordance with MPI instructions prior to pavement markings installation.
 - .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Pavement surface: dry, free from water, frost, ice, dust, oil, grease and other deleterious materials.
- .3 Proceed with Work only after unacceptable conditions have been rectified.

3.02 EQUIPMENT REQUIREMENTS

- .1 Paint applicator: approved pressure type [mobile] with positive shut-off distributor capable of applying paint in single, double and dashed lines and capable of applying marking components uniformly, at rates specified, and to dimensions as indicated.
- .2 Distributor: capable of applying reflective glass beads as overlay on freshly applied paint.

3.03 TRAFFIC CONTROL

- .1 Follow traffic control measures in accordance with Section 01 35 00.06 - Special Procedures for Traffic Control.

3.04 APPLICATION

- .1 Pavement markings: lay out pavement markings.
- .2 Unless otherwise approved by Departmental Representative, apply paint only when air temperature is above 10 degrees C, wind speed is less than 60 km/h and no rain is forecast within next 4 hours.
- .3 Apply traffic paint evenly at rate of 3 m² /L.
- .4 Do not thin paint unless approved by Departmental Representative.
- .5 Symbols and letters to dimensions indicated.
- .6 Paint lines of uniform colour and density with sharp edges.
- .7 Thoroughly clean distributor tank before refilling with paint of different colour.
- .8 Apply glass beads at rate of 0.5 kg/L of painted area immediately after application of paint.

3.05 TOLERANCE

- .1 Paint markings: within plus or minus 12 mm of dimensions indicated.
- .2 Remove incorrect markings in accordance with Section 32 01 11.01 - Pavement Cleaning and Marking Removal.

3.06 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.
 - .1 Remove insulation material spilled during installation and leave work area ready for

application of wall board.

- .3 Waste Management: separate waste materials for reuse and 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.

3.07 PROTECTION

- .1 Protect pavement markings until dry.
- .2 Repair damage to adjacent materials caused by pavement marking application.

END OF SECTION

1.0 GENERAL

1.1 DOCUMENTS

- .1 This section of the specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SECTION INCLUDES

- .1 Furnish all labour, materials, equipment and service necessary for the complete installation of fencing as indicated on the drawings and as hereinafter specified.
- .2 The work of this section shall include the supply and installation of the following:
 - .1 Wire wall steel fencing, posts and gates.
 - .2 Concrete footings for fencing line posts and terminal posts.
 - .3 Barbed wire at top of top rail.

1.3 SUBMITTALS

- .1 Provide shop drawings of fencing a minimum of one week prior to installation to the Consultant for approval- Drawings shall show the general arrangement with proper details of all components necessary to complete installation.
- .2 Provide samples of proposed galvanized steel chain link fence components for approval prior to installation.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Store packaged material in original containers with manufacturer's seals and labels intact.
- .2 Prevent damage to materials during handling and storage. Keep materials under cover and free from dampness.

1.5 APPROVED EQUALS

- .1 All items as specified or pre-approved equals.

2.0 PRODUCTS

2.1 MATERIALS

- .1 All pipe, tie wires, tension wires and bands, connectors, fittings, throw-bolts and hardware shall be hot-dipped galvanized.
- .2 Pipe: to CAN2-138.2 MBO, Table 1 Medium Duty. Schedule 40 (wall thicknesses as shown below), standard continuous weld, modulus of elasticity 30,000.

Pipe Dia.	Sched. 40 Wall Thickness
1-5/8"	0.140" (9/64")
1-7/8"	0.145" (19/128")
2-3/8"	0.154" (5/32")
2-7/8"	0.203" (13/64")
3-1/2"	0.226" (7/32")
4-1/2"	0.237" (15/64")

- .3 Tension Bar: 16 x 5mm (5/8" x 3/16"), length to match entire height of fencing.
- .4 Tie Wire: 3.55mm. (9 gauge) galvanized.
- .5 Bottom Tension Wire (where applicable) 4.88mm (6ga.) fixed to fencing by hog rings.
- .6 Woven fabric: to CAN2-138.1.M80. See 2.1.8. for gauge and mesh size. Top and bottom selvages to

have knuckled finish. Wire diameters shall be as follows for the specified wire gauges:

<u>Specified Gauge</u>	<u>Min. Core Wire Diameter</u>
6ga.:	3.60mm (0.142")
9ga.:	2.64mm (0.104")
11ga.:	1.98mm (0.078")

- .7 Concrete Footings: compressive strength 18 MPa at 28 days.
- .8 Table One: Component Size and Description for each Location. Note: pipe sizes shown are outside diameter.
- | <u>Component</u> | <u>Fences</u> |
|------------------|---------------------------------------------------------------------------------------------------------------------------|
| Bottom Rail | 41mm (1-5/8") |
| Mid Rail | 41mm (1-5/8") |
| Top Rail | 41mm (1-5/8") |
| Line Posts | 60mm (2-3/8") |
| End Posts | 89mm (3-1/2") |
| Gate Posts | 89mm (3-1/2") |
| Mid Brace | 41mm (1-5/8") |
| Chain Link | 50 mm (2") |
| Fabric | galvanized grid 12.7mm x 76mm, 10.5ga.
Tie Wire, Hog Rings 300mm. (12") o.c.
at all tension bands and frame members |
- .9 Touch-up paint: Zinc rich organic ready-mixed coating to CGSB-1-GP-18M.
- .10 Gate Hardware: Galvanized pin-type hinge. Latch for exterior gate, to be designed to receive padlock. All sized to suit the gate they are installed on.
- .11 Fabric fastening mechanism in accordance with wire wall manufacturer's recommendation.

3.0 EXECUTION

3.1 POST SPACING

- .1 Maximum post spacing 2.1 metres on centre. Set end posts of straight runs and adjust on centre spacing of line posts equally between.

3.2 FOOTINGS

- .1 All footings shall be set relative to finished surfaces as detailed.
- .2 Minimum footing dimensions, except where detailed otherwise: footing depth 1200 mm, footing diameter 150mm larger than outside post diameter, post depth 75mm from bottom of footing.
- .3 All posts shall be installed in footings for each section of fence before welding in the rails for that section.

3.3 FENCE CONSTRUCTION

- .1 All fences shall be all welded construction. Weld all ends continuously to adjoining member. Grind all welds smooth.
- .1 Cope all posts to accept top rail
 - .2 Cope all mid braces and bottom rails to fit posts
 - .3 Cut angle iron to fit backstop posts
- .2 Cope all Connections. NO crimping or flattening will be permitted. Any connection not meeting this specification will be rejected and replaced with specified construction at the contractors expense.

- .3 Mid braces shall be installed at all end sections and all sections adjacent to gates and comers, for all fences. All fences 2.4m high or higher shall have horizontal mid rails installed continuous in all sections.

3.4 TACK WELDING

- .1 Tack weld ALL 6 gauge galv. wire mesh in lieu of tie wires as described in item Table One above. Spacing for tack welds shall match specified tie wire spacing and as detailed.

3.5 TENSION BANDS

- .1 Install tension bands where fabric terminates at all terminal, comer and gate posts.

3.6 FINISH

- .1 Clean all welds and other breaks in the galvanized surface. Touch up with zinc rich paint. All link fence and posts to be galvanized finish.

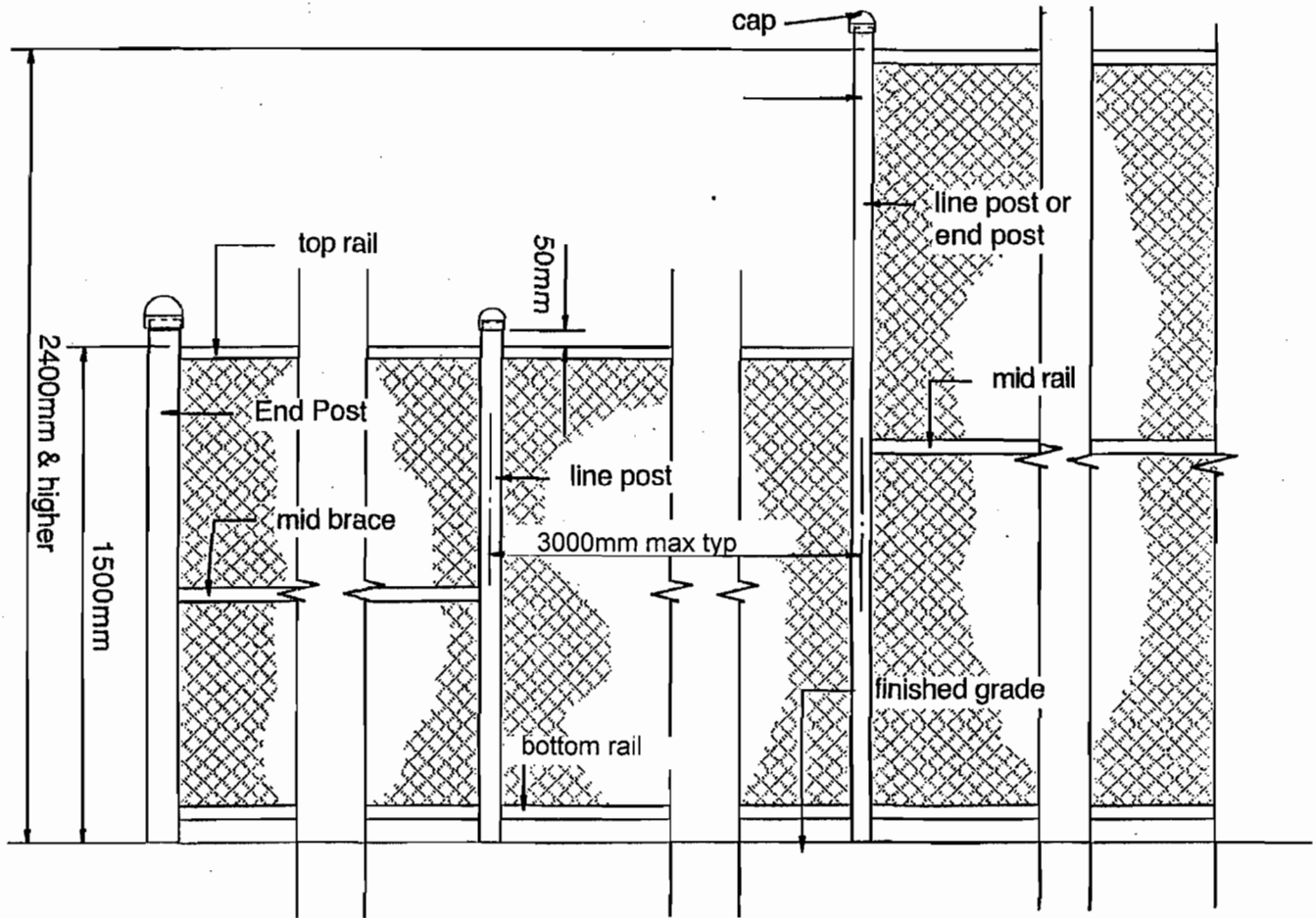
3.7 CLEANUP

- .1 Clean up all excess and waste material and remove from the site.

FENCE CONSTRUCTION

Definition of Terms

- see tables in this section for sizes and gauges of components
- mid braces shall occur for a minimum one full panel, each side of a corner or bend
- where a change in fence height occurs along a continuous run of fence, the line post shall be sized and treated as an end post
- top rails, bottom rails and mid rails shall be continuous between line posts
- install a continuous mid rail on all fences equal to or greater than 2400mm high
- Post to be a maximum 2.1m spacing to suit maximum width of wire wall. Diagram below is only generic.



END OF SECTION 32 31 13

1 GENERAL

1.01 MATERIAL SUPPLIED BY

- .1 N/A.

1.02 RELATED REQUIREMENTS

- | | | |
|----|-----------------------------------------|---------------------|
| .1 | Rough Grading | Section 31 22 13 |
| .2 | Mechanical Seeding | Section 32 92 19.13 |
| .3 | Hydraulic Seeding | Section 32 92 19.16 |
| .4 | Sodding | Section 32 92 23 |
| .5 | Trees, Shrubs and Ground Cover Planting | Section 32 93 10 |

1.03 MEASUREMENT PROCEDURES

- .1 Preparation of sub-grade for placing of topsoil will be measured under Section 31 22 01 – Site Grading.
- .2 Topsoil stripping will be measured by Departmental Representative in cubic metres of stockpiled topsoil and volume will be determined by average end area method.
- .3 Measure placing of topsoil in cubic metres removed from stockpile.
- .1 Stockpiles will be measured by Departmental Representative and volume of topsoil removed calculated by average end area method.
- .4 Measure supply and application of soil amendments, including fertilizer, in standard commercial units of weight/volume and square metres of area treated as determined by Departmental Representative.
- .5 Measure supplying, placing and spreading topsoil in cubic metres determined by truck box measurement as loaded.
- .1 Truck box capacity determined by Departmental Representative.
- .6 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 accepted by Departmental Representative after settlement and consolidation as specified.
- .7 Measure finish grading in square metres from actual surface measurements as determined by Departmental Representative.

1.04 PAYMENT

- .1 Testing of topsoil: Departmental Representative will pay for cost of tests as specified in Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

1.05 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 Canada Green Building Council (CaGBC)
- .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).

- .2 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
- .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.

1.06 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).

1.07 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 LEED Submittals:
 - .1 N/A
- .3 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.

1.08 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 16.06 - Construction Progress Schedule - Critical Path Method (CPM) or 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.

1.09 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.

2 PRODUCTS

2.01 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.

2.02 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 course textured.
- .4 Organic matter: compost Category A, B 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 Use composts meeting Category B requirements for land fill reclamation and large scale industrial applications.
- .6 Limestone:
 - .1 Ground agricultural limestone.
 - .2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.
- .7 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.

2.03 SOURCE QUALITY CONTROL

- .1 Advise Departmental Representative of sources of topsoil and 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.

3 EXECUTION

3.01 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 construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.02 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Departmental Representative and after area has been cleared of brush, weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .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.

3.03 PREPARATION OF EXISTING GRADE

- .1 Verify that grades are correct.
 - .1 If discrepancies occur, notify Departmental Representative 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.

3.04 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.

3.05 SOIL AMENDMENTS

- .1 N/A

3.06 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.

3.07 ACCEPTANCE

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

3.08 SURPLUS MATERIAL

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

3.09 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

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|-----------------------------------------|---------------------|
| .1 | Rough Grading | Section 31 22 13 |
| .2 | Topsoil Placemen and Grading | Section 32 91 19.13 |
| .3 | Hydraulic Seeding | Section 32 92 19.16 |
| .4 | Sodding | Section 32 92 23 |
| .5 | Trees, Shrubs and Ground Cover Planting | Section 32 93 10 |

1.02 MEASUREMENT AND PAYMENT

- .1 Payment for seeding will be made at unit price bid per square metre of actual surface measurements taken and computed by Departmental Representative. Areas of blending into existing turf grass will not be measured for payment.

1.03 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meeting.
- .2 Scheduling:
- .1 Schedule sod laying to coincide with preparation of soil surface.
 - .2 Schedule sod installation when frost is not present in ground.
 - .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.

1.04 REFERENCES

- .1 Canada Green Building Council (CaGBC)
- .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.

1.05 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 seed, and fertilizer.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.
- .3 Samples:
- .1 Submit 0.5 kg container of each type of fertilizer used.
- .4 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.06 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 N/A

1.07 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:
 - .1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
 - .2 Fertilizer must be dry.
- .3 Storage and Handling Requirements:
 - .1 Store fertilizer in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.08 WARRANTY

- .1 For seeding, 12 months warranty period is extended to 24 months.
- .2 Contractor hereby warrants that seeding will remain free of defects in accordance with General Conditions CCDC GC 12.3, but for 24 months.
- .3 End-of-warranty inspection will be conducted by Departmental Representative.

2 PRODUCTS

2.01 GRASS SEED

- .1 Grass seed to meet requirements of Government of Canada "Seeds Act" for "Canada No. 1 seed". Where specified, all nurse crop seed to meet requirements of Canada Seed Act for "Canada No. 1 seed".
- .2 In packages individually labelled in accordance with "Seeds Regulations" and indicating name of supplier.

2.02 WATER

- .1 Free of impurities that would inhibit germination and growth.
- .2 Supplied by Departmental Representative at designated source.
- .3 Water for required irrigation will be supplied via hydrant or hose bib.

2.03 FERTILIZER

- .1 To Canada "Fertilizers Act" and Regulations.
- .2 Complete synthetic fertilizer with guaranteed minimum analysis as specified.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for mechanical seeding 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.

3.02 INSTALLERS

- .1 Use installers approved by Departmental Representative.

3.03 SEED BED PREPARATION

- .1 Do not perform work under adverse field conditions as determined by Departmental Representative.
- .2 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; in location as directed by Departmental Representative and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Verify that grades are correct. If discrepancies occur, notify Departmental Representative and commence work when instructed by Departmental Representative.
- .4 Fine grade surface free of humps and hollows to smooth, even grade, to elevations indicated with a tolerance of plus or minus 15 mm, surface draining naturally.
- .5 Cultivate fine graded surface accepted by Departmental Representative to 25 mm depth immediately prior to seeding.

3.04 SEED PLACEMENT

- .1 Ensure seed is placed under supervision of certified Landscape Planting Supervisor.
- .2 For mechanical seeding:
 - .1 Mechanical landscape drill seeder ("Brillion" type or equivalent) which accurately places seed at specified depth and rate and rolls in single operation.
 - .2 Use equipment and method acceptable to Departmental Representative.
- .3 For manual seeding:
 - .1 Use manually operated drop seeder ("Cyclone" type or equivalent).
 - .2 Use manually operated, water ballast, landscaping type, smooth steel drum roller. Ballast as directed by Departmental Representative.
 - .3 Use equipment and method acceptable to Departmental Representative.
- .4 Blend applications 150 mm into adjacent grass areas to form uniform surfaces.
- .5 Sow half of required amount of seed in one direction and remainder at right angles as applicable.
- .6 Incorporate seed by light raking in cross directions.
- .7 Consolidate mechanically seeded areas by rolling area if soil conditions warrant or if directed by Departmental Representative with equipment approved by Departmental Representative immediately after seeding.

3.05 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
 - .1 Clean and reinstate areas affected by Work.
- .3 Waste Management: separate waste materials for reuse and 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.
 - .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by Departmental Representative.

3.06 PROTECTION

- .1 Erect plastic snow fence around newly seeded areas sufficient to protect against deterioration due to pedestrian or other traffic.

3.07 FERTILIZING PROGRAM

- .1 Apply fertilizer in accordance with soil test results instructions.
- .2 Apply after smooth raking of topsoil and prior to installation of sod.
- .3 Apply fertilizer no more than 48 hours before laying sod.
- .4 Mix thoroughly into upper 50 mm of topsoil.
- .5 Lightly water to aid the dissipation of fertilizer.

3.08 MAINTENANCE DURING ESTABLISHMENT PERIOD

- .1 Ensure maintenance is carried out under supervision of certified Landscape Maintenance Supervisor.
- .2 Perform following operations from time of seed application until acceptance by Departmental Representative:
 - .1 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.
 - .2 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
 - .3 Cut grass to 50 mm whenever it reaches height of 70 mm. Remove clippings which will smother grass as directed by Departmental Representative.
 - .4 Fertilize seeded areas after first cutting in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
 - .5 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.
 - .1 If chemical means are used, comply with Section 31 31 19.13 - Chemical Vegetation Control.
 - .6 Adjust protection barrier as necessary to protect against deterioration due to pedestrian or other traffic as needed.

3.09 FINAL ACCEPTANCE

- .1 Seeded areas will be accepted by Departmental Representative provided that:

- .1 Areas are uniformly established free of rutted, eroded, bare or dead spots and extent of weeds apparent in grass is acceptable.
- .2 Areas have been cut at least twice.
- .3 Areas have been fertilized.
- .2 Areas seeded in fall will be accepted in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.10 MAINTENANCE DURING WARRANTY PERIOD

- .1 Perform following operations from time of acceptance until end of warranty period.
 - .1 Water seeded area to maintain optimum soil moisture level for continued growth of grass. Control watering to prevent washouts.
 - .2 Repair and reseed dead or bare spots to satisfaction of Departmental Representative.
 - .3 Cut grass to 50 mm whenever it reaches height of 70 mm. Remove clippings which will smother grass as directed by Departmental Representative.
 - .4 Fertilize seeded areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
 - .5 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.
 - .1 If chemical means are used, comply with Section 31 31 19.13 - Chemical Vegetation Control.

END OF SECTION

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|-----------------------------------------|---------------------|
| .1 | Rough Grading | Section 31 22 13 |
| .2 | Topsoil Placemen and Grading | Section 32 91 19.13 |
| .3 | Hydraulic Seeding | Section 32 92 19.16 |
| .4 | Sodding | Section 32 92 23 |
| .5 | Trees, Shrubs and Ground Cover Planting | Section 32 93 10 |

1.02 MEASUREMENT AND PAYMENT

- .1 Measure hydraulic seeding in square metres of actual surface area for:
 - .1 Grass mixture including fertilizer.
 - .2 Legume mixture including fertilizer.
 - .3 Areas of blending into existing turf grass will not be measured for payment.
- .2 Measure maintenance during establishment period and warranty period of areas seeded in square metres.
- .3 Payment for seeding made at unit price bid of actual area surface measurements taken and computed by Departmental Representative DCC Representative Consultant.

1.03 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.
- .2 Scheduling:
 - .1 Schedule hydraulic seeding to coincide with preparation of soil surface.
 - .2 Schedule hydraulic seeding using grass mixtures and mixtures containing Crownvetch or Trefoil between dates recommended by the Regional Agricultural Department.

1.04 REFERENCES

- .1 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.

1.05 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 seed, mulch, tackifier, fertilizer, liquid soil amendments and micronutrients.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
- .3 Submit in writing prior to commencing work:
 - .1 Volume capacity of hydraulic seeder in litres.
 - .2 Amount of material to be used per tank based on volume.
 - .3 Number of tank loads required per hectare to apply specified slurry mixture per hectare.

- .4 Samples:
 - .1 Submit 0.5 kg container of each type of fertilizer used.
- .5 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .6 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.06 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Landscape Contractor: to be a Member in Good Standing of Horticultural Trades Association.
 - .2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
 - .3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

1.07 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:
 - .1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
 - .2 Inoculant containers to be tagged with expiry date.
- .3 Storage and Handling Requirements:
 - .1 Store fertilizer and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal Requirements.

1.08 WARRANTY

- .1 For seeding, 12 months warranty period is extended to 24 months.
- .2 Contractor hereby warrants that seeding will remain free of defects in accordance with General Conditions CCDC GC 12.3, but for 24 months.
- .3 End-of-warranty inspection will be conducted by Departmental Representative.

2 PRODUCTS

2.01 MATERIALS

- .1 Seed: "Canada pedigreed grade" in accordance with Government of Canada Seeds Act and Regulations.
 - .1 Grass seed to meet requirements of Government of Canada "Seeds Act" for "Canada No. 1 seed". Where specified, all nurse crop seed to meet requirements of Canada Seed Act for "Canada No. 1 seed".

- .2 Mulch: N/A
- .3 Tackifier: water dilutable, liquid dispersion or water soluble vegetable carbohydrate powder.
- .4 Water: free of impurities that would inhibit germination and growth.
- .5 Fertilizer:
 - .1 To Canada "Fertilizers Act" and Regulations.
 - .2 Complete synthetic, slow release with 35% of nitrogen content in water-insoluble form.
- .6 Inoculants: inoculant containers to be tagged with expiry date.
- .7 Liquid Soil Amendment and Micronutrients: N/A.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for hydraulic seeding 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.

3.02 INSTALLERS

- .1 Use installers approved by Departmental Representative.

3.03 PROTECTION OF EXISTING CONDITIONS

- .1 Protect structures, signs, guide rails, fences, plant material, utilities and other surfaces not intended for spray.
- .2 Immediately remove any material sprayed where not intended as directed by Departmental Representative.

3.04 PREPARATION OF SURFACES

- .1 Do not perform work under adverse field conditions such as wind speeds over 10 km/h, frozen ground or ground covered with snow, ice or standing water.
- .2 Fine grade areas to be seeded free of humps and hollows.
 - .1 Ensure areas are free of deleterious and refuse materials.
- .3 Cultivated areas identified as requiring cultivation to depth of 25 mm.
- .4 Ensure areas to be seeded are moist to depth of 150 mm before seeding.
- .5 Obtain Departmental Representative's approval of grade and topsoil depth before starting to seed.

3.05 FERTILIZING PROGRAM

- .1 Apply fertilizer in accordance with soil test results instructions.
- .2 Apply after smooth raking of topsoil and prior to installation of sod.
- .3 Apply fertilizer no more than 48 hours before laying sod.
- .4 Mix thoroughly into upper 50 mm of topsoil.
- .5 Lightly water to aid the dissipation of fertilizer.

3.06 PREPARATION OF SLURRY

- .1 Measure quantities of materials by weight or weight-calibrated volume measurement satisfactory to Departmental Representative. Supply equipment required for this work.
- .2 Charge required water into seeder. Add material into hydraulic seeder under agitation. Pulverize mulch and charge slowly into seeder.
- .3 After materials are in seeder and well mixed, charge tackifier into seeder and mix thoroughly to complete slurry.

3.07 SLURRY APPLICATION

- .1 Ensure seed is placed under supervision of certified Landscape Planting Supervisor.
- .2 Hydraulic seeding equipment:
 - .1 Slurry tank.
 - .2 Agitation system for slurry to be capable of operating during charging of tank and during seeding, consisting of recirculation of slurry and/or mechanical agitation method.
 - .3 Capable of seeding by 0] m hand operated hoses and appropriate nozzles.
 - .4 Tank volume to be certified by certifying authority and identified by authorities "Volume Certification Plate".
- .3 Slurry mixture applied per m² as per manufacturer's specifications.
- .4 Apply slurry uniformly, at optimum angle of application for adherence to surfaces and germination of seed.
 - .1 Using correct nozzle for application.
 - .2 Using hoses for surfaces difficult to reach and to control application.
- .5 Blend application 300 mm into adjacent grass areas to form uniform surfaces.
- .6 Re-apply where application is not uniform.
- .7 Remove slurry from items and areas not designated to be sprayed.

3.08 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
 - .1 Clean and reinstate areas affected by Work.
- .3 Waste Management: separate waste materials for reuse and 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.
 - .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by Departmental Representative.

3.09 PROTECTION

- .1 Protect seeded areas from trespass until plants are established.
- .2 Remove protection devices as directed by Departmental Representative.

3.10 MAINTENANCE DURING ESTABLISHMENT PERIOD

- .1 Ensure maintenance is carried out under supervision of certified Landscape Maintenance Supervisor.
- .2 Perform following operations from time of seed application until acceptance by Departmental

- Representative.
- .3 Grass Mixture:
- .1 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
 - .2 Mow grass to 50 mm whenever it reaches height of 70 mm. Remove clippings which will smother grass as directed by Departmental Representative.
 - .3 Fertilize seeded areas after 10 weeks after germination provided plants have mature true leaves in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles.
 - .4 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.
 - .1 If chemical means are used, comply with Section 31 31 19.13 - Chemical Vegetation Control.
 - .5 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.
- .4 Legume Mixture:
- .1 Repair minor dead and bare spots as determined by Departmental Representative to allow establishment of seed prior to acceptance.
 - .2 Repair major dead and bare spots as determined by Departmental Representative in accordance with site climatic averages and recommendations of local agricultural governmental representative.
 - .3 Mow legume mixtures to 100 mm whenever height reaches 200 mm and as follows:
 - .1 Do not mow within period commencing 3 weeks before and ending 3 weeks after first severe, average fall frost date and 3 weeks after actual severe fall frost.
 - .2 When mowing after first severe fall frost, mow at a height of not less than 300 mm.
 - .4 Remove clippings that will smother plants as directed by Departmental Representative.
 - .5 Water seeded areas to maintain optimum soil moisture level for germination and continued growth. Control watering to prevent washouts.

3.11 ACCEPTANCE

- .1 Seeded areas will be accepted by Departmental Representative provided that:
 - .1 Plants are uniformly established. Seeded areas are free of rutted, eroded, bare or dead spots.
 - .2 Areas have been mown at least twice.
 - .3 Areas have been fertilized.
- .2 Areas seeded in fall will achieve final acceptance in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.12 MAINTENANCE DURING WARRANTY PERIOD

- .1 Perform following operations from time of acceptance until end of warranty period:
 - .1 Repair and reseed dead or bare spots to satisfaction of Departmental Representative.
 - .2 Mow areas seeded, remove clippings that will smother grassed areas, as directed by Departmental Representative.
 - .3 Fertilize seeded areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles.
 - .1 If chemical means are used, comply with Section 31 31 19.13 - Chemical Vegetation Control.

END OF SECTION

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|----------------------------------------------|---------------------|
| .1 | Excavating, Trenching and Backfilling | Section 31 23 33.01 |
| .2 | Maintenance Holes and Catch Basin Structures | Section 33 44 01 |
| .3 | Concrete Reinforcing | Section 03 20 00 |
| .4 | Cast-in-Place Concrete | Section 03 30 00 |
| .5 | Aggregate Materials | Section 31 05 16 |
| .6 | Cathodic Protection | Section 26 42 00 |

1.02 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- .1 N/A

1.03 MEASUREMENT PROCEDURES

- .1 Measure trenching and backfilling, other than granular bedding and surround in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Measure water main including trenching and backfilling, in metres of each size of pipe installed.
- .1 Horizontal measurement will be made over surface, through valves and fittings, after work has been completed.
- .2 Measure lateral connections from water main to hydrants as water main and include curb valve and adjustable valve box.
- .3 Measure tunnelling, boring or jacking for under crossings, including encasing pipes and grouting, in metres, as indicated.
- .4 Measure hydrants including excavation and backfilling, in units installed.
- .5 Measure service connections including trenching and backfilling, in metres of each size of pipe installed.
- .6 Measure valves in units installed including excavation and backfilling, valves and valve boxes and thrust blocks.
- .7 Measure valve chambers including excavation and backfilling, in units installed.
- .8 Measure granular bedding and surround material in cubic metres.
- .9 Measure concrete for bedding, encasement of pipes, supports and thrust blocks in cubic metres.

1.04 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
- .1 ANSI/AWWA B300-[10], Standard for Hypochlorites.
- .2 ANSI/AWWA B301-[10], Standard for Liquid Chlorine.
- .3 ANSI/AWWA B303-[10], Standard for Sodium Chlorite.
- .4 ANSI/AWWA C104/A21.4-[08], Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
- .5 ANSI/AWWA C105/A21.5-[10], Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- .6 ANSI/AWWA C111/A21.11-[07], American National Standard for Rubber-Gasket Joints for Ductile-Iron and Fittings.
- .7 ANSI/AWWA C110/A21.10-[08], American National Standard for Ductile-Iron and Gray Iron Fittings for Water.
- .8 ANSI/AWWA C150/A21.50-[08], Standard for Thickness Design of Ductile-Iron Pipe.
- .9 ANSI/AWWA C151/A21.51-[09], Standard for Ductile-Iron Pipe, Centrifugally Cast.

- .10 ANSI/AWWA C153/A21.53-[11], Standard for Ductile-Iron Compact Fittings.
- .11 ANSI/AWWA C200-[05], Standard for Steel Water Pipe - 6 Inch (150 mm) and Larger.
- .12 ANSI/AWWA C203-[08], Standard for Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
- .13 ANSI/AWWA C205-[07], Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch (100 mm) and Larger - Shop Applied.
- .14 ANSI/AWWA C206-[11], Standard for Field Welding of Steel Water Pipe.
- .15 ANSI/AWWA C207-[07], Standard for Steel Pipe Flanges for Waterworks Service, 4 Inch through 144 Inch (100 mm through 3,600 mm).
- .16 ANSI/AWWA C208-[07], Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
- .17 ANSI/AWWA C300-[11], Standard for Reinforced Concrete Pressure Pipe, Steel-Cylinder Type.
- .18 ANSI/AWWA C301-[07], Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.
- .19 ANSI/AWWA C303-[08], Standard for Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.
- .20 ANSI/AWWA C500-[09], Standard for Metal-Seated Gate Valves for Water Supply Service.
- .21 ANSI/AWWA C504-[10], Standard for Rubber-Seated Butterfly Valves.
- .22 ANSI/AWWA C600-[10], Standard for Installation of Ductile-Iron Water Mains, and Their Appurtenances.
- .23 ANSI/AWWA C602-[11], Standard for Cement-Mortar Lining of Water Pipelines - 4 Inch (100 mm) and Larger.
- .24 ANSI/AWWA C651-[05], Standard for Disinfecting Water Mains.
- .25 ANSI/AWWA C800-[05], Standard for Underground Service Line Valves and Fittings.
- .26 ANSI/AWWA C900-[07], Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution.
- .2 ASTM International
 - .1 ASTM A 53/A 53M-[10], Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
 - .2 ASTM A 123/A 123M-[09], Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A 307-[10], Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - .4 ASTM B 88M-[05(2011)], Standard Specification for Seamless Copper Water Tube [Metric].
 - .5 ASTM C 117-[04], Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .6 ASTM C 136-[06], Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .7 ASTM C 478M-[11], Standard Specification for Precast Reinforced Concrete Manhole Sections [Metric].
 - .8 ASTM D 698-[07e1], Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft² (600 kN-m/m²)).
 - .9 ASTM D 2310-[06], Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
 - .10 ASTM D 2657-[07], Standard Practice for Heat Fusion Joining of Polyolefin Pipe and

- Fittings.
- .11 ASTM D 2992-[06], Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fitting.
- .12 ASTM D 2996-[01(2007)e1], Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
- .13 ASTM F 714-[10], Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- .14 ASTM C 618-[08a], Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- .3 American Water Works Association (AWWA)/Manual of Practice
 - .1 AWWA M9-[2008], Concrete Pressure Pipe.
 - .2 AWWA M11-[2004], Steel Pipe - A Guide for Design and Installation.
 - .3 AWWA M17-[2006], Installation, Field Testing, and Maintenance of Fire Hydrants.
- .4 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-NC-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations 2009.
 - .3 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Commercial Interiors.
 - .4 LEED Canada-EB: O&M-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Existing Buildings: Operations and Maintenance 2009.
- .5 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 CAN/CGSB-34.1-[94], Pipe, Asbestos Cement, Pressure.
 - .4 CGSB 41-GP-25M-[77], Pipe, Polyethylene, for the Transport of Liquids.
- .6 CSA International
 - .1 CAN/CSA-A257 Series-[09], Standards for Concrete Pipe (Consists of A257.0, A257.1, A257.2, A257.3 and A257.4).
 - .2 CAN/CSA-A3000-[08], Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .3 CAN/CSA-B137 Series-[09], Thermoplastic Pressure Piping Compendium. (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12).
 - .1 CAN/CSA-B137.1-[09], Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
 - .2 CAN/CSA-B137.3-[09], Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.
 - .4 CSA G30.18-[09], Carbon and Steel Bars for Concrete Reinforcement.
- .7 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - [current edition].
- .8 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S520-[07], Standard for Fire Hydrants.
 - .2 CAN/ULC-S543-[09], Standard for Internal-Lug, Quick Connect Couplings for Fire Hose.

1.05 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 distribution piping materials and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Pipe certification to be on pipe.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of British Columbia, Canada.
 - .2 Submit complete drawings and construction schedule for water mains 600 mm diameter and larger. Include method for installation of water main.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Inform Departmental Representative of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing work.
 - .3 Submit for testing 4 weeks minimum prior to beginning work, samples of materials proposed for use.
 - .4 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.
- .5 Sustainable Design Submittals:
 - .1 LEED Canada submittals: N/A.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.
 - .3 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages of recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .2 Submit evidence, when Supplementary Cementing Materials (SCMs) are used, to certify reduction in cement from Base Mix to Actual SCMs Mix, as percentage.
 - .4 Regional Materials: submit evidence that project incorporates required percentage 10% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

1.06 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release

valves, hydrant details.

- .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.
- .3 Operation and Maintenance Data: submit operation and maintenance data for pipe, valves, valve boxes, valve chambers and hydrants] for incorporation into manual.

1.07 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect water distribution piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.08 SCHEDULING OF WORK

- .1 Schedule Work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative and building occupants minimum of 24 hours in advance of interruption in service.
- .4 Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.
- .5 Notify fire department of planned or accidental interruption of water supply to hydrants.
- .6 Provide and post "Out of Service" sign on hydrant not in use.
- .7 Advise local police department of anticipated interference with movement of traffic.

1.09 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Tools: N/A

2 PRODUCTS

2.01 PIPE, JOINTS AND FITTINGS

- .1 Ductile iron pipe: to ANSI/AWWA C151/A21.51, pressure class 200.
- .2 Joints and fittings for ductile iron pipe.
 - .1 Joints:
 - .1 Push-on joints: to ANSI/AWWA C111/A 21.11.
 - .2 Rubber gasket for mechanical pipe joints: to ANSI/AWWA C111/A21.11.
 - .3 Rubber gasket for flange pipe joints 1.6 mm thick: to ANSI/AWWA

- C111/A21.11.
- .4 Bolts, nuts, hex head with washers: to ASTM A 307, heavy series.
- .5 Ensure electrical conductivity across joints.
- .2 Fittings:
 - .1 Mechanical joint cast iron and ductile iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.
 - .2 Flanged cast iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10].
 - .3 Compact Fittings to ANSI/AWWA C153/A21.53.
- .3 Reinforced concrete pipe: to CAN/CSA-A257, ANSI/AWWA C300, ANSI/AWWA C301 or ANSI/AWWA C303 class 200.
 - .1 Pipe joints: flanged to ANSI/AWWA C207 or push-on joints with performance requirements to ANSI/AWWA C111/A21.11.
 - .2 Fitting joints: flanged to ANSI/AWWA C207 or push-on with performance requirements to ANSI/AWWA C111/A21.11.
 - .3 Pipe fittings: reinforced concrete to ANSI/AWWA C301 or ANSI/AWWA C303.
- .4 Polyvinyl chloride pressure pipe: to ANSI/AWWA C900, pressure class 150, DR 18, 1 MPa gasket bell end, cast iron outside diameter.
 - .1 CAN/CSA-B137.3, PVC series 160, 1.1 MPa elastomeric gasket coupling.
 - .2 Composite epoxy impregnated fibreglass PVC pipe to ASTM D 2996, class H. Unplasticized PVC core over wrapped with bonded fibreglass reinforced epoxy resin. Pressure class 300, 2.4 MPa with cast iron outside diameter and integral bell gasketed joints to ANSI/ASTM D2992. Material to ASTM D 2310, classification RTRP-11HZ-5001-PVC-13223.
 - .3 Cast iron fittings: to ANSI/AWWA C110/A21.10, and for pipe diameters larger than NPS 4 cement mortar lined to ANSI/AWWA C104/A21.4.
- .5 Polyethylene pressure pipe:
 - .1 NPS 1/2 to NPS 6: to CAN/CSA-B137.1 type PE 3406, series 160 or ASTM F 714, type PE 3408, series DR 11.
 - .2 90 mm to 1600 mm: to CGSB 41-GP-25M, type PE 1404, series 250.
 - .3 Polyethylene to polyethylene joints: to be thermal butt fusion joined, to ASTM D 2657 or flanged with steel, aluminum or ductile iron backing flanges.
 - .4 Cast iron fittings with flanged ends: to ANSI/AWWA C110/A21.10 for pipe size above NPS 4, Cement mortar lined to ANSI/AWWA C104/A21.4.
 - .5 Polyethylene fittings: to CAN/CSA-B137.1, for pipe sizes NPS 4 and less.

2.02 PIPE PROTECTION

- .1 Provide means of protection for iron pipe in corrosive soils in accordance with local practices and authorities having jurisdiction to ANSI/AWWA C105/A21.5.

2.03 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to ANSI/AWWA C500, standard iron body, brass or bronze mounted wedge or double disc valves with non-rising stems, suitable for 1 Pa with mechanical, flanged, push-on, or grooved type coupling joints.
- .3 Butterfly valves: to ANSI/AWWA C504, short body or long body, class 1 MPa with mechanical or flanged joints.
- .4 Underground type indicator valve where indicated. Indicator post to accurately indicate valve

- open or closed.
- .5 Air and vacuum release valves: heavy duty combination air release valves employing direct acting kinetic principle.
 - .1 Fabricate valves of cast iron body and cover, with bronze trim, stainless steel floats with shock-proof synthetic seat suitable for 2 MPa working pressure.
 - .2 Valves to expel air at high rate during filling, at low rate during operation, and to admit air while line is being drained.
 - .3 Valve complete with surge check unit.
 - .4 Ends to be flanged to ANSI/AWWA C110/A21.10.
 - .6 Cast iron valve boxes: bituminous coated screw type or three piece sliding type adjustable over minimum of 450 mm complete with valve operating extension rod, 30 mm minimum diameter, 25 x 25 mm cross section, of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover.
 - .1 Base to be large round type with minimum diameter of 300 mm.
 - .2 Top of box to be marked "WATER"/"EAU".

2.04 VALVE CHAMBERS

- .1 Concrete and reinforcing steel: to Section 03 30 00 - Cast-in-Place Concrete and Section 03 20 00 - Concrete Reinforcing.
- .2 Precast concrete sections to ASTM C 478M. Cast ladder rungs integral with unit; field installation not permitted.
- .3 Valve chamber frames and covers: gray iron castings, minimum tensile strength 200 MPa, with two coats, shop applied, approved asphalt coating with a mass of approximately 215 kg per set.
 - .1 Design and dimensions as indicated.
 - .2 Cover to be marked "WATER"/"EAU".
- .4 Jointing materials:
 - .1 Manufacturer's rubber ring gaskets.
 - .2 Mastic joint filler.
 - .3 Cement mortar.
 - .4 Combination of above types.
- .5 Mortar:
 - .1 Aggregate in accordance with Section 04 05 12 - Mortar and Masonry Grout.
 - .2 Masonry cement to CAN/CSA-A3000.
- .6 Ladder rungs for valve chambers: 20 mm diameter deformed rail steel bars to CSA G30.18, hot-dipped galvanized after fabrication to ASTM A 123/A 123M. Rungs to be safety pattern.

2.05 SERVICE CONNECTIONS

- .1 Copper tubing: to ASTM B 88M type K, annealed.
- .2 Ductile iron pipe: to ANSI/AWWA C151/A21.51 pressure class 200 cement mortar lined to ANSI/AWWA C104/A21.4.
- .3 Polyvinyl chloride pressure pipe: to class 200 series DR21
- .4 Copper tubing joints: compression type suitable for 1 MPa working pressure.
- .5 PVC joints: solvent welded in accordance with manufacturer's specifications.
- .6 Polyethylene pipe joints: thermal butt fusion welded or plastic insert type serrated sleeves with four stainless steel screws and band-type clamps per joint.
- .7 Joints for ductile iron pipe: push-on joints to ANSI/AWWA C111/A21.11. Rubber gaskets to ANSI/AWWA C111/A21.11. Verify requirement to maintain electrical conductivity between pipes.

- .8 Brass corporation stops: red brass to ASTM B 62 or compression type having threads to ANSI/AWWA C800.
- .10 Brass inverted key-type curb stops: red brass to ASTM B 62, compression type without drains.
 - .1 Curb stops to have adjustable bituminous coated cast iron service box with stem to suit depth of bury.
 - .2 Top of cast iron box marked "WATER"/"EAU".
- .11 Polyethylene tapping tees or multi-saddle tees: for Polyethylene pipe. Tees to be socket fused to pipe.
- .12 Service connections for PVC pipe:
 - .1 Service connections less than 100 mm: corporation stop, tapped to main using AWWA threads, complete with stainless service saddle. Service saddle to consist of circumferential band type complete with side bars and fingers, keeper bar, stud bolts, nuts, washers and gaskets.
 - .2 Service connections 100 mm and over: use tee fitting or tapping valve and sleeve.
- .13 Bronze type service clamps: for PVC pipe service connections.
 - .1 Service clamps to be of strap-type, with confined "O" ring seal cemented in place.
 - .2 Clamps to be tapped with threads to ANSI/AWWA C800.
- .14 Tee connections: for services above NPS 1. Tee connections to be fabricated of same material and to same standards as specified pipe fittings and to have ends matching pipe to which they are joined.

2.06 HYDRANTS

- .1 Post type hydrants: compression type hydrant, to CAN/ULC-S520, designed for working pressure of 2070 kPa with two 65 mm threaded hose outlets, one 100 mm threaded pumper connection, 150 mm riser barrel, 125 mm bottom valve and 150 mm connection for main.
 - .1 Hydrants to open counter clockwise, threads to local standard, fittings to be internal lug quick-connect to CAN/ULC-S543. Provide metal caps and chains.
 - .2 Provide key operated gate valve located [1] m from hydrant.
 - .3 Depth of bury 1.0 m.
- .2 Hydrant paint: exterior enamel to MPI #96.

2.07 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117 . Sieve sizes to CAN/CGSB-8.1 or CAN/CGSB-8.2.
 - .3 Table

Sieve Designation	% Passing
12.5 mm	100
9.5 mm	-
4.75 mm	80-100
2.00 mm	50- 90
0.425 mm	10- 50
0.180 mm	-
0.075 mm	[0- 10]
- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks:

to Section 03 30 00 - Cast-in-Place Concrete.

2.08 BACKFILL MATERIAL

- .1 As indicated. Type 3, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.09 PIPE DISINFECTION

- .1 Sodium hypochlorite, Calcium hypochlorite, Liquid chlorine or Sodium chlorite to ANSI/AWWA B300, ANSI/AWWA B301, or ANSI/AWWA B303 to disinfect water mains.
- .2 Disinfect water mains in accordance with ANSI/AWWA C651.
- .3 All cleaning, flushing, pressure and leakage testing, disinfection and final flushing to be done by the Contractor. Costs are included in payment for items described in this section.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for distribution piping 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.

3.02 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects.
 - .2 Remove defective materials from site as directed by Departmental Representative.

3.03 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Ensure trench depth allows coverage over pipe of 1.0 m minimum from finished grade.
- .3 Trench alignment and depth require Departmental Representative's acceptance prior to placing bedding material and pipe.

3.04 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .1 Place concrete to details as indicated.
- .2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placing.

3.05 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth indicated.
- .2 Do not place material in frozen condition.

- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to 95% minimum of corrected maximum dry density.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling with compacted type 3 fill.

3.06 PIPE INSTALLATION

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection; otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Lay pipes to ANSI/AWWA C600, ANSI/AWWA, M-9, M-11, and manufacturer's standard instructions and specifications.
 - .1 Do not use blocks except as specified.
- .3 Join pipes in accordance with ANSI/AWWA C600, ANSI/AWWA C602, ANSI/AWWA C206 AWWA, M-9, M-11 and manufacturer's recommendations.
- .4 Bevel or taper ends of PVC pipe to match fittings.
- .5 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore as the weight of pipe bears on the pipe ends.
- .6 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
- .7 Face socket ends of pipe in direction of laying. For mains on grade of 2% or greater, face socket ends up-grade.
- .8 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .9 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .10 Position and join pipes with equipment and methods accepted by Departmental Representative.
- .11 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .12 Align pipes before jointing.
- .13 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .14 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .15 Complete each joint before laying next length of pipe.
- .16 Minimize deflection after joint has been made.
- .17 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .18 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
- .19 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down

time.

- .20 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .21 Do not lay pipe on frozen bedding.
- .22 Do hydrostatic and leakage test and have results accepted by Departmental Representative before surrounding and covering joints and fittings with granular material.
- .23 Backfill remainder of trench.

3.07 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers by means of concrete located between valve and solid ground. Bedding to be same as adjacent pipe. Maximum length of pipe on each end of valve shall be 1 m. Valves not to be supported by pipe.
- .3 Install underground post-type indicator valves as indicated.

3.08 VALVE CHAMBERS

- .1 Use cast-in-place, or precast units as approved by Departmental Representative.
- .2 Construct units as indicated, plumb and centered over valve nut, true to alignment and grade, and not resting on pipe.
- .3 Place reinforcing steel and miscellaneous metals required to be embedded in concrete to details indicated and in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .4 Cast bottom slabs for precast units directly on undisturbed ground when permitted by Departmental Representative, set precast concrete slab on 150 mm minimum of compacted granular bedding.
- .5 Set bottom section of precast unit in bed of cement mortar and bond to bottom slab.
 - .1 Make each successive joint watertight with approved rubber ring gaskets, mastic joint filler, cement mortar, or combination thereof.
- .6 Clean surplus mortar and joint compounds from interior surface of valve chamber as work progresses.
- .7 Plug lifting holes with precast concrete plugs set in cement mortar, mastic compound or mortar.
- .8 Set frame and cover to required elevation on at least four and not more than six courses of brick.
 - .1 Make brick joints and join brick to frame with cement mortar, parge and trowel smooth. Concrete ring with preformed bituminous gasket.
- .9 Place frame and cover on top section to elevation indicated. If adjustment is required use concrete ring.
- .10 Clean valve chambers of debris and foreign materials; remove fins and sharp projections.

3.09 UNDERCROSSING

- .1 Excavate working pit to dimensions indicated, outside right-of-way or facility to be crossed.
- .2 Excavate working pit to not less than 0.6 m below lowest invert of encasing pipe.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.
- .5 Install heavy timber or steel frame backstop.
- .6 Place encasing pipe to exact line and grade indicated. Encasing pipe to cross under obstruction at angle indicated.
- .7 Install encasing pipe by jacking, boring or tunnelling.
- .8 Ensure encasing pipe is not in tension.
- .9 Joints for encasing pipe: mechanical or welded type.

- .10 Place concrete grout levelling pad in encasing pipe. Control level of grout during placing.
- .11 Insert water main into encasing pipe, in end with largest open area, after placement of levelling pad.
- .12 Use approved blocking method to guide water main in true alignment.
- .13 Clearance between blocks and encasing pipe: maximum 15 mm when water main is in position.
- .14 Join water main one length at time outside encasing pipe. Push or Pull water main into position.
- .15 Couplings of water main shall not rest on levelling pad when water main is in position.
- .16 Place concrete cradle around water main after it is positioned. Cradle to be minimum of 225 mm and maximum of 300 mm above levelling pad.

3.10 SERVICE CONNECTIONS

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.
- .3 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops as indicated.
- .4 Tappings on ductile iron, asbestos cement or PVC-C900 pipe, may be threaded without service clamps.
 - .1 Double strap service connections with galvanized malleable iron body and neoprene gasket cemented in place may be used.
 - .2 Tappings on asbestos-cement must use double strap service clamps.
 - .3 Tappings for asbestos cement or PVC-C900 pipe to conform to following:

Pipe Diameter (mm)	Maximum Tap Without Clamp (mm)	Maximum Tap With Clamp (mm)
100	20	25
150	20	40
200	25	50
250	25	50
300	40	75

- .5 Maximum dried direct tappings (mm) for ductile iron pipe to conform to:

Nominal Pipe Size (mm)	Pressure Class/Max.				
	150	200	250	300	350
75	-	-	-	-	19
102	-	-	-	-	19
152	-	-	-	-	25
203	-	-	-	-	25
254	-	-	-	-	25
305	-	-	-	-	32
356	-	-	32	38	38
406	-	-	38	50	50
457	-	-	50	50	50
508	-	-	50	50	50

610	-	50	50	50	50
762	50	50	50	50	50

- .6 Tappings on PVC pipe to be either PVC valve tees or bronze type service clamps, strap type with "O" ring seal cemented in place.
- .7 Tappings for PE pipe: PE tapping tees or multi-saddle tees.
- .8 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .9 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .10 Install multiple corporation stops, 30 degrees apart around circumference of pipe and minimum of 300 mm apart along pipe.
- .11 Tap main at 2:00 o'clock or 10:00 o'clock position only; not closer to joint nor closer to adjacent service connections than recommended by manufacturer, or 1 m minimum, whichever is greater.
- .12 Leave corporation stop valves fully open.
- .13 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .14 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .15 Install curb stop with corporation box on services NPS 2 or less in diameter.
 - .1 Equip larger services with gate valve and cast iron box.
 - .2 Set box plumb over stop and adjust top flush with final grade elevation.
 - .3 Leave curb stop valves fully closed.
- .16 Place temporary location marker at ends of plugged or capped unconnected water lines.
 - .1 Each marker to consist of 38 x 89 mm stake extending from pipe end at pipe level to 600 mm above grade.
 - .2 Paint exposed portion of stake red with designation "WATER SERVICE LINE" in black.

3.11 HYDRANTS

- .1 Install hydrants at locations as indicated.
- .2 Install hydrants in accordance with AWWA M17.
- .3 Install 150 mm gate valve and cast iron valve box on hydrant service leads as indicated.
- .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation of 50 mm above final grade.
- .5 Place concrete thrust blocks as indicated and specified [ensuring that drain holes are unobstructed.
- .6 To provide proper draining for each hydrant, excavate pit measuring not less than 1 x 1 x 0.5 m deep and backfill with coarse gravel or crushed stone to level 150 mm above drain holes.
- .7 Place appropriate sign on installed hydrants indicating whether or not they are in service during construction.

3.12 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative.
- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.
- .5 For restrained joints: only use restrained joints approved by Departmental Representative.

3.13 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with ANSI/AWWA C600.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Departmental Representative at least 24 hours in advance of proposed tests.
 - .1 Perform tests in presence of Departmental Representative.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .5 Test pipeline in sections not exceeding 365 m in length, unless otherwise authorized by Departmental Representative.
- .6 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated.
- .7 Leave hydrants, valves, joints and fittings exposed.
- .8 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .9 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- .10 Open valves.
- .11 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .12 Fill asbestos cement pipe and concrete pipe at least 24 hours before testing to allow water absorption by pipe material.
- .13 Thoroughly examine exposed parts and correct for leakage as necessary.
- .14 Apply hydrostatic test pressure of 1380 kPa minimum based on elevation of lowest point in main and corrected to elevation of test gauge, for period of 1 hour.
- .15 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
- .16 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .17 Repeat hydrostatic test until defects have been corrected.
- .18 Apply leakage test pressure of 1380 kPa minimum after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 hours.
- .19 Define leakage as amount of water supplied from water metre in order to maintain test pressure for 2 hours.
- .20 Do not exceed allowable leakage of 1.25 L/mm of pipe, including lateral connections.
- .21 Locate and repair defects if leakage is greater than amount specified.
- .22 Repeat test until leakage is within specified allowance for full length of water main.

3.14 PIPE SURROUND

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1.0m m of pipe.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.

- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% of corrected maximum dry density.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% of corrected maximum dry density.

3.15 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density.
 - .1 In other areas, compact to at least 90% corrected maximum dry density.

3.16 HYDRANT FLOW TESTS

- .1 Conduct flow tests on every hydrant to determine fire flows prior to painting hydrant caps and ports.

3.17 PAINTING OF HYDRANTS

- .1 After installation, paint hydrants as directed by Departmental Representative.
- .2 After hydrant flow tests, paint caps and ports to meet colour selections approved by authority having jurisdiction.

3.18 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: under direct control of Departmental Representative to be carried out by Contractor.
 - .1 Notify Departmental Representative at least 4 days in advance of proposed date when disinfecting operations will begin.
- .2 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .3 Flushing flows as follows:

<u>Pipe Size NPS</u>	<u>Flow (L/s) Minimum</u>
6 and below	38
8	75
10	115
12	150
- .4 Provide connections and pumps for flushing as required.
- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .6 When flushing has been completed to Departmental Representative's satisfaction, introduce strong solution of chlorine as directed by Departmental Representative into water main and ensure that it is distributed throughout entire system.
- .7 Disinfect water mains.
- .8 Rate of chlorine application to be proportional to rate of water entering pipe.
- .9 Chlorine application to be close to point of filling water main and to occur at same time.
- .10 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .11 Flush line to remove chlorine solution after 24 hours.
- .12 Measure chlorine residuals at extreme end of pipe-line being tested.
- .13 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
 - .1 Take samples daily for minimum of 2 days.

- .2 Should contamination remain or recur during this period, repeat disinfecting procedure.
- .3 Contractor to submit certified copy of test results.
- .14 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .15 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 hours.
 - .1 After 24 hours, take further samples to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.
- .16 Discharging flushing water:
 - .1 Contractor to obtain municipal approval prior to discharging flushing water to municipal sanitary sewers.
 - .2 Discharging into ditches or the storm system is not permitted.
- 3.19 SURFACE RESTORATION**
 - .1 After installing and backfilling over water mains, restore surface to original condition as directed by Departmental Representative.
- 3.20 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 for reuse and 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

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|----------------------------------------------|---------------------|
| .1 | Excavating, Trenching and Backfilling | Section 31 23 33.01 |
| .2 | Maintenance Holes and Catch Basin Structures | Section 33 44 01 |
| .3 | Concrete Reinforcing | Section 03 20 00 |
| .4 | Cast-in-Place Concrete | Section 03 30 00 |
| .5 | Aggregate Materials | Section 31 05 16 |
| .6 | Cathodic Protection | Section 26 42 00 |

1.02 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C104/A21.4-[08], Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - .2 ANSI/AWWA C110/A21.10-[08], American National Standard for Ductile Iron and Gray Iron Fittings for Water.
 - .3 ANSI/AWWA C111/A21.11-[07], American National Standard for Rubber Gasket-Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .4 ANSI/AWWA C151/A21.51-[09], AWWA Standard for Ductile-Iron Pipe, Centrifugally Cast.
 - .5 ANSI/AWWA C901-[08], AWWA Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½ Inch (13 mm) through 3 Inch (76 mm), for Water Service.
- .2 ASTM International
 - .1 ASTM A 307-[10], Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations (including Addendum [2007]).
 - .2 LEED Canada-NC-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations 2009.
 - .3 LEED Canada-CI Version 1.0-[2007], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Commercial Interiors.
 - .4 LEED Canada-EB: O&M-[2009], LEED (Leadership in Energy and Environmental Design): Green Building Rating System for Existing Buildings: Operations and Maintenance 2009.
- .4 Manufacturer's Standardization Society of the Valve and Fittings Industry
 - .1 MSS-SP-70-[11], Gray Iron Gate Valves, Flanged and Threaded Ends.

1.03 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 valves, couplings and mechanical joints and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 LEED Canada submittals: N/A.

- .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.

1.04 CLOSEOUT SUBMITTALS

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

1.05 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect piping materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 PIPE

- .1 Service water pipe: ductile iron, cement mortar lined or polyethylene (PE) from 1 m outside of building.
 - .1 Ductile iron: ANSI/AWWA C151/A21.51.
 - .2 Cement mortar lining for ductile iron pipe: ANSI/AWWA C104/A21.4.
 - .3 Polyethylene (PE) pipe: ANSI/AWWA C901.

2.02 CATHODIC PROTECTION

- .1 Cathodic Protection: to Section 26 42 00.01 - Telethermics: Cathodic Protection.

2.03 FITTINGS

- .1 NPS 3 and larger mechanical joints or flanged: to ANSI/AWWA C110/A21.10.

2.04 JOINTS

- .1 Rubber gaskets for mechanical joints or flanges: to ANSI/AWWA C111/A21.11.
- .2 Bolts, nuts, hex head with washers: to ASTM A 307, heavy series.

2.05 GATE VALVES

- .1 Rising stem: to MSS SP-70, class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet.

2.06 PROTECTIVE COATING

- .1 N/A

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for distribution piping 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.

3.02 INSTALLATION

- .1 Install in accordance with Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.
- .2 Piping cut square, reamed and free of cuttings and foreign material.
- .3 Minimum depth of bury: as indicated.
- .4 Lay buried piping in compacted washed sand in accordance with AWWA Class "B" bedding, where existing ground below bedding is unstable, install pipe on continuous concrete support.
- .5 Where piping enters building, provide support, and seal against ingress of moisture; to approval of authority having jurisdiction.
- .6 Assemble piping using fittings manufactured to ANSI standards and in accordance with manufacturer's instructions.
- .7 Apply 1 layer of protective coating to buried piping.

3.03 PRESSURE TESTING

- .1 Conform to Section 21 05 01 - Common Work Results for Mechanical.

3.04 DISINFECTION

- .1 Co-ordinate with Section 33 11 16 - Site Water Utility Distribution Piping and Section 22 11 16 - Domestic Water Piping.

3.05 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 for reuse and 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

1 GENERAL

1.01 RELATED REQUIREMENTS

- | | | |
|----|----------------------------------------------|---------------------|
| .1 | Excavating, Trenching and Backfilling | Section 31 23 33.01 |
| .2 | Maintenance Holes and Catch Basin Structures | Section 33 44 01 |
| .3 | Concrete Reinforcing | Section 03 20 00 |
| .4 | Cast-in-Place Concrete | Section 03 30 00 |

1.02 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- .1 N/A

1.03 MEASUREMENT AND PAYMENT

- .1 Measure excavation and backfill under Section 31 23 33.01 - Excavating Trenching and Backfilling.
- .2 Measure supply and installation of sanitary sewer including testing, excavation and backfilling and granular bedding and surround horizontally from manhole face to manhole face in metres of each size pipe and depth class installed.
- .3 Measure concrete bedding and encasement of pipes in cubic metres in place.
- .4 Measure granular bedding and surround in cubic metres compacted in place.
- .5 After video and photographic pipe inspections:
- .1 If no defective work is found, Departmental Representative will pay costs for inspectors, trained operators, equipment rental and materials.
 - .2 If defective Work is found, pay Departmental Representative part of total inspection cost proportional to number of defective pipe sections of sewer to total number of pipe sections inspected.

1.04 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
- .1 ANSI/AWWA C111/A21.11-[07], Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 ASTM International
- .1 ASTM C 12-[09], Standard Practice for Installing Vitrified Clay Pipe Lines.
 - .2 ASTM C 14M-[07], Standard Specification for Nonreinforced Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .3 ASTM C 76M-[10a], Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .4 ASTM C 117-[04], Standard Test Method for Material Finer Than 75 [MU] m (No. 200) Sieve in Mineral Aggregates by Washing.
 - .5 ASTM C 136-[06], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .6 ASTM C 425-[09], Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - .7 ASTM C 428-[05(2006)], Standard Specification for Asbestos-Cement Nonpressure Sewer Pipe.
 - .8 ASTM C 443M-[07], Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
 - .9 ASTM C 663-[98(2008)], Standard Specification for Asbestos Cement Storm Drain Pipe.

- .10 ASTM C 700-[09], Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- .11 ASTM C 828-[06], Standard Test Method for Low-pressure Air Test of Vitrified Clay Pipe Lines.
- .12 ASTM D 698-[07e1], Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft⁴-lbf/ft³ (600 kN-m/m³)).
- .13 ASTM D 1869-[95(2005)e1], Standard Specification for Rubber Rings for Asbestos Cement Pipe.
- .14 ASTM D 2680-[01(2009)], Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- .15 ASTM D 3034-[08], Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .16 ASTM D 3350-[10], Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- .3 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
- .4 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 CAN/CGSB-34.9-[M94], Pipe, Asbestos Cement, Sewer.
- .5 CSA International
 - .1 CSA A3000-[08], Cementitious Materials Compendium.
 - .2 CSA A257 Series-[09], Standards for Concrete Pipe and Manhole Sections.
 - .3 CAN/CSA-B70-[06], Cast Iron Soil Pipe, Fittings, and Means of Joining.
 - .4 CSA B1800-[11], Thermoplastic Non-pressure Pipe Compendium.
 - .1 CSA B182.1-[11], Plastic Drain and Sewer Pipe and Pipe Fittings.
 - .2 CSA B182.2-[11], PSM Type Polyvinylchloride PVC Sewer Pipe and Fittings.
 - .3 CSA B182.6-[11], Profile Polyethylene (PE) Sewer Pipe and Fittings for Leak-Proof Sewer Applications.
 - .4 CSA B182.11-[11], Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.
- .6 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.

1.05 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.
 - .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.
 - .3 Notify Departmental Representative and building manager 24 hours minimum in advance of any interruption in service.

1.06 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 pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia.
 - .2 Indicate on drawings proposed method for installing carrier pipe for undercrossings.
- .4 Samples:
 - .1 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
 - .2 Submit for testing at least 2 weeks prior to beginning Work, samples of materials proposed for use.
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification 2 weeks minimum before beginning Work.
- .7 Sustainable Design Submittals:
 - .1 LEED Canada submittals: N/A.
 - .2 Erosion and Sedimentation Control: submit copy of erosion and sedimentation control plan in accordance with EPA 832/R-92-2005 and authorities having jurisdiction.
 - .3 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.
 - .4 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .2 Submit evidence, when Supplementary Cementing Materials (SCMs) are used, to certify reduction in cement from Base Mix to Actual SCMs Mix, as percentage.

1.07 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.01 VITRIFIED CLAY PIPE FOR MAIN SEWERS

- .1 N/A

2.02 ASBESTOS- CEMENT PIPE FOR MAIN SEWERS

- .1 N/A

2.03 CONCRETE PIPE

- .1 N/A

2.04 PLASTIC PIPE

- .1 Type PSM Polyvinyl Chloride (PVC): to ASTM D 3034 and CSA B182.2.
.1 Standard Dimensional Ratio (SDR): 35.
.2 Locked-in or Separate gasket and integral bell system.
.3 Nominal lengths: 4 or 6 m.
.2 Alternative materials to be approved by Departmental Representative.

2.05 SERVICE CONNECTIONS

- .1 Type PSM Poly (Vinyl) Chloride: to CSA B182.2.
.2 Plastic pipe: to CSA B182.1, with push-on joints.
.3 Vitrified clay pipe and fittings: to ASTM C 700, standard strength, unglazed bore, bell and spigot type with flexible joints.
.4 Asbestos-cement pipe: to [ASTM C 428], class 200 with rubber gasket joints to ASTM D 1869.
.5 Cast iron pipe: to CAN/CSA-B70, with rubber gasket push-on joints to ANSI/AWWA C111/A21.11. Fittings: to CAN/CSA-B70.
.6 Cast iron service saddles: with oil resistant gaskets, bronze or stainless steel clamp and oil resistant "O" rings in branch end.

2.06 CEMENT MORTAR

- .1 Portland cement: to CSA A3000, normal type 10.
.2 Mix mortar 1 part by volume of cement to two parts of clean, sharp sand mixed dry.
.1 Add only sufficient water after mixing to give optimum consistency for placement.
.2 Do not use additives.

2.07 PIPE BEDDING AND SURROUND MATERIALS

- .1 Granular material to Section 31 05 16 - Aggregate Materials and following requirements:
.1 Crushed or screened stone, gravel or sand.
.2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117.
.1 Sieve sizes to CAN/CGSB-8.1 or CAN/CGSB-8.2.

.2 Table:

<u>Sieve Designation</u>	<u>% Passing Gravel/Sand</u>
12.5 mm	100
9.5 mm	-
4.75 mm	50-100
2.00 mm	30-90
0.425 mm	10-50
0.180 mm	-
<u>0.075 mm</u>	<u>0-10</u>

- .3 Concrete mixes and materials for cradles, encasement, and supports: to Section 03 30 00 - Cast-in-Place Concrete.

2.08 BACKFILL MATERIAL

- .1 As indicated.
.2 Type 3, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
.3 Unshrinkable fill: to Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sewer pipe 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.

3.02 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 construction until permanent vegetation has been established.
.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
.2 Clean pipes and fittings of debris and water before installation, and remove defective materials from site as directed by Departmental Representative.
.3 Clean and dry pipes and fittings before installation.
.4 Obtain Departmental Representative's approval of pipes and fittings prior to installation.

3.03 TRENCHING

- .1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
.2 Protect trench from contents of sewer or sewer connection.
.3 Trench alignment and depth require acceptance by Departmental Representative prior to placing

bedding material and pipe.

3.04 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .1 Place concrete to details as indicated.
- .2 Position pipe on concrete blocks to facilitate placing of concrete.
 - .1 When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placing.

3.05 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding materials in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% corrected maximum dry density.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.06 INSTALLATION

- .1 Lay and join pipes to: ASTM C 12.
- .2 Lay and join pipes in accordance with manufacturer's recommendations.
- .3 Handle pipe using methods approved by Departmental Representative.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
Tolerances: ± 50 mm from specified horizontal alignment and ± 10 mm from specified grade; reverse grade not acceptable.
- .5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .6 Joint deflection permitted within limits recommended by pipe manufacturer.
- .7 Water to flow through pipe during construction, only as permitted by Departmental Representative.
- .8 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .9 Install plastic pipe and fittings in accordance with CSA B182.11.
- .10 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's written recommendations.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and foreign material.
 - .5 Avoid displacing gasket or contaminating with dirt or foreign material. Gaskets so disturbed to be removed, cleaned and lubricated and replaced before joining is attempted.
 - .6 Complete each joint before laying next length of pipe.
 - .7 Minimize joint deflection after joint has been made to avoid joint damage.

- .8 At rigid structures, install pipe joints not more than 1.2 m from side of structure.
- .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .11 When stoppage of Work occurs, block pipes as directed by Departmental Representative to prevent creep during down time.
- .12 Plug lifting holes with pre-fabricated plugs accepted by Departmental Representative, set in shrinkage compensating grout.
- .13 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .14 Make watertight connections to manholes.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .15 Use prefabricated saddles or field connections accepted by Departmental Representative, for connecting pipes to existing sewer pipes.
 - .1 Joints to be structurally sound and watertight.

3.07 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1.0 m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% corrected maximum dry density.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density.
- .7 When field test results are acceptable to Departmental Representative, place surround material at pipe joints.

3.08 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 95% corrected maximum dry density.
 - .1 In other areas, compact to at least 90% corrected maximum dry density.
- .4 Place unshrinkable fill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.09 UNDERCROSSING

- .1 Excavate working pit to dimensions indicated, outside right-of-way to be crossed.
- .2 Excavate working pit to minimum of 0.5 m below lowest invert of encasing pit.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.
- .5 Install a heavy timber or steel frame backstop.
- .6 Place encasing pipe to exact line and grade as indicated.

- .1 Encasing pipe: undercross obstruction at angle indicated.
- .7 Install encasing pipe by jacking, boring or tunnelling.
- .8 Ensure encasing pipe is not in tension.
- .9 Use mechanical or welded type joints for encasing pipe.
- .10 Place concrete grout levelling pad in encasing pipe.
 - .1 Control level of grout during placing.
- .11 Provide shop drawings showing proposed method of installation for sanitary sewer in undercrossing.
- .12 Insert sanitary sewer pipe into encasement pipe, in end with largest opening after placement of levelling pad.
- .13 Use approved blocking method to guide sanitary sewer pipe in true alignment.
- .14 Clearance between blocks and encasement pipe: maximum 12 mm when sanitary sewer pipe is in position.
- .15 Join sanitary sewer pipe one length at time outside encasement pipe.
 - .1 Push sanitary sewer pipe into position.
- .16 Couplings of sanitary sewer pipe: not to rest on levelling pad when sanitary sewer pipe is in position.
- .17 Place 20 MPa concrete cradle around sanitary sewer pipe after it is positioned.
 - .1 Cradle to be minimum of 225 mm and maximum of 300 mm above levelling pad.
- .18 Pressure grout remaining void with grout consisting of 1 part Portland cement and 2 parts clean washed sand with only sufficient amount of water added to allow placement.
 - .1 Do not install pressure grout until sanitary sewer pipe is secure against flotation.
 - .2 Do not use additives.
- .19 Do field testing before placing concrete cradle and grouting.

3.10 SERVICE CONNECTIONS

- .1 Install pipe to CSA B182.11 and manufacturer's instructions and specifications.
- .2 Maintain grade for 100 and 125 mm diameter sewers at 1 vertical to 50 horizontal (2.0%) unless directed otherwise by Departmental Representative.
- .3 Service connections to main sewer: standard, Tee or Wye fittings with Departmental Representative approved saddles.
 - .1 Do not use break-in and mortar patch-type joints.
- .4 Service connection pipe: not to extend into interior of main sewer.
- .5 Make up required horizontal and vertical bends from 45 degrees bends or less, separated by straight section of pipe with minimum length of 4 pipe diameters.
 - .1 Use long sweep bends where applicable.
- .6 Plug service laterals with water tight caps or plugs as approved by Departmental Representative.
- .7 Place location marker at ends of plugged or capped unconnected sewer lines.
 - .1 Each marker: 38 x 89 mm stake extending from pipe end at pipe level to 0.6 m above grade.
 - .2 Paint exposed portion of stake red with designation SAN SWR LINE in black.

3.11 FIELD TESTING

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 When directed by Departmental Representative, draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are

- complete, and service connections have been installed.
- .5 Do infiltration and exfiltration test to ASTM C 828.
 - .6 Do infiltration and exfiltration testing as specified herein and as directed by Departmental Representative.
 - .1 Perform tests in presence of Departmental Representative.
 - .2 Notify Departmental Representative 24 hours minimum in advance of proposed tests.
 - .7 Carry out tests on each section of sewer between successive manholes including service connections.
 - .8 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.
 - .9 Exfiltration test:
 - .1 Fill test section with water to displace air in line. Maintain under nominal head for 24 hours to ensure absorption in pipe wall is complete before test measurements are begun.
 - .2 Immediately prior to test period add water to pipeline until there is head of 1 m over interior crown of pipe measured at highest point of test section or water in manhole is 1 m above static ground water level, whichever is greater.
 - .3 Duration of exfiltration test: 2 hours.
 - .4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.
 - .10 Infiltration test:
 - .1 Conduct infiltration test in lieu of exfiltration test where static ground water level is 750 mm or more above top of pipe measured at highest point in line to be used.
 - .2 Do not interpolate a head greater than 750 mm to obtain an increase in allowable infiltration rate.
 - .3 Install watertight plug at upstream end of pipeline test section.
 - .4 Discontinue pumping operations for at least 3 days before test measurements are to begin and during this time, keep thoroughly wet at least one third of pipe invert perimeter.
 - .5 Prevent damage to pipe and bedding material due to flotation and erosion.
 - .6 Place 90 degrees V-notch weir, or other measuring device approved by Departmental Representative in invert of sewer at each manhole.
 - .7 Measure rate of flow over minimum of 1 hour, with recorded flows for each 5 min interval.
 - .11 Infiltration and exfiltration: not to exceed following limits in L per hour per 100 m of pipe, including service connections.

Nominal Pipe diameter in mm	Asbestos-Cement or Plastic pipe
100	3.88
125	4.62
150	5.51
200	7.45
250	9.39
300	11.33
350	13.27
400	14.91
450	16.84
500	18.78
550	20.72
600	22.80
700	26.53

800	30.11
900	33.69
1000	37.56
1100	41.29
<u>1200</u>	<u>45.01</u>

- .12 Leakage: not to exceed following limits in litres per hour per mm of diameter per 100 m of sewer including service connections:
- .1 Exfiltration, based on 600 mm head: 0.175 L.
 - .2 Infiltration: 0.150 L.
- .13 Repair and retest sewer line as required, until test results are within limits specified.
- .14 Repair visible leaks regardless of test results.
- .15 Television and photographic inspections:
- .1 Carry out inspection of installed sewers by video camera, digital camera or by other related means.
 - .2 Provide means of access to permit Departmental Representative to do inspections.
 - .3 Payment for inspection services in accordance with Measurement and Payment in Part 1.

3.12 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 for reuse and 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