Public Works and Government Services Canada

Requisition Number: EZ899-192962

MERX I.D. Number: _____

SPECIFICATIONS for:

NRC Herzberg Astronomy & Astrophysics
ATP Integration Facility

Project No: R.077596.001

Issued for 100% - Phase 2

APPROVED BY:

_____ 2018 05 07
Regional Manager, AES Date

_____ 2018.03.15
Construction Safety Coordinator Date

TENDER:

_____ 2019-02-26
Project Manager Date

DRAWING LIST

W - WOOD PACKAGE

ARCHITECTURAL

STRUCTURAL

MECHANICAL

END OF SECTION 00 00 10

SEAL AND SIGNATURE

CONSULTANTS – SEAL & SIGNATURE

Discipline	**Seal/Signature/Date**
Architectural Chernoff Thompson Architects	REGISTERED ARCHITECT TONY Y. W. YIP BRITISH COLUMBIA MARCH 13, 2018
Structural Consultant CWMM Consulting Engineers Ltd.	PROVINCE OF BRITISH COLUMBIA Y. W. P. LAM PROFESSIONAL ENGINEER # 14686 DESIGNATED STRUCTURAL ENGINEER Mar 13, 2018
Mechanical Consultant AME Group	PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. A. OZATA # 31744 MAR 14 2018
Electrical Consultant AES Engineering Ltd.	PROFESSIONAL ENGINEER PROVINCE OF I. A. BARNES March 13, 2018
Civil Consultant Westbrook Consulting Ltd.	PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA B. W. CRAWSHAW March 13/2018

END OF SECTION 00 01 07

1.0 GENERAL

1.1 RELATED SECTIONS

.1 General Instructions Section 01 11 55

1.2 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this contract comprises of the construction of the ATP Integration Facility at NRC HERZBERG ASTRONOMY AND ASTROPHYSICS at 5071 West Saanich Road., Victoria, BC. Work is comprised of tasks listed in Section 01 11 55 item 1.2.1.

1.3 BIDDING AND CONTRACT METHOD

.1 There are 2 sets of drawings for the same scope of work under this contract:

.1 W-Wood Package – The intent shown in this package is to construct the ATP Integration Facility using a combination of heavy timber and steel construction. Heavy timber construction generally includes but not limited to the use of glulam column, glulam beam and Cross Laminated Timber panels. Architectural, mechanical, electrical designs are based on the structural design in this set of drawings. Civil design is the same as the other package. Specification division 0 to 33 will apply except Section 05 21 00 Steel Joist.

.2 S-Steel Package – The intent shown in this package is to construct the ATP Integration Facility using steel construction. Steel construction generally includes but not limited to the use of steel column, steel beam and steel joist. Architectural, mechanical, electrical designs are based on the structural design in this set of drawings. Civil design is the same as the other package. Specification division 0 to 33 will apply except Section 06 18 00 Glue-Laminated Structural Units and 06 18 12 Cross Laminated Timber (CLT).

.2 The bid price will reflect the intent to complete the contract work using either one of the packages only. Contractor can decide to complete the contract work using one of the packages, i.e., either W-Wood Package or S-Steel Package, but not a combination of both packages.

.4 Contractor to inform Departmental Representative with 2 business days after award of contract which package they intend to use to complete the contract work. Submittal, commissioning and close out document will be provided based on the requirement of that package. The other drawing package will become obsolete during the full duration of the contract period.

.5 Construct work under lump sum contract.

1.4 WORK BY OTHERS

.1 Co-operate with other Contractors on site in carrying out their respective works and carry out instructions from the Departmental Representative.

.2 Coordinate work with that of other Contractors. If any part of the work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Departmental Representative, in writing, any defects which may interfere with proper execution of work.

.3 Phase 1 Contractor responsible for site services, civil and electrical site service will need to access the site for transformer installation and final commissioning. Phase 2 Contractor to allow access and coordinate Phase 1 Contractor to complete their scope of work.

1.5 WORK SEQUENCE

.1 Construct work in stages to accommodate continued use of premises and access road in immediate surrounding areas.

.2 Do not close public usage of facilities such as roadways, walkways and building access until alternate usage has been provided.

.3 Closing of Road during weekday is not permitted. Work that requires closing of road may be permitted during weekend subject to coordination with NRC.

.4 Maintain fire truck access throughout the duration of the contract.

.5 Sequence this phase of the work so as to take into account delivery, installation and commissioning of the new transformer by Phase 1 Contractor and provide permanent power at the end of Phase 1 contract.

1.6 CONTRACTOR USE OF PREMISES

.1 Co-ordinate use of premises under direction of Departmental Representative.

.2 Obtain and pay for use of additional storage or work areas needed for work under this contract.

1.7 OWNER OCCUPANCY

.1 During the entire construction period, the owner will occupy all adjacent buildings and parking lots around the project work site for execution of their normal operations.

.2 Co-operate with Departmental Representative in scheduling operations to minimize conflict and to facilitate Owner usage of all adjacent areas. In the event of a conflict the contractor will accommodate changes to their operations to minimize interference with owner operations.

1.8 OWNER AND CONTRACTOR RESPONSIBLITIES

.1 Owner Responsibilities:

.1 Arrange for delivery of up-to-date utility location information, safety requirements, and any site specific work policies that may have changed or were not available at the time of specification and drawing preparation.

.2 Contractor Responsibilities:

.1 Work in progress schedule.

.2 Review all submittals and contract requirements. As soon as it becomes apparent, submit to Departmental Representative written and verbal notification of observed discrepancies or problems anticipated due to non-conformance with Contract Documents.

.3 Provide any installation inspections required by public safety authorities and authority having jurisdiction.

.4 Receive and unload products and equipment at site.

.5 Review deliveries jointly with Departmental Representative, record shortages, and damaged or defective items.

.6 Handle product at site, including uncrating and storage.

.7 Protect product from damage.

.8 Repair or replace items damaged by Contractor or subcontractor on site.

1.9 EXISTING SERVICES

.1 Notify Departmental Representative of intended interruption of services and obtain required permission. Where work involves breaking into or connecting to existing services, contractor shall submit a request to the Departmental Representative a minimum of 6 weeks prior to the event. The contractor will not proceed until approval has been granted. The Departmental Representative will make all reasonable efforts to accommodate the request; however the Departmental Representative will not accept delay charges should the request not be accepted.

.2 Minimize duration of interruptions, and where required, provide temporary services to maintain critical systems.

.3 Provide alternative routes for personnel and vehicular traffic when existing route is interrupted by construction work.

.4 Establish location and extent of service lines in area of work before starting work. Notify Departmental Representative of findings.

.5 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including but not limited to mechanical, plumbing, power and communication services. Adhere to approved schedule and provide notice to affected parties.

.6 Provide temporary services, when directed by Departmental Representative to maintain critical systems.

.7 Provide adequate bridging over trenches which cross roads or walkways to permit normal traffic.

.8 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in a manner approved by authorities having jurisdiction.

.10 Record locations of maintained, re-routed and abandoned service lines.

.11 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

END OF SECTION 01 11 00

1.0 GENERAL

1.1 CODES, BYLAWS, STANDARDS

.1 Perform work in accordance with the National Building Code of Canada (NBCC) 2015, and other indicated Codes, Construction Standards and/or any other Code or Bylaw of local application.

.2 Comply with applicable local bylaws, rules and regulations enforced at the location concerned.

.3 Meet or exceed requirements of Contract documents, specified standards, codes and referenced documents.

.4 In any case of conflict or discrepancy, the most stringent requirements shall apply.

1.2 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 construction of ATP Integration Facility, using the W-Wood Package or the S-Steel Package, but not a combination of both.

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 Upon confirmation of the intent of the contractor which drawing package to use after award of contract, the other unused package will become obsolete and will not be used for construction.

1.4 TIME OF COMPLETION

.1 Commence work immediately upon official notification of acceptance of offer and complete the project within fifty-two (52) weeks after contract award, irrespective which drawing package the contractor has decided to proceed.

1.5 HOURS OF WORK

.1 All work shall be executed during the normal operating hours of NRC from Monday through Friday, 7:30am to 6:00pm, when gate is open. Office is opened from 8:00am to 4:30pm Monday to Friday.

.2 Notify Departmental Representative of all after hours work, including weekends and holidays. Weekend and afterhours is allowed with prior approval from Departmental Representative. Contractor must make sure the gate to be closed and secured after any afterhours work.

.3 All work conducted during and outside of normal operating hours will be subject to restrictions outlined in sections 01 14 00 and 01 51 00, including the City of Saanich Noise Bylaw.

1.6 WORK SCHEDULE

.1 Carry out work as follows:

.1 Within 10 working days after Contract award, submit Bar (GANTT) chart as per specification sections 01 32 16.07 Construction Progress Schedule Bar (GANTT) chart. 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 monthly by Departmental Representative and schedule updated by Contractor in conjunction with and approval of Departmental Representative. A copy of the updated schedule will be provided with monthly progress payment.

1.7 DIVISION OF SPECIFICATIONS

.1 The specifications are subdivided in accordance with the current 6-digit National Master Specifications System.

.2 A division may consist of the work of more than 1 subcontractor. Responsibility for determining which subcontractor provides the labour, material, equipment and services required to complete the work rests solely with the Contractor.

.3 In the event of discrepancies or conflicts when interpreting the drawings and specifications, the specifications govern.

1.8 DOCUMENTS REQUIRED

.1 Maintain one 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.
- .15 Building Permit
- .16 Request for Information (RFI)
- .17 Contemplated Change Notices
- .18 WHMIS Documents
- .19 Site Instructions
- .20 Contractor’s Health and Safety Plan, including map to nearest hospital.

1.9 REGULATORY REQUIREMENTS

.1 Building permit will be applied for by Departmental Representative.

.1 Only building permit processing fee has been paid. Contractor to pay for remaining permit fee and obtain building permit from District of Saanich.
.2 Other permit such as occupancy permit, certificates or licenses required by District of Saanich or Provincial Authority to complete work will be the responsibility of the contractor.

.2 Furnish inspection certificates in evidence that the work installed conforms with the requirements of the authority having jurisdiction.

.3 Comply with conditions as stated in Standard Acquisition Clauses and Conditions (SACC) Manual.

1.10 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 Provide security of Contractor's work site and all Contractors and Subcontractor's equipment and material. Secure Contractor's work site at the end of each work day.
.5 Perform work in accordance with the Contract documents. Ensure work is carried out in accordance with indicated phasing.
.6 Do not unreasonably encumber site with material or equipment
.7 Any area of the NRC-ATP property to which access is restricted by sign is a secured or restricted area and shall not be entered.
.8 Do not obstruct access to other areas outside of the Contractor's work site. Maintain overhead clearances, keep roadways and walkways clear, and maintain routes for emergency response vehicles.

.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.

.4 Coordinate work in particular crossover of underground duct banks entering and under the building.

1.11 EXAMINATION

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

1.12 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 barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

.4 Contractor to provide ground penetrating radar (GPR) scan as required prior to excavation work to verify hidden or underground services.

1.13 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.

1.14 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 2015 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.

1.15 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.
.4 Departmental Representative is not responsible for, or accountable for extra costs incurred as a result of Contractor's failure to coordinate Work.

.5 Maintain efficient and continuous supervision.

1.16 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.

1.17 PROJECT MEETINGS

.1 Contractor shall arrange project meetings and assume responsibility for setting times and distributing minutes. Meeting frequency should be at a minimum of once every 2 weeks throughout the contract period.

.2 The contractor shall record the meeting minutes and distribute meeting agenda 5 days prior to the meeting to Departmental Representative and all other parties as directed by Departmental Representative for review.

.3 Meeting room will be provided by the contractor in a site trailer on site.

1.18 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.

.2 The Contractor will appoint and pay for all the services of testing agency or testing laboratory for all the required tests 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 Sprinkler material and testing certificate.
.3 Domestic water pressure test and verification of water quality.
.4 Balancing Report.
.5 Commissioning Report.
.6 Duct leakage test.
.7 Seismic Engineer’s Report.

.8 Tests specified in the contract documents to be carried out by Contractor which may be under the Departmental Representative's supervision.

.3 Within 10 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 to verify compliance of contractor's work to the requirement of the Contract document.

.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 carry out specified testing and 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 digital copy of testing laboratory reports as soon as they are available.

1.19 SITE SECURITY

.1 Contractor shall be fully responsible for securing the job site and its contents throughout construction period.

1.20 SURVEYING

.1 All construction layout and final accurate construction records shall be the responsibility of the contractor and shall be set by a licensed land surveyor in the Province of British Columbia.

.2 Contractor to submit name of licensed land surveyor to Departmental Representative during first project meeting (startup meeting).

1.21 AS-BUILT DOCUMENTS

.1 The Departmental Representative will provide 5 sets of drawings and 5 sets of specifications, including 1 set of drawings and specification for "as-built" purposes.

.2 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 Departmental Representative.

.3 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.

.4 Provide accurate as-built drawings by a qualified professional surveyor identifying the various elements shown on the drawings in the requested format.

.5 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 Departmental Representative in hard copy with contractor's review stamp and date confirming that the set submitted are a true record of "as-built" information.

.6 Refer to Section 01 78 00 – Close-out Submittals.

1.22 CLEANING

.1 Refer to Section 01 74 11 - Cleaning.

1.23 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.

.4 Falling of trees must be notified to Departmental Representative for approval prior to execution of work. All trees are considered environmentally sensitive and of high environmental value. The project site is within the protected area of Gary Oak Ecosystem.

.5 The project site is a highly sensitive natural habitat for wild life. Should any natural habitat be discovered or be potentially disturbed by construction activities, notify Departmental Representative immediate and work to be stopped until further instruction is provided or natural habitat is relocated by owner's authorized personnel.

1.24 ADDITIONAL DRAWINGS

.1 The Departmental Representative may furnish additional drawings for clarification. These additional drawings have the same meaning and intent as if they were included with drawings referred to in the Contract Documents.

.2 Departmental Representative will furnish up to a maximum of five (5) sets of Contract Documents for use by the Contractor at no additional cost. Should more than five (5) sets of documents be required, the Departmental Representative can provide them at additional cost.

1.25 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 at the project area.

.3 Smoking is only allowed in designated locations within NRC. “Designated Smoking Areas” are at the discretions of NRC and Departmental Representative.

1.26 SYSTEM OF MEASUREMENT

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

1.27 FAMILIARIZATION WITH SITE

.1 A site visit will be set up during the bidding period for the benefit of the bidder to familiarize with the existing site condition. Attendance at the site visit, though not mandatory, is highly encouraged.

1.28 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 Within 10 days after award of contract, provide a monthly cash flow projection for the whole contract period in detail as directed by Departmental Representative. Contractor should provide a monthly update of the cash flow projection according to the actual work schedule and progress payment submitted.

1.29 SUBSTANTIAL COMPLETION

.1 Substantial completion includes commissioning and functional use of the project in addition to the requirements under the terms and conditions of the Contract listed in the Standard Acquisition Conditions and Clauses.

END OF SECTION 01 11 55

1.0 GENERAL

1.1 FACILITY OPERATIONS AND SECURITY PROCEDURES

.1 All construction staff shall become thoroughly familiar with and abide by all provisions and requirements of NRC-ATP's Operations, Safety and Security Procedures and Restrictions.

.1 The parking area(s) to be used by construction employees will be designated by NRC. Parking in other locations will be prohibited and vehicles may be subject to removal.

.2 Speed limits are posted on site. Failure to abide by site speed limits may result in removal of employee and vehicle from site.

.3 NRC may require photographs to be taken for construction identification badges used to access the site.

.4 NRC enforces a zero tolerance policy for the following misbehavior:

.1 Appear to be under the influence of alcohol, drugs or narcotics.

.2 Behave in an unusual or disorderly manner.

.3 In possession of contraband.

.2 Cooperate with and coordinate construction/demolition activities with NRC-ATP.

1.2 ACCESS AND EGRESS

.1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant Federal, municipal, provincial and other regulations.

.2 Provide hoarding, and scaffolding plan for Departmental Representative to review 5 business days prior to installation.

.3 Refer to drawings for designated Laydown Area.

1.3 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.

.2 Maintain existing services to building and provide for personnel and vehicle access.

.3 Where security is reduced by work, provide temporary means to maintain security as per Departmental Representatives direction.

.4 Closures: protect work temporarily until permanent enclosures are completed.

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

1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to NRC-ATP's operations, occupants. Arrange with Departmental Representative to facilitate execution of work.

1.5 EXISTING SERVICES SHUT DOWNS

.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 6 weeks of notice for necessary interruption of civil, 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.

1 Optimize and plan shut-downs so that services are restored in time for normal facility operation hours. Coordinate all shut-downs with utility providers and facility users.

.1 Sprinkler Installation: Contractor to coordinate installation with Departmental Representative. Installation shall be done in rational manner, such that installation can occur in individual spaces without affecting the entire building.

.2 Review the foregoing shutdown requirements; submit within the Project Schedule suggested time and duration for any planned outages. The Departmental Representative will review the proposed schedule and may stipulate changes. Any such changes, modifications, or revisions shall not be the basis for any extra claim.

.3 After review of draft schedule, contractor to submit firm time and duration for each outage required. Include all input from the Departmental Representative as described above.

.2 Contractor shall be held responsible for damages to facility equipment as the result of service shut-downs.

.3 Contractor shall be held responsible for any and all unscheduled shut-downs of building utilities and services.

.4 Contractor will not be allowed to connect to Departmental Representative's existing data communication services.

.5 Submit a "Fire Alarm Bypass" request to Departmental Representative 3 working days advance for approval.

.6 Obtain permission from Departmental Representative for access to restricted areas the construction zones 3 working days in advance.

.3 Provide for personnel and vehicular traffic (if required) and barricades or walkway delineation for personal walkways.

.4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.6 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions.

1.7 NOISE CONTROL

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

1.8 SECURITY CLEARANCES

.1 Personnel employed on this project will be subject to security check. Obtain requisite clearances, as instructed, for each individual required to enter the premises.

.2 Personnel will need to obtain security clearance at start of project through NRC and be provided with a pass which must be worn at all times.

END OF SECTION 01 14 00

1.0 GENERAL

.1 This section includes the following:

.1 Coordination of Work under administration of Departmental Representative.

.2 Scheduled Pre-construction and Site meetings.

.3 Project planning and construction schedule.

.4 Site progress monitoring and control.

1.1 DESCRIPTION

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

1.2 PRE-CONSTRUCTION MEETING

.1 Pre-construction Meeting:

.1 Within 10 days after award of Contract, Departmental Representative will arrange pre-construction meeting.

.2 Departmental Representative, Contractor and members of NRC Project Management Office (PMO) will be in attendance.

.3 Departmental Representative will establish time and location of meeting and notify parties concerned.

.4 The Departmental Representative will chair the meeting, record minutes and issue minutes to all attendees.

.1 Agenda of meeting is generally as follows:

.1 Project team introductions including main construction personnel, PWGSC personnel, NRC and consultants.

.2 Communication protocol for submittals.

.3 Start date on site.

.4 NRC security requirements.

.5 Construction Organization and Start-up:

.1 Comply with Departmental Representative's allocation of mobilization areas of site; for access, traffic, and parking facilities.

.2 During construction coordinate use of site and facilities through Departmental Representative's procedures for intra-project communications: Submittals, reports and records, schedules, coordination of drawings, recommendations, and resolution of ambiguities and conflicts.

.3 Comply with instructions of Departmental Representative for use of temporary utilities and construction facilities.

.4 Coordinate layout of construction barrier with Departmental Representative.

1.3 PROJECT PLANNING

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

1.4 SCHEDULES

.1 Submit preliminary construction schedule to Departmental Representative during Pre-Construction meeting.

.2 After review, revise and resubmit schedule. Submit final full schedule within 2 weeks after Pre-Construction meeting.

.3 During progress of Work revise and resubmit with the monthly progress payment draw to the Departmental Representative.

1.5 CONSTRUCTION SITE MEETINGS

.1 During course of Work and prior to project completion, Contractor will set up bi-weekly site meeting.

.2 Contractor will record minutes of meetings and circulate to attending parties and affected parties not in attendance.

.3 Agenda to include following:

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

1.6 WALK THROUGH FIELD REVIEW BY DEPARTMENTAL REPRESENTATIVE

.1 Departmental Representative will carry out the following:

.1 Walk-through field review of the work with contractor's representatives.
.2 Preparation and distribution of the Walk-through field review Reports. Reports will be distributed after field review.

1.7 SUBMITTALS

.1 Submit requests for interpretation of Contract Documents, and obtain instructions through Departmental Representative utilizing Request for Information forms.

.2 Process substitutions through Departmental Representative.

.3 Deliver closeout submittals for review and inspections, for transmittal to Departmental Representative.

1.8 CLOSEOUT PROCEDURES

.1 Notify Departmental Representative when Work is considered Substantially Complete. Contractor to prepare list of defects, deficiencies and incomplete work prior to inspection by Departmental Representative. Follow procedures as outlined in Section 01 78 00 – Closeout Submittals.

.2 Accompany Departmental Representative on preliminary inspection to determine items listed for completion or correction.

.3 Comply with Departmental Representative's instructions for correction of items of Work listed in deficiency list.

.4 Notify Departmental Representative of instructions for completion of items of Work determined in Departmental Representative's final inspection.

END OF SECTION 01 31 00

1.0 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 will be held in site trailer provided by the Contractor.

.5 Preside at meetings.

.6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within five (5) days after meetings and transmit to meeting participants and affected parties not in attendance, Departmental Representative and Consultants.

.8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRE- CONSTRUCTION MEETING

.1 Within 10 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, representative of the NRC, consultants, and Contractor.

.3 Departmental Representative to establish time and location of preconstruction meeting, Contractor to notify parties concerned a minimum of 5 working days before meeting.

.4 Contractor 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 NRC Security requirements.
- .6 Site safety in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and Section 01 35 33 Health and Safety Requirements.
- .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 Review of surveyors, inspection and testing agencies or firms being submitted for use in the project.

1.3 PROGRESS MEETINGS

.1 During course of Work and two weeks prior to Project Completion, schedule progress meetings on bi-weekly interval.

.2 Attendance to include but is not limited to Departmental Representatives, representative of the NRC, consultants, and Contractor.

.3 Contractor is responsible to record minutes of meetings and circulate to attending parties and affected parties not in attendance within five (5) days after meeting.

.4 Record next meeting dates in the meeting minutes or notify parties minimum of seven (7) days in advance for other ad-hoc meetings.

.5 Agenda to include, at a minimum, the following:
.1 Review, approval of minutes of previous meeting.
.2 Review of Health and Safety including any incidents, near misses, and WorkSafe BC visits.
.3 Review of Work progress since previous meeting.
.4 Coordination discussions with NRC.
.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 Structural
.3 Mechanical
.4 Electrical
.5 Civil
.10 Change order log review.
.11 Review submittal schedule.
.12 Review updated as built.
.13 Review and resolve site issues.
.14 New business.

END OF SECTION 01 31 19

1.0 GENERAL

1.1 DEFINITIONS

.1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.

.2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.

.3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.

.4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.

.5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.

.6 Master Plan: summary-level schedule that identifies major activities and key milestones.

.7 Milestone: significant event in project, usually completion of major deliverable.

.8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.

.9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

.1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.

.2 Plan to complete Work in accordance with prescribed milestones and time frame.

.3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.

.4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

.5 Clearly show sequence and interdependence of construction activities and indicate:
- .1 Start and completion of all items of Work, their major components and interim milestones completion dates.
- .2 Activities for procurement, delivery, installation and completion of each major piece of equipment, materials and other supplies, including:
  - .1 Time for submittals, re-submittal and review.
  - .2 Time for fabrication and delivery of manufactured products for Work.
  - .3 Interdependence of procurement and construction activities.
- .3 Include sufficient detail for project activities to assure adequate planning and execution of work. Activities should generally range in duration from 3 to 15 days each.
- .4 Provide level of detail for project activities such that sequence and interdependency of Contract tasks are demonstrated to allow coordination and control of project activities. Show continuous flow from left to right.
- .5 Ensure activities with no float are calculated and clearly indicated on logical CPM construction network system as being whenever possible, continuous series of activities throughout length of project to form critical path.

1.3 SUBMITTALS

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

.2 Submit to Departmental Representative within 28 working days after Award of Contract Project schedule in form of Bar (GANTT) Chart for planning, monitoring and reporting of project progress.

1.4 REVIEW OF THE SCHEDULE

.1 Allow 10 working days for Departmental Representative to review proposed schedule. Make necessary changes to proposed schedule within 5 days.

.2 Submit letter ensuring the schedule has been prepared in coordination with major subcontractors and suppliers.

.3 Promptly provide additional information to validate practicability of schedule as required by Departmental Representative.

.4 Submittal of Schedule indicates that it meets Contract Requirements and will be executed generally in sequence.

1.5 COMPLIANCE WITH SCHEDULE

.1 Comply with reviewed schedule.

.2 Proceed with significant changes and deviations from schedule sequence of activities which cause delay only after review by Departmental Representative.

.3 Identify activities that are behind schedule and causing delay. Provide recovery plan and schedule to regain slippage.
- .1 Recovery plan and schedule must include:
  - .1 An increase of personnel on the site for effective activities or work packages.
  - .2 An increase in materials and equipment.
  - .3 Additional work shifts, longer hours.
  - .4 Resource loaded schedule indicating the items noted above.

1.6 PROJECT SCHEDULE

.1 Develop detailed Project Schedule derived from Master Plan.

.2 Ensure detailed Project Schedule that shows milestone and activity types and expand from the following items:
- .1 Award.
- .2 Shop Drawings, Samples and Approvals.
- .3 Permits.
- .4 Mobilization.
- .5 Mock-ups and Approvals.
- .6 Procurement.
- .7 Construction.
- .8 Installation.
- .9 Site Works.
- .10 Training.
- .11 Shutdowns for systems indicated in Section 01 14 00.15 – Existing Services Shutdown.
- .12 Commissioning.

1.7 PROJECT SCHEDULE REPORTING

.1 On an ongoing basis, schedule on job site must show “progress to date”. Arrange participation on and off site of subcontractor and suppliers, as and when necessary, for purpose of network planning, scheduling, updating and progress monitoring. Inspect Work with Departmental Representative at least once monthly to establish progress on each current activity shown on applicable networks.

.2 Maintain a daily log of progress of the work:
- .1 Submit daily force report to Departmental Representative daily prior to noon the following day indicating:
  - .1 Total number of personnel on site.
  - .2 Major subcontractors on site listed by trade.
  - .3 Major equipment on site, i.e. excavators, cranes, drills.
  - .4 Concrete volumes.
  - .5 Visitors to site.
  - .6 Weather
  - .7 Documents required from Departmental Representative to Contractor to maintain.

.3 Perform schedule update monthly dated on last working day of the month. Update to reflect activities completed to date, activities in progress, logic and duration changes.

.4 Do not automatically update actual start and finish dates by using default mechanisms found in project management software.

.5 Requirements for monthly progress monitoring and reporting are basis for progress payment request.

.6 Submit monthly schedule updates with the progress payment request.

.7 Submit monthly written reports based on schedule, showing Work to Date performed, comparing work progress planned and presenting current forecasts. Report must summarize progress, defining problem areas and anticipated delays with respect to Work Schedule, and critical paths. Explain alternatives for possible schedule recovery to mitigate any potential delay. Include in report:

.1 Description of progress made.

.2 Pending items and status of: Permits, shop drawings, samples, mockups, deliveries, change orders, possible time extension.

.3 Status of Contract Completion Date and Milestones.

.4 Current and Anticipated problem areas, potential delays and corrective measures.

.8 Submit weekly 3 week look ahead schedule to Departmental Representative on each Friday of the Week indicating the planned tasks of the next three week period.

1.8 PROJECT MEETINGS

.1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

END OF SECTION 01 32 16.07

1.0 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 co-ordinated 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 co-ordinated.

.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 co-ordinated, 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 co-ordination 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 keep 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 Collaborative site hosted by PWGSC. Contractor will be responsible for becoming familiar with and utilizing the system.

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 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 01 33 00

PSPC Update on Asbestos Use
Effective April 1, 2016, all Public Service and Procurement Canada (PSPC) contracts for new construction and major rehabilitation will prohibit the use of asbestos-containing materials. Further information can be found at http://www.tpsgc-pwgsc.gc.ca/comm/vedette-features/2016 04-19-00-eng.html

1.0 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 2015):
- .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 National Fire Code of Canada 2015 (as amended)
- .1 Part 5 – Hazardous Processes and Operations and Division B as applicable and required.

.5 American National Standards Institute (ANSI):
- .1 ANSI A10.3, Operations – Safety Requirements for Powder-Actuated Fastening Systems.

.6 Province of British Columbia:
- .1 Workers Compensation Act Part 3-Occupational Health and Safety.
- .2 Occupational Health and Safety Regulation

.7 Current B.C. Electrical Code

1.2 RELATED SECTIONS

.1	Construction Progress Schedule Bar (GANTT) Chart	Section 01 32 16.7
.2	Submittal Procedures	Section 01 33 00
.3	Temporary Utilities	Section 01 51 00
.4	Temporary Barriers Enclosures	Section 01 56 00

1.3 WORKERS' COMPENSATION BOARD COVERAGE

.1 Comply fully with the Workers' Compensation Act, regulations and orders made pursuant thereto, and any amendments up to the completion of the work.

.2 Maintain Workers' Compensation Board coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

1.4 COMPLIANCE WITH REGULATIONS

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

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

1.5 SUBMITTALS

.1 Submit to Departmental Representative submittals listed for review. In accordance with Section 01 33 00.

.2 Work effected by submittal shall not proceed until review is complete.

.3 Submit the following:

.1 Health and Safety Plan.

.2 Copies of reports or directions issued by Federal and Provincial health and safety inspectors.

.3 Copies of incident and accident reports.

.4 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Material Information System (WHMIS) requirements.

.5 Emergency Procedures.

.4 The Departmental Representative will review the Contractor's site-specific project Health and Safety Plan and emergency procedures, and provide comments to the Contractor within 2 days after Receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.

.5 Medical surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of work, and submit additional certifications for any new site personnel to Departmental Representative.

.6 Submission of the Health and Safety Plan, and any revised version, to the Departmental Representative is for information and reference purposes only. It shall not:

.1 Be construed to imply approval by the Departmental Representative.

.2 Be interpreted as a warranty of being complete, accurate and legislatively compliant.

.3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

1.6 RESPONSIBILITY

.1 Assume responsibility as the Prime Contractor for work under this contract. Responsibility should also cover Phase 1 Contractor on site during installation and commissioning of transformer.

.2 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

.3 Comply with and enforce compliance by employees with safety requirements of Contract documents, applicable Federal, Provincial, Territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.7 HEALTH AND SAFETY COORDINATOR

.1 The Health and Safety Coordinator must:

.1 Be responsible for completing all health and safety training, and ensuring that personnel that do not successfully complete the required training are not permitted to enter the site to perform work.

.2 Be responsible for implementing, daily enforcing, and monitoring the site-specific Health and Safety Plan.

.3 Be on site during execution of work.

1.8 GENERAL CONDITIONS

.1 Provide safety barricades and lights around work site as required to provide a safe working environment for workers and protection for pedestrian and vehicular traffic.

.2 Ensure that non-authorized persons are not allowed to circulate in designated construction areas of the work site.

.1 Provide appropriate means by use of barricades, fences, warning signs, traffic control personnel, and temporary lighting as required.

.2 Secure site at night time as deemed necessary to protect site against entry.

1.9 PROJECT/SITE CONDITIONS

.1 Other safety hazards or risks which may be encountered include, but are not limited to:

.1 Contact with traveling and mobile cranes, forklifts, manlifts and other motorized vehicles.

.2 Overhead hazards such as that created by material transported by cranes.

.3 Fall hazards.

.4 Drowning hazards.

.5 Confined space hazards.

.6 Electrical hazards.

.7 Contact with operating mechanical, electrical, electronic, pneumatic, thermal, and hydraulic machinery and equipment.

.8 Fire hazards.

1.10 REGULATORY REQUIREMENTS

.1 Comply with specified codes, acts, bylaws, standards and regulations to ensure safe operations at site.

.2 In event of conflict between any provision of the above authorities, the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, the Departmental Representative will advise on the course of action to be followed.

1.11 WORK PERMITS

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

1.12 FILING OF NOTICE

.1 The General Contractor is to complete and submit a Notice of Project as required by Provincial authorities.

.2 Provide copies of all notices to the Departmental Representative.

1.13 HEALTH AND SAFETY PLAN

.1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.

.2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:

.1 Primary requirements:

.1 Contractor's safety policy.
.2 Identification of applicable compliance obligations.
.3 Definition of responsibilities for project safety/organization chart for project.
.4 General safety rules for project.
.5 Job-specific safe work, procedures.
.6 Inspection policy and procedures.
.7 Incident reporting and investigation policy and procedures.
.8 Occupational Health and Safety Committee/Representative procedures.
.9 Occupational Health and Safety meetings.
.10 Occupational Health and Safety communications and record keeping procedures.

.2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.
.3 List hazardous materials to be brought on site as required by work.
.4 Indicate Engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
.5 Identify personal protective equipment (PPE) to be used by workers.
.6 Identify personnel and alternates responsible for site safety and health.
.7 Identify personnel training requirements and training plan, including site orientation for new workers.

.3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.

.4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.

.5 Departmental Representative's review: the review of Health and Safety Plan by Public Works and Government Services Canada (PWGSC) shall not relieve the Contractor of responsibility for errors or omissions in final Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

1.14 EMERGENCY PROCEDURES

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

.1 Designated personnel from own company.
.2 Regulatory agencies applicable to work and as per legislated regulations.
.3 Local emergency resources.
.4 Departmental Representative and site staff.

.2 Include the following provisions in the emergency procedures:
- .1 Notify workers and the first-aid attendant, of the nature and location of the emergency.
- .2 Evacuate all workers safely.
- .3 Check and confirm the safe evacuation of all workers.
- .4 Notify the fire department or other emergency responders.
- .5 Notify adjacent workplaces or residences which may be affected if the risk extends beyond the workplace.
- .6 Notify Departmental Representative and site staff.

.3 Provide written rescue/evacuation procedures as required for, but not limited to:
- .1 Work at high angles.
- .2 Work in confined spaces or where there is a risk of entrapment.
- .3 Work with hazardous substances.
- .4 Underground work.
- .5 Work on, over, under and adjacent to water.
- .6 Workplaces where there are persons who require physical assistance to be moved.

.4 Design and mark emergency exit routes to provide quick and unimpeded exit.

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

1.15 HAZARDOUS PRODUCTS

.1 Comply with requirements of Workplace Hazardous Materials Information system (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labeling and provision of material Safety Data Sheets (MSDS) acceptable to the Departmental Representative and in accordance with the Canada Labour Code.

.2 Where use of hazardous and toxic products cannot be avoided:
- .1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS and WHMIS documents as per Section 01 33 00.
- .2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when NRC-ATP staff have left the building.
- .3 Provide adequate means of ventilation in accordance with Section 01 51 00.

1.16 ELECTRICAL SAFETY REQUIREMENTS

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

1.17 ELECTRICAL LOCKOUT

.1 Develop, implement and enforce use of established procedures to provide electrical lockout and to ensure the health and safety of workers for every event where work must be done on any electrical circuit or facility.

.2 Prepare the lockout procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request/authorization form. Have procedures available for review upon request by the Departmental Representative.

.3 Keep the documents and lockout tags at the site and list in a log book for the full duration of the Contract. Upon request, make such data available for viewing by Departmental Representative or by any authorized safety representative.

1.18 OVERLOADING

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

1.19 CONFINED SPACES

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

1.20 POWDER-ACTUATED DEVICES

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

1.21 FIRE SAFETY AND HOT WORK

.1 Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.

.2 Hot work includes cutting/melting with use of torch, flame heating roofing kettles, or other open flame devices and grinding with equipment which produces sparks.

1.22 FIRE SAFETY REQUIREMENTS

.1 Store oily/paint-soaked rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

1.25 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.

1.23 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.

1.24 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.

1.25 MEETINGS

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

1.26 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 01 35 33

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 Submittal Procedures.

1.2 REFERENCES

.1 Definitions:

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

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.

1.3 ACTION AND INFORMATION SUBMITTALS

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

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

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

.4 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.5 Include in Environmental Protection Plan:

.1 Name[s] of person[s] responsible for ensuring adherence to Environmental Protection Plan.

.2 Name[s] and qualifications of person[s] responsible for manifesting hazardous waste to be removed from site.

.3 Name[s] and qualifications of person[s] responsible for training site personnel.

.4 Descriptions of environmental protection personnel training program.

.5 Erosion and sediment control plan identifying type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations. Drawings indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.

.6 Traffic Control Plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather.

.1 Plans to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff.

.7 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.

.1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.

.8 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

.9 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.10 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.

.11 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

.12 Waste Water Management Plan identifying methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

.13 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.

.14 Pesticide treatment plan to be included and updated, as required.

1.4 FIRES

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

1.5 ENVIRNMENTAL PROTECTION PLAN

.1 This Environmental Protection Plan including mitigation measures is a requirement of the contract. The successful contractor shall be responsible to ensure all staff and all sub-contractors are provided copies of this plan, are familiar with its content and follow these requirements throughout the project.

.1 To help mitigate impacts related to air emissions and noise, all equipment used during construction will be in good working order, free from leaks, and meet applicable standards and regulations regarding noise and air emissions (e.g., Occupational Health and Safety Act, provincial Drive Clean standards, etc.). Equipment idling will also be reduced or eliminated when possible.

.2 Natural vegetation will be retained as much as possible.

.3 The construction limits will be physically delineated with fencing to avoid any impact to vegetation outside the area.

.4 Any disturbed areas will be re-vegetated with native plant species as soon as possible. NRC to provide lists of native plant species to be planted.

.5 The work will follow a project-specific invasive species management plan to help avoid infestation of disturbed areas by invasive plant species.

.6 All mature trees that can be retained should be protected during construction. This can be accomplished by installing snow fence or other markings around the critical root zone to ensure no disturbance in that area. As a general rule, the critical root zone extends outward from the trunk of each tree for a distance 12 times the tree's diameter at breast height. If there are specific high-value mature trees (e.g. Garry Oak and Douglas Fir) requiring protection, consider evaluation by an arborist to determine tree-specific protection zones If possible, do not place fill in the critical root zone of any retained Garry Oak, as it may kill the tree

.7 If possible, do not place fill in the critical root zone of any retained Garry Oak, as it may kill the tree

.8 A composite soil sample should be collected from any excavated soil and sent to an accredited laboratory for analysis to determine the available options (i.e. re-use on site or landfill). This is not required for rock.

.9 The contractor must ensure proper drainage and erosion control as indicated in the design documents.

.10 Existing monitoring wells should be flagged and avoided. If this is not possible, they must be decommissioned by a provincially-qualified person before construction starts.

.11 There should be no fuel storage or overnight heavy equipment parking in areas that slope towards any monitoring well.

.12 Known occurrences of SARA-listed species will be avoided.

.13 Contractors will be provided with information on the Sharp-tailed Snake and Blue-grey Taildropper Slug and will stop work and advise the PWGSC Site Coordinator or the NRC Site Operations Supervisor (Clyde Donnelly) if they believe these species have entered the work area.

.14 An NRC provided qualified biologist, familiar with the Sharp-tailed Snake and Blue-grey Taildropper Slug and their distribution on the site, will conduct a pre-clearing survey. If an individual is located it will be relocated by the biologist to a suitable site nearby.

.15 During the stripping process, the NRC qualified biologist will be provided access to the construction site and will work with the machine operator while the top layers are removed. The contractor shall provide necessary training to the biologist for working around heavy equipment.

.16 Because this construction has the potential to cause incidental impacts to species at risk, NRC has applied for a federal Species at Risk Act permit (application ID: 637). All work will be conducted in accordance with the conditions listed in the permit.

.17 A pre-clearing nest survey may be conducted by NRC via a qualified biologist. Suitable buffers should be established around identified active nests to reduce potential disturbance or destruction to nests and nesting birds.

.18 Should clearing involve the removal of western red cedar, the Pauquachin First Nation has requested to be notified so they can harvest the bark prior to removal.

.19 The contractor will have adequate spill containment kit readily available for any malfunctions or unplanned events that may cause petroleum or other hazardous product spill. Contractor staff shall be trained in spill containment and the contractor will provide and review a spill response plan with the PWGSC Site Coordinator and the NRC Site Operation Supervisor prior to commencement of work.

.20 The contractor shall consult with the NRC Site Operations Supervisor regularly who may provide additional information via the PWGSC Site Coordinator.

.21 The contractor will follow a chance finds procedure to manage any unanticipated archaeological finds during construction, as recommended in the Archeological Impact Assessment.

.2 Before Start of Construction, Contractor to submit Stormwater management plan for review and approval by NRC's Environmental Safety Officer. The Stormwater Management plan will need to sketches, instruction and equipment required to meet all Federal and Local Government Policies and Regulations for Stormwater Discharge.

1.6 DRAINAGE

.1 Develop and submit erosion and Sediment Control Plan (ESC) identifying type and location of erosion and sediment controls provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.

.2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sediment control plan.

.3 Provide temporary drainage and pumping required to keep excavations and site free from water.
.4 Ensure pumped water into waterways, sewer or drainage systems is free of suspended materials.
.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.7 SITE CLEARING AND PLANT PROTECTION

.1 Protect trees and plants on site and adjacent properties as indicated.
.2 Obtain tree removal permit from District of Saanich prior to the removal of any trees.
.3 Protect trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of [2] m minimum.
.4 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage.
.1 Avoid unnecessary traffic, dumping and storage of materials over root zones.

.5 Minimize stripping of topsoil and vegetation.
.6 Restrict tree removal to areas indicated.

1.8 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this Contract.
.2 Control emissions from equipment and plant in accordance with local authorities' emission requirements.

1.9 HISTORICAL/ARCHAEOLOGICAL CONTROL

.1 Archaeological Chance Finds Procedure.
.1 Construction personnel should receive “Archaeological Awareness” training prior to construction start-up, although if they have received equivalent training previously, this could be waived. The training program includes a review of this Procedure. If potentially cultural sediments or features are identified the following procedures should be immediately implemented:
.2 STOP WORK that could cause additional damage to the site deposits;
.3 Inform on-site supervisor;
.4 Record location of the find;
.5 Retain potentially cultural sediments on-site (i.e., do not release dump truck if loaded with fill from the suspected location;
.6 Site supervisor is to contact an archaeologist for further direction.
.7 Be prepared to initiate work at another location while archaeological testing and/or mitigation is conducted.
.8 Treat human remains, regardless of age or condition, with utmost respect at all times.
.9 Cover remains with a blanket or other readily available cover. Depending on the location and nature of the discovery, the project archaeologist may be required to contact the RCMP.

.2 NOTIFICATION
.1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

.2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

.3 Take action only after receipt of written approval by Departmental Representative.

.4 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

.5 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

2.0 EXECUTION

2.1 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

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

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION 01 35 43

1.0 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 the Contractor for the purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Contractor.

.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 Co-operate 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 Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.

.2 Make good other Contractor's work damaged by such removals or replacements promptly.

.3 If in opinion of 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. Testing and inspection companies engaged by Contractor will also furnish paper copies of reports on site to allow for work to proceed

.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.

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 22, 23, 26, 27, 28, 31, 32, and 33 for definitive requirements.

END OF SECTION 01 45 00

1.0 GENERAL

1.1 ACCESS AND DELIVERY

.1 Only the designated entrance may be used for access to the site. The designated entry and exit will be via the Main NRC-ATP gate on Observatory Road.

.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 Maintain road cleanliness in front of project site utilizing mechanical means.

.3 Use of the NRC-ATP facility will be granted to the Contractor through the Departmental Representative.
- .1 The contractor's work site is to be used for loading and unloading purposes

.4 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.

.5 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 NRC-ATP.

1.2 CONSTRUCTION PARKING

.1 Construction staff will be responsible for their own parking outside facility as required. Some construction parking will be provided and assigned by NRC-ATP. NRC-ATP will not guarantee that there will be sufficient parking for all construction staff.

1.3 STORAGE FACILITIES

.1 Confine work and operations of employees to areas indicated on Contract Documents. Do not unreasonably encumber premises with products. Storage space to be limited to the area of construction.

.2 Do not load or permit to load any part of Work with weight or force that will endanger Work or existing structure or elements.

.3 Provide and pay for all off-site storage as required. Note that storage space is limited on site. Refer to site plan for location of Contractor's site storage and lay-down area.

1.4 POWER

.1 NRC can provide power for construction use from the site services building. Contractor will be responsible for providing their own electrical panel and hook-up.

.2 Contractor will remove all connections and panels after completion of project.

.3 There is no guarantee of uninterrupted power supply throughout the Contract period. The Owner will not be responsible for any loss of power and interruption. Contractor will utilize at their own risk and no claim of loss of productivity will be accepted as a result of using Owner's supply power.

.4 There is also no guarantee that the power provided will be sufficient for Contractor's use. Contractor will allow to provide supplemental power as needed to complete work.

1.5 AIR

.1 Contractor to supply his own compressed air for the duration of the contract.

1.6 WATER SUPPLY

.1 Water supply is available at existing hose bibb at the Site Services Building.

.2 There is no guarantee that water supply will be uninterrupted. Contractor will use at their own risk.

1.7 SANITARY FACILITIES

.1 Contractor will provide their own portable sanitary facilities. Maintain in a safe and sanitary condition.

1.8 HEATING AND VENTILIATION

.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.

1.9 SCAFFOLDING

.1 Construct and maintain scaffolding in rigid, secure and safe manner.

.2 Erect scaffolding independent of walls. Remove promptly when no longer required.

1.10 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.

1.11 HOARDING

.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 Erect and maintain safety barricades around all openings and other danger areas as required by Building Code and WCB.

.3 Contractor to take over the construction fence from Phase 1 Contractor. After taking over, Contractor will assume responsibility, cost, and to modify the fence layout as required to suit construction use.

1.12 SITE OFFICE

.1 Contractor to provide their own trailer as temporary site office within the fenced project work area.

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

1.13 REMOVAL OF TEMPORARY FACILITIES

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

1.14 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.

1.15 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.

.2 Clean dirt of mud tracked onto paved or surfaced roadways.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material not in construction facilities.

.5 At completion of Project: Remove and dispose of all debris, thoroughly clean and restore site to condition found at commencement of Work. Repair and make good to all damage caused by construction activities.

END OF SECTION 01 51 00

1.0 GENERAL

1.2 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.

1.3 INSTALLATION AND REMOVAL

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

.2 Remove from site all such work after use.

1.4 HOARDING

.1 Refer to Section 01 51 00 Temporary Utilities Clause 1.11.

1.5 GUARD RAILS AND BARRICADES

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

.2 Provide as required by governing authorities.

1.6 ACCESS TO SITE

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

1.7 PUBLIC TRAFFIC FLOW

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

1.8 FIRE ROUTES

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

.2 Maintain clearance for all egress routes.

1.9 PROTECTION OFF-SITE AND PUBLIC PROPERTY

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

.2 Be responsible for damage incurred.

1.10 PROTECTION OF EXISTING PROPERTY

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

.2 Provide necessary screens, covers, and hoardings.

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

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

1.11 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION 01 56 00

1.0 GENERAL

1.1 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.

1.2 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.

1.3 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.

1.4 CONTRACTOR'S OPTIONS FOR SELECTION OF PRODUCTS

.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 solicitation documents.

.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.

1.5 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 contractor 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 01 61 00

1.0 GENERAL

1.1 REFERENCES

1 There is no existing as-built drawings available for the site services building. There is some partial existing underground services drawing, which can be made available for viewing by Contractor.

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 manufacturer's recommendations for safety, access and maintenance.

.3 Inform Departmental Representative of impending installation and obtain approval for actual location.

.4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.5 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 with 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, a Contemplated Change Notice and subsequently a Change Order will be issued to the contractor should the pricing be accepted.

END OF SECTION 01 71 00

1.0 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.

1.4 EXECUTION

.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 assembly.

.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.

1.5 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION 01 73 00

1.0 GENERAL

1.1 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 19 - 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.

1.2 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.

1.3 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION 01 74 11

1.0 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/disassembly 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 Co-ordinator (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 2 copies of completed Waste Reduction Workplan (WRW): Schedule B.
- .2 Submit 2 copies of completed Demolition Waste Audit (DWA): Schedule C.
- .3 Submit 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 labeling 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 Co-ordinate Work with other activities at site to ensure timely and orderly progress of Work.

2.0 PRODUCTS

2.1 NOT USED

.1 Not Used.

3.0 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 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 01 74 19

1.0 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 two weeks prior to the satisfactory completion site visit of the Contractor’s Inspection to allow Departmental Representative to schedule relevant authorities.
- .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 and Departmental Representative will agree to the value set forth in the Deficiencies identified in the Certificate of Final Completion and set a schedule of completion for all deficiencies.
- .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 have been demonstrated to Owner's personnel.
  - .7 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 01 77 00

1.0 GENERAL

1.1 RELATED SECTIONS

.1	Quality Control	Section	01 45 00
.2	Examination & Preparation	Section	01 71 00
.3	Closeout Procedures	Section	01 77 00
.4	Demonstration and Training	Section	01 79 00
.5	General Commissioning CX Requirements	Section	01 91 31
.6	Building Management Manual (BMM)	Section	01 91 51

1.2 SUBMISSION

.1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.

.2 Copy of maintenance manual will be returned after substantial completion inspection, with Departmental Representative's comments.

.3 Revise content of documents as required prior to final submittal.

.4 Two weeks prior to Substantial Completion of the Work, submit to the Departmental Representative, four draft 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 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 4 sets of the Hard Copy of 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.

.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.

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 Structure
.3 Mechanical
.4 Electrical
.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 provided in CAD format and 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 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. Provide 2 sets of full size hard copy drawings.

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 Manufacturer's 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 Provide an electronic copy of as constructed drawings.

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 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 01 78 00

1.0 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: provide list of personnel to receive instructions, and co-ordinate 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 Division.
- .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 31 Commissioning (Cx) Plan.

.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 1.7 of Section 01 91 31.

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 01 79 00

1.0 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:

Section 01 33 00 - Submittal Procedures

Section 01 45 00 - Quality Control.

Section 01 91 31- Commissioning (Cx) Plan

Section 01 91 33- Commissioning Forms

Section 01 91 41- Commissioning Training

Section 01 91 51- Building Management Manual (BMM)

Section 21 05 01 – Common Work Results

Section 22 05 00- Plumbing – General Requirements

Section 22 30 05- Domestic Hot Water Heaters and Tanks

Section 23 05 00- Common Work Results - Mechanical

Section 23 05 05- Installation of Pipework

Section 23 05 93- Testing, Adjustment & Balancing - HVAC

Section 23 08 00- General Commissioning

Section 23 08 02- Cleaning & Start-Up of Mechanical Piping Systems

Section 23 11 23- Propane Piping

Section 23 34 00- HVAC Fans

Section 23 73 11- Air Handling Units – Packaged

Section 23 81 26- Split System Air Conditioners

Section 26 05 00 - Common Work Results for Electrical.

Section 26 05 20 – Wire and Box Connectors 0-1000 V

Section 26 05 21 – Wires and Cables (0-1000 V)

Section 26 05 28 – Grounding – Secondary

Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings

Section 26 05 44 – Installation of Cables in Trenches and in Ducts

Section 26 12 17 – Dry Type Transformer up to 600V Primary

Section 26 28 21 – Moulded Case Circuit Breakers

.3 Acronyms:
- .1 AFD - Alternate Forms of Delivery, service provider.
- .2 BMM - Building Management Manual.
- .3 Cx - Commissioning.
- .4 EMCS - Energy Monitoring and Control Systems.
- .5 O&M - Operation and Maintenance.
- .6 PV - Performance Verification.
- .7 TAB - Testing, Adjusting and Balancing.
- .8 CxA – Commissioning Authority.
- .9 DC – Design Consultant.
- .10 PWGSC – Public Works and Government Services Canada.
- .11 ECxC – Electrical Commissioning Coordinator.
- .12 MCxC – Mechanical Commissioning Coordinator.
- .13 QCM - .Quality control Manger.
- .14 ECA – Electrical Commissioning Agent.
- .15 MCA – Mechanical Commissioning Agent.
- .16 O&M – Operations and Maintenance.

1.2 REFERENCE

.1 CSA Z 320-11

1.3 GENERAL

.1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
Objectives:
- .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
- .2 Ensure appropriate documentation is compiled into the BMM.
- .3 Effectively train O&M staff.

.2 Cx is to be performed by an independent third party professional Cx Agent(s) after work is completed and prior to energizing any equipment. The independent third party must have performed similar HV work for a minimum of 5 years. Qualifications of Cx Agent submitted by General Contractor shall be reviewed by Commissioning Authority and can only be hired after acceptance by Departmental Representative.

.3 General Contractor to retain the services of an independent third party professional Cx Agent to carry out the tests and calibration as required herein. Testing Agency shall be familiar with NETA Standards as specified herein and shall have accreditation equivalent to a full NETA member company:

.1 This project shall only be undertaken by firms familiar with and having a long and demonstrable successful track record in the field of switchgear and transformer modification and installation, protection and control, and arc flash mitigation. The proponent shall be experienced in working with an industrial type primary voltage distribution system using parallel feeders. Provide documented experience on projects of this type.

.2 All protection settings must be reviewed by a Professional Engineer registered in British Columbia who is an employee of Cx Agency. Provide documentation naming this individual along with their credentials.

.3 All work must be performed by qualified technicians/electricians with applicable accreditation for the appropriate permitting required. Provide a list of all personnel and their qualifications.

.4 Provide three references, including contact information for completed projects similar to this in scope and technical content.

.5 Qualifications of the Cx Agency must be submitted and reviewed by Departmental Representative and only after acceptance will the Testing Agency be allowed to perform the work.

.4 Furnish Independent Cx agency professional engineer's letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions. The letter is to be submitted stamped by a Professional Engineer, registered in BC, and provided to the Commissioning Authority.

.5 Employ only personnel who are qualified and experienced in high voltage work. Personnel must be familiar with the equipment and procedures necessary to complete the work as specified herein.

.6 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems must interact with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments will be made to enhance performance to meet environmental or user requirements.

.7 Design Criteria: as per client's requirements or determined by designer to meet Project functional and operational requirements.

1.4 COMMISSIONING OVERVIEW

.1 Cx to be a line item of General Contractor's cost breakdown.

.2 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.3 Cx is to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.4 Complete all start-up and verification of systems prior to review by Commissioning Agent.

.1 To bring mechanical, electrical and building architectural systems and components from a state of static completion to a state of dynamic operation.

.2 To verify conformance to contract requirements.
.3 To confirm installations meet requirements of Contract Documents.
.4 To provide all testing documents and records.
.5 To ensure completed facility meets contract requirements.
.6 To provide a documented operator training program.
.7 To verify accuracy of project record drawings and operating and maintenance manuals.

.5 Departmental Representative will issue Certificate of Substantial Completion when:
.1 Completed Cx documentation has been received, reviewed for suitability and approved by 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. Above costs to be in form of progress payment reductions or hold-back assessments.

1.6 PRE-CX REVIEW

.1 Before Construction:
.1 Review contract documents, confirm by writing to Departmental Representative.
.1 Adequacy of provisions for Cx.
.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:
.1 Co-ordinate provision, location and installation of provisions for Cx.

.3 Before start of Cx:
.1 Have completed Cx Plan up-to-date.
.2 Ensure installation of related components, equipment, sub-systems, systems is complete.
.3 Fully understand Cx requirements and procedures.
.4 Have Cx documentation shelf-ready.
.5 Understand completely design criteria and intent and special features.
.6 Submit complete start-up documentation to Departmental Representative.
.7 Have Cx schedules up-to-date.
.8 Ensure systems have been cleaned thoroughly.
.9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
.10 Submit factory testing report of Electrical Equipment to Departmental Representative for review and approval.
.11 Ensure "As-Built" system schematics are available.
.12 Conduct coordination and protection study of upstream breakers, as indicated in drawings, to determine if trip settings are adequate for additional demand. Determine trip setting adjustments and where required re-set breakers accordingly. The study shall be performed at both 12.5 kV and 25 kV distribution voltages.

.13 Factory test each transformers, regulator and switchgear assemblies and all accessories. Notify Departmental Representative 7 days in advance of tests and confirm 2 days in advance. Departmental Representative and Engineer will attend/witness tests. Tests must be conducted in the Lower Mainland area of British Columbia. Alternatively, if tests are conducted elsewhere, pay the costs of travel time (at $130/hour) and all travel/living expenses for two attendees (at actual cost) associated with Departmental Representative's and engineer's attendance at factory tests and at repeat tests if necessary.

.4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.7 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.8 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  .1 Submit no later than 4 weeks after award of Contract:
    .1 Name of 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 Factory testing reports
  .9 Approved Training and Attendance forms
  .10 Accepted "As-built" Plans and Specifications
  .11 Final Cx Report

1.9 COMMISSIONING DOCUMENTATION

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

.2 General Contractor to review and approve Cx documentation submitted by Cx Agent prior to submission to Cx Authority for review.

.3 Provide completed and approved Cx documentation to Commissioning Authority.

1.10 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 17 Construction Progress 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 per Construction Progress Schedule and as specified herein.

.2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 60% construction completion stage. Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart). General Contractor to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:

.1 Review duties and responsibilities of General Contractor and subcontractors, addressing delays and potential problems.

.2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meeting will be chaired by General Contractor with their Commissioning Agent, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.12 STARTING AND TESTING

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

1.13 WITNESSING OF STARTING AND TESTING

.1 Provide 14 days’ notice prior to commencement.

.2 Cx Authority and Departmental Representative to witness of start-up and testing.

.3 General Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

.1 Minimum of 5 years experience in design, installation and operation of equipment and systems.
.2 Ability to interpret test results accurately.
.3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and general testing in following distinct phases
.1 Included in delivery and installation
.1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
.2 Visual inspection of quality of installation.
.2 Prior to startup:
.1 Insulation resistance test and continuity test of all new cables and all cables with connections changed during construction
.2 All high voltage terminations tested with infrared imaging. Spot temperature readings are not acceptable
.3 Refer to the NETA Acceptance Testing specifications for detailed commissioning requirements for the following equipment:
.1 Cables, Low Voltage, 600 volt maximum.
.2 Switches, Air, Low Voltage
.3 Circuit Breakers, Air, Insulated/Molded Case
.4 Circuit Breakers, Air, Low-Voltage Power
.5 Instrument Transformers
.6 Metering Devices, Microprocessor-Based
.7 Motor Control, Motor Starters, Low-Voltage
.8 Emergency Systems, Uninterruptable Power Systems
.9 Emergency Systems, Automatic Transfer Switches
.10 Fiber-Optic Cables
.4 Startup: follow accepted start-up procedures.
.5 Operational testing: document equipment performance.
.6 System PV: include repetition of tests after correcting deficiencies.
.7 Post-substantial performance verification: to include fine-tuning.

.3 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
.1 Power distribution system including phasing, voltage, grounding and load balancing.
.2 Circuits originating from branch distribution panels.
.3 Lighting and its control.
.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
.5 Systems: fire alarm system communications.
.6 Insulation resistance testing:
.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Megger 600-2.4kV circuits, feeder and equipment with a 5000V instrument.
.4 Check resistance to ground before energizing.

.4 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.

.5 Document requires tests on approved PV forms.

.6 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following
- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
  - .1 Rejected equipment to be removed from site and replace with new.
  - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.

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

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of Certificate of Substantial Performance.

1.17 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

.1 Notify Departmental Representative at least 4 weeks prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

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

.2 Provide the following equipment as required:
- .1 2-way radios.
- .2 Ladders.

.3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:
- .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
- .2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

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

1.21 WITNESSING COMMISSIONING

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

.2 Notify Cx Authority and Departmental Representative 1 week prior to tests, and confirm 48 hours before test.

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 Cx Authority within 5 days of test and with Cx report.

.4 Authorities having jurisdiction in this project include Township of Esquimalt, BC, and BC Safety Authority.

1.23 EXTRAPOLATION OF RESULTS

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

1.24 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.25 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of Cx Authority.

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

1.26 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx, leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities, complete Cx prior to issuance of Certificate of Substantial Performance.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Cx Authority.

1.27 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.29 OCCUPANCY

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

1.30 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with Departmental Representative.

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

1.31 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- 10% of recorded values for mechanical system and within +/- 2% of recorded values for electrical system.

1.32 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 01 91 13

1.0 GENERAL

1.1 SUMMARY

.1 Section Includes:
- .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.
- .2 Related requirements:
  - .1 Section 01 91 13 General Cx Requirements
  - .2 Section 01 91 33 Cx Forms.
  - .3 Section 01 91 41 Cx Training.
  - .4 Section 01 91 51 Building Management Manual.

1.2 REFERENCES

.1 CSA Z 320-11.

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 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 Five Phases of Cx to be Used on This Project
- .1 System readiness or Pre-functional Testing
- .2 System start-up, testing, balancing, and adjustment
- .3 Verification of integrated system performance
- .4 Demonstration and training
- .5 Seasonal or deferred testing and verification.

.5 Acronyms:
- .1 Cx - Commissioning.
- .2 BMM - Building Management Manual.
- .3 EMCS - Energy Monitoring and Control Systems (aka DDC or BAS).
- .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.
.9 CxA – Commissioning Authority.
.10 DR – Departmental Representative
.11 PWGSC – Public Works and Government Services Canada.
.12 ECxC – Electrical Commissioning Coordinator.
.13 MCxC – Mechanical Commissioning Coordinator.
.14 QCM - .Quality control Manger.
.15 ECA – Electrical Commissioning Agent.
.16 MCA – Mechanical Commissioning Agent.
.17 O&M – Operations and Maintenance.

.5 Commissioning terms used in this Section:
.1 Bumping: short term start-up to prove ability to start and prove correct rotation.
.2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

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

.2 Submit completed Cx Plan to 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 Submit each revised Cx Plan to Commissioning Authority for review every 3 months, and obtain written approval.

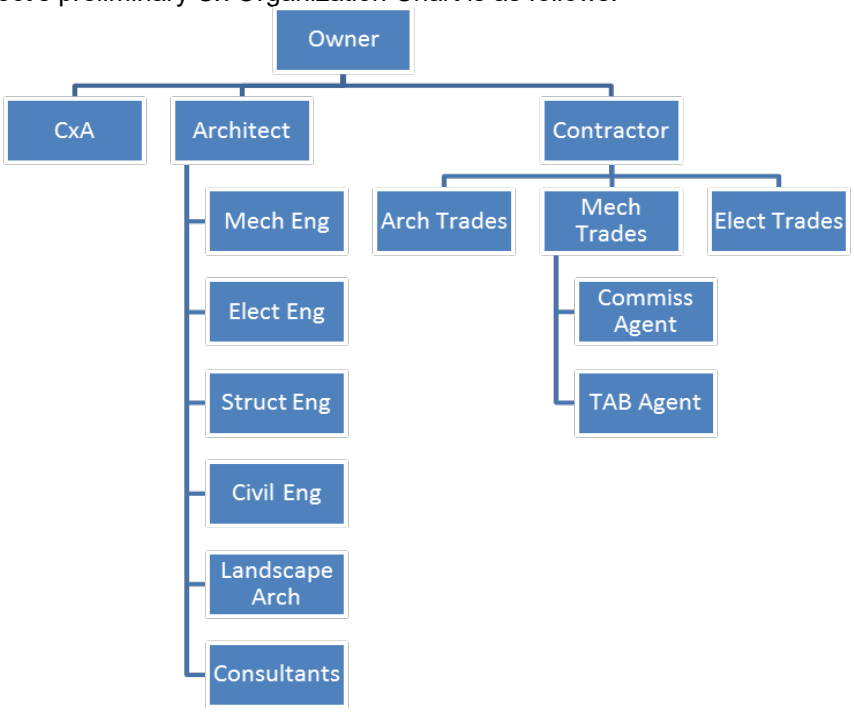
1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

.1 General Contractor to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

.2 The “Commissioning Team” consists of various participants involved in the Cx process. The table below lists team members, and shows some required tasks.

	Provide Design Intent	Review CxA's Design Review	Review Cx Plan	Respond to CxA Documen t Review	Attend Cx Meetings	Other Duties Described Herein
PWGSC, DR		✓	✓	✓	✓	✓
PWGSC Cx Manager		✓	✓	✓	✓	✓
Architect		✓	✓		✓	✓
General Contractor			✓			✓
Commissioning Authority:			✓		✓	✓
Contractor's Mechanical Commissioning Agent	✓	✓	✓	✓	✓	✓
Mechanical Engineer	✓	✓	✓	✓	✓	✓
Electrical Engineer	✓	✓	✓	✓		✓
Envelope	✓	✓	✓	✓		✓
Testing and Balancing Agent			✓		✓	✓
Controls Trade Contractor			✓		✓	✓
Electrical Contractor					✓	✓
Manufacturer's Representatives (as applicable						✓
Inspectors and Testing Agencies						✓

.3 The project's preliminary Cx Organization Chart is as follows:



The team members' commissioning responsibilities are detailed in the specifications and this

Commissioning Plan. The following is a summary table to assist team members in better understanding their roles:

LEGEND: "**A**" denotes ACCEPT; "**L**" denotes LEAD;
"**P**" denotes PARTICIPATE

TASK	Building rep.	Building op's and maint. staff	CxA	Cx provider	DR	Contractor& sub-contractors	Manuf're p's	Independent testing specialists
Concept Phase								
Define owner's project req's	**L**				**P**			
Select a Cx authority	**L**							
Form a Cx team		**P**	**L**		**P**	**P**	**P**	
Review OPRs			**P**		**P**			
Include Cx responsibilities		**P**	**L**		**P**	**P**	**P**	
Determine scope and initial Cx budget	**A/L**		**P**		**P**			
Develop basis of design (BOD)			**P**		**L**	**P**	**P**	
Develop initial Cx plan outline			**L**		**P**	**P**	**P**	
Acceptance	**A**							
Design Phase								
Hold design phase Cx meetings		**P**	**L**		**P**	**P**	**P**	**P**
Identify project-specific Cx responsibilities		**P**	**L**		**P**	**P**	**P**	**P**
Verify OPR and BOD for completeness and clarity			**L**		**P**			
Perform Cx-focused design reviews of drawings and specs		**P**	**P**		**L**			
Plan/prepare verification checklists and test procedures			**L**		**P**	**P**	**P**	**P**

Define requirements for systems manuals		**P**	**P**		**L**	**P**		
Determine operational training requirements		**P**	**L/P**		**L/P**			
Develop Cx specifications	**A**		**P**		**L**			
Prepare Cx report			**L**					
Update Cx plan			**L**					
Acceptance	**A**							
Construction Phase								
Integrate Cx activities into project schedule			**P**			**L**		
Hold construction Cx phase kickoff and progress meetings		**P**	**L**	**P**	**P**	**P**	**P**	**P**
Review contractor submissions and shop drawings			**P**		**L**	**P**		
Construct mock-ups	**A**	**P**	**P**	**P**	**P**	**L**	**P**	**P**
Update OPR and BOD	**A**		**P**		**L**			
Perform and document static verification			**P**	**L/P**		**L/P**	**P**	**P**
Perform and document start-up			**P**	**P**		**L**	**P**	**P**
Perform and document functional performance testing		**P**	**P**	**L**		**P**	**P**	**P**
Prepare and update issues logs			**L**		**P**	**P**		
Resolve issues resulting from all tests			**P**	**P**	**L**	**P**		
Verify, review, and conduct training		**P**	**P**	**L**	**P**	**P**	**P**	
Review maintenance and data manuals		**P**	**P**		**L**	**P**		
Review operations manuals		**P**	**P**		**L**	**P**		

Prepare Cx report			**P**	**L**				
Update Cx plan			**L**					
Prepare Cx manual			**L**					
Acceptance	**A**							
Occupancy & operations phase								
Resolve outstanding Cx issues		**P**	**P**	**L**	**P**	**P**	**P**	**P**
Perform seasonal/deferred testing		**P**	**P**	**L**		**P**	**P**	**P**
Resolve issues resulting from seasonal/deferred tests		**P**	**P**	**L**	**P**	**P**	**P**	**P**
Update issues logs resulting from seasonal/deferred tests			**L**		**P**	**P**		
Complete final Cx report		**P**	**L**	**P**	**P**	**P**		
Acceptance	**A**							

General Contractor will select independent Commissioning Agent to ensure Cx activities are carried out to ensure delivery of a fully operational project including:

.1 Organizing Cx.
.2 Monitoring operations Cx activities.
.3 Review of Cx documentation from operational perspective.
.4 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
.5 Protection of health, safety and comfort of occupants and O&M personnel.
.6 Monitoring of Cx activities, training, development of Cx documentation.
.7 Work closely with members of Cx Team.
.8 Certifying accuracy of reported results
.9 Certifying tabs and other results
.10 Developing BMM.
.11 Ensuring implementation of final Cx Plan.
.12 Implementation of Training Plan

.4 Departmental Representative is responsible for:

.1 Witnessing reported results.
.2 Witnessing TAB and other tests.
.3 Provides basis of design data not included in the Contract Documents.
.5 Attends commissioning activities as required to certify the site adaptation and related work meet the design intent and the project requirements.

.5 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:

.1 Testing.

.2 TAB.
.3 Performance of Cx activities.
.4 Delivery of training and Cx documentation.
.5 Assigning one person as point of contact Departmental Representative for administrative and coordination purposes.

.6 General Contractor's Cx agent implements specified Cx activities including:
.1 Demonstrations.
.2 Training.
.3 Testing.
.4 Preparation, submission of test reports.
.5 Performing verification of performance of installed systems and equipment.

.7 NRC-ATP Facility Manager: represents lead role in Operation Phase and onwards and is responsible for:
.1 Receiving facility.
.2 Day-To-Day operation and maintenance of facility.

.8 Cx Authority is responsible for:
.1 Reviews commissioning checklists and test forms to ensure applicability to the project and provide comments to the Commissioning Agent.

1.7 EXTENT OF CX

.1 The General Contractor shall provide commissioning services for the mechanical and electrical systems, cranes and process equipment provided under the contract.

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, including BMM.
.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 Deliverables: provide:
.1 Cx Work Plans.
.2 Startup, pre-Cx activities and documentation for systems, and equipment.
.3 Completed installation checklists (ICL).
.4 Completed product information (PI) report forms.
.5 Completed performance verification (PV) report forms.
.6 Results of Performance Verification Tests and Inspections.
.7 Description of Cx activities and documentation.
.8 Description of Cx of integrated systems and documentation.

.9 Tests witnessed by Departmental Representative and/or CxA.
.10 Training Plans.
.11 Cx Reports.
.12 Prescribed activities during warranty period.

1.10 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Items listed in this Cx Plan include the following:
.1 Pre-Start-Up inspections: by Departmental Representative and/or CxA prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
.2 Departmental Representative and/or CxA will monitor some of these pre-start-up inspections.
.3 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and/or CxA.
.4 Include completed documentation in Cx report.

.2 Pre-Cx Activities - MECHANICAL:
.1 Plumbing systems:
.1 "Bump" each item of equipment in its "stand-alone" mode.
.2 Complete pre-start-up checks and complete relevant documentation.
.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

1.11 START-UP

.1 Once Pre-Start process is complete, start up components, equipment and systems.

.2 Equipment manufacturer, supplier, installing specialist sub-contractor to start-up, as appropriate, under Contractor's direction.

.3 Departmental Representative and/ or CxA to monitor some of these start-up activities.
.1 Rectify start-up deficiencies to satisfaction of Departmental Representative and/or CxA.

.4 Performance Verification (PV):
.1 Approved Cx Agent to perform.
.1 Repeat when necessary until results are acceptable to Departmental Representative and/or CxA.
.2 Use procedures and modified generic procedures to suit project requirements.
.3 Departmental Representative and/or CxA to witness and certify reported results using approved PI and PV forms.
.4 Departmental Representative and/or CxA to approve completed PV reports and provide to Departmental Representative.
.5 Departmental Representative and/or CxA reserves right to will 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 agency using procedures approved by Departmental Representative and/or CxA.

.2 Departmental Representative and/or CxA to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.5 Departmental Representative and/or CxA reserves right to verify a percentage of reported results at no cost to Contract.

1.13 MECHANICAL SYSTEMS TESTING, ADJUSTING AND BALANCING

.1 Testing:

.1 Quality Assurance;

.1 Test equipment and material where specified or required by authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, SMACNA, NFPA, CSA and other recognized test codes as far as field conditions permit.

.3 Provide notice to the Departmental Representative before tests.

.2 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

.3 Pressure Tests:

.1 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers just prior to tests to avoid changes in calibration.

.2 Carry out hydraulic tests for 8 hours and maintain pressure. Where leakage occurs, repair and re-test.

.3 Domestic Water Piping: Test to 1.5 times maximum working pressure or 1034 kPa water pressure measured at system low point.

.4 Drainage Systems: Test by filling with water to produce water pressure of 30 kPa minimum and 75 kPa maximum. Check for proper grade and obstruction by ball test.

.5 Compressed Air: Test to 1.5 time's maximum working pressure or minimum 1035 kPa pressure with air. Maintain pressure for 24 hours with maximum 1 percent pressure drop.

.6 Refrigerant Piping: Test with nitrogen to 2070 kPa on high pressure side and 1035 kPa on low side and refrigerant halide torch test.

.7 Low Pressure Ducts: Test for tightness such that leakage is inaudible and not detectable by feel.

.8 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air or nitrogen test medium and halide torch for refrigerant medium.

.9 When using water as test medium for system not using water or steam, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of work.

.10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

1.15 ELECTRICAL TESTING, ADJUSTING AND BALANCING

.1 Conduct and pay for tests of the following:

.1 Distribution system including phasing, voltage, grounding, load balancing, hi-pot testing of the 12.5/25kV system and transformer prior to energizing.

.2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer’s instructions.

.3 Carry out tests in presence of the Departmental Representative.

.4 Give advance notice of proposed time of tests so that the Departmental Representative can be represented at the tests.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for review by the Departmental Representative.

.7 Test all systems in accordance with details in appropriate sections.

.8 Testing methods and test results: in accordance with CSA, CEC, NETA MTS, and regulations of the supply authority and other authorities having jurisdiction.

.9 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

.10 Remove and replace with new materials all conductors that are found to be shorted or grounded.

.11 Conduct dielectric tests, hi-pot tests, insulation resistance tests and ground continuity tests as required by the nature of the various systems and equipment.

.12 With the systems completely connected and lamped, conduct the following tests on the power system:

.1 Control and Switching: test all circuits for the correct operation of devices, switches and controls.

.2 Polarity Tests: test all circuits for correct operation of devices, switches and controls.

.3 Voltage Tests: make a voltage test at the last outlet of each circuit. Maximum drop in potential permitted will be 2% on 120V, and 208V branch circuits. 2% on 208V feeder circuits and 5% on 600V feeder circuits. Correct any deficiency in this respect.

.4 Phase Balance: measure the load on each phase at each switchboard, splitter, distribution panel board and lighting and power panel board. Report results in writing to the Departmental Representative. Re-arrange phase connections as necessary to balance the load on each phase as instructed by the Departmental Representative with the re-arrangement being restricted to the exchanging of connections at the distribution points mentioned in this paragraph. After marking any such changes, make available to the Departmental Representative, drawings or marked prints showing the modified connections.

.5 Supply Voltage: measure the line voltage of each phase at the load terminals of the main breakers and report the results in writing to the Departmental Representative. Perform this test with the majority of electrical equipment in use.

.6 Motor Loading: measure the line current of each phase of each motor with the motor

operating under load and report the results in writing to the Departmental Representative. Upon indications of any imbalance or overload, thoroughly examine electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the Departmental Representative. Verify motor full load amps and overload relays are properly sized and adjusted accordingly.

.7 General Operations: energize and put into operation each and every electrical circuit and item. Make repairs, alterations, replacements, tests and adjustments necessary for a complete and satisfactory operating electrical system.

.13 Carry out tests covering "General Operation" at the time of acceptance of the work.

.14 Test all systems and obtain written confirmation from the manufacturer of each system that all components have been installed correctly and that the system is functioning as intended. Present separate certification for all systems including: fire alarm, power distribution, to the Departmental Representative and/or CxA.

.15 Provide labour, instruments, apparatus and pay all expenses required for the tests. The Departmental Representative reserves the right to demand proof of the accuracy of all instruments used.

.16 When tests are performed, the Departmental Representative and/or CxA may require that equipment be opened and removed from their housings to examine interior of equipment, terminations and connections. Provide all required labour and tools.

.17 Co-ordinate the testing of motors with the trades providing the equipment driven by the motors so that they are carried out at the time the driven equipment is put on test. In addition to the motor loading tests, provide labour and instruments to take and record all motor load readings required to supplement the tests on the driven equipment through various load sequences, as required by the trades involved.

.18 Immediately prior to building occupancy, test the entire electrical system by performing a loss and return of utility power test. Demonstrate the operation of:

.1 High and low voltage service equipment and metering.
.2 Exit and emergency lighting.
.3 Fire alarm operation during power outage, including remote monitoring system.
.4 EMCS system shut down and auto restart, including re-stabilization of systems after power return. Attach printouts as evidence of expected operation on all systems including all air handling systems and pump systems.
.5 User equipment shutdown and auto-restart.

1.16 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.

1.17 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.

1.18 PERFORAMNCE VERIFICATION (PV) REPORT

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

1.19 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.

1.20 CX SCHEDULES

.1 Prepare detailed Cx Schedule and submit to Departmental Representative and/or CxA for review and approval same time as project Construction Schedule. Include:

.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

.1 Design criteria, design intents.

.2 Pre-TAB review: 28 days after contract award, and before construction starts.

.3 Cx agents' credentials: 60 days before start of Cx.

.4 Cx procedures: 3 months after award of contract.

.5 Cx Report format: 3 months after contract award.

.6 Discussion of heating/cooling loads for Cx: 3 months before start-up.

.7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.

.8 Notification of intention to start TAB: 21 days before start of TAB.

.9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.10 Notification of intention to start Cx: 14 days before start of Cx.

.11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.

.12 Identification of deferred Cx.

.13 Implementation of training plans.

.14 Cx reports: immediately upon successful completion of Cx.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.

.3 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 Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

1.21 CX REPORTS

.1 Submit reports of tests, witnessed and certified by Departmental Representative and/or CxA 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 Departmental Representative and/or CxA.

1.22 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.

1.23 TESTS TO BE PERFORMED BY OWNER/USER

.1 None is anticipated on this project.

1.24 TRANING PLANS

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

1.25 FINAL SETTINGS

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

2.0 PRODUCTS

NOT USED

3.0 EXECUTION

1. SYSTEMS TO BE CX'D

.1 The proposed is generally comprised of the following systems to be Cx'd:

.1 Mechanical Equipment

.1 Washroom Exhaust Fans
.2 Propane
.3 Space Heat
.4 Space Cool
.5 Ventilation
.6 Conventional Controls
.7 Gas Metering
.8 Domestic water system (including water heaters)
.9 Plumbing fixtures
.10 Compressed air system
.11 Air handling units
.12 Exhaust fans (washroom, general)
.13 Air curtains
.14 BMS (controls) Operator Workstation (software)

.2 List of Electrical Equipment and Acceptance Tests:

.1 Preventable Inspections - Box, Conduit & Cable Installations
.2 Underground Services/Manholes
.3 Ground system inspection/report
.4 Digital Metering & Power System SCADA
.5 Protective Relay System
.6 Instrument Transformers
.7 25kV Switchgear and Circuit Breakers
.8 2.4kV Switchgear and Circuit Breakers
.9 Dry Type Transformer: Preventable Inspection
.10 Meggering and Hi-Pot Report
.11 DC Battery and Charging System
.12 Main switchboard
.13 Lighting Fixtures
.14 Lighting Controls
.15 Pole Mounted Fixtures

.16 Exterior lighting- control panel
.17 Emergency lighting Battery Unit
.18 Low Voltage lighting Control
.19 Motor Control Centre: Preventable Inspection
.20 Wiring Devices Checklist
.21 Fire Alarm System
.22 Implementation of Coordination Study Settings
.23 Consolidated Load Balance Report
.24 Certificates and/or Equipment Test Report
.25 Equipment Spare Parts Report
.26 Generic Acceptance Report
.27 Twelve Step Final Acceptance Report.

.3 List of Process Equipment and Acceptance Tests:
.1 Cranes.
.2 Other process equipment installed under the contract.

.2 The Contractor shall use the 5 phase Cx process and document the proper operation of the above systems, and the sub-systems they depend on, at least.

.3 This plan, or any other commissioning document or correspondence, does not relieve contractors from other testing, verification and commissioning duties that may be described in the project specifications or other agreements.

2. CXA'S DUTIES

.1 The Commissioning Authority (CXA) serves as an objective advocate for the Owner, oversees the commissioning process and presents final recommendations to the Owner regarding the performance of the commissioned building. Commissioning Authority will perform the following tasks:
.1 Support efforts to implement the Building Systems Commissioning requirements throughout the project.
.2 List all relevant systems included in the Commissioning scope. The contractors are to provide the detailed equipment lists, checklists, and schedules.
.3 Review the design requirements and basis of design.
.4 Help coordinate the commissioning-related activities of the "Commissioning Team".
.5 Review the Contract Documents to help verify inclusion of commissioning responsibilities.
.6 Review Contractor's testing plans and criteria for each of the 5 Cx Phases
.7 Organize and chair Cx meetings of the Commissioning Team; facilitate the process of distributing minutes to all Commissioning Team members as required.
.8 Monitor construction for commissioning-related installation issues.
.9 Review startup process by observing a sampling of measurements.
.10 Verify commissioning process of automatic control systems by:
.1 Observing a sampling of commissioning
.2 Obtaining and reviewing a copy of installation end-to-end check sheets.
.3 Reviewing sample trend logs
.4 Verifying documentation of the testing of control sequences under all operating modes.
.11 Verify the documentation of performance of all systems being commissioned and witness a sample of functional performance tests, and review whether the results meet test criteria.
.12 Verify reported Testing and Balancing results by observing a sampling of measurements.
.13 Review Operating and Maintenance Manuals for compliance with specified content.
.14 Review seasonal testing by contractors, and carry out warranty year duties.

.15 Compile a commissioning report in accordance with the requirements.

3. GENERAL CONTRACTOR`S DUTIES

.1 The General Contractor shall ensure that the following Cx procedures and tests are within the scope of appropriate trades and sub-trades, and that they are performed and documented as required to meet the Owner's Project Requirements:

System	PRE-START	STARTUP	MANUF START RPT	ADJUST	FUNCTIONAL PERFORMANCE	VALIDATION & VERIFICATION
Propane	□	□	□	□	□	□
Space Heat	□	□	□	□	□	□
Space Cool	□	□	□	□	□	□
Ventilation	□	□	□	□	□	□
Controls	□	□		□	□	□
Gas Metering	□	□		□	□	□
Power	□	□	□	□	□	□
Emergency Power	□	□	□	□	□	□
Interior Lighting	□	□		□	□	□
Exterior Lighting	□	□		□	□	□
Energy Performance	□	□		□	□	□
Interior Plumbing	□	□		□	□	□
DHW	□	□		□	□	□
Fire Alarm	□	□	□	□	□	□
Air Curtains	□	□		□	□	□
Cranes	□	□	□	□	□	□
Process Cooling	□	□	□	□	□	□

.2 General Contractor will select independent Commissioning Agents and/or Coordinators to ensure Cx activities are carried out to deliver a fully operational project including. Activities include:

.1 Planning, scheduling and organizing Cx.
.2 Monitoring operations Cx activities.
.3 Reviewing Cx documentation from operational perspective.
.4 Reviewing for performance, reliability, durability of operation, accessibility, maintainability,
.5 Verifying operational efficiency under conditions of operation.
.6 Supporting health, safety and comfort of occupants and O&M personnel.
.7 Monitoring of Cx activities, training, and development of Cx documentation.
.8 Working closely with other members of Cx Team.
.9 Certifying accuracy of reported results
.10 Certifying tabs and other results
.11 Developing BMM.
.12 Ensuring implementation of final Cx Plan.

.3 The General Contractor shall incorporate the mechanical and electrical Cx schedules into the project's construction schedule, and coordinate milestones with the CxA.

.4 The General Contractor shall oversee or delegate the preparation for testing and Cx. The following are examples:

DYNAMIC TEST READINESS CHECKLIST

	YES	NO	N/A	DATE	INITIALS
GENERAL					
Applicable tests such as duct/pipe pressure tests submitted					
Construction, painting, millwork and flooring complete in areas served					
Building rooms clean and ready for fan start-up; "All Clean" declared					
AIRSIDE MECHANICAL					
TAB contractor has reviewed the system and completed job preparation					
Ductwork complete, terminals installed, dampers open					
Duct and fan plenum cleaning complete					
Correct filters installed					
Piping complete, gauges installed					
Piping filled, tested, treated and documented					
Valves positioned for testing					
Equipment mounts complete, shipping bolts removed, vibration isolation active					
Equipment lubricated					
Manufacturer's start-up reports received					
PLUMBING & WATERSIDE MECHANICAL					
Drainage connected					
Piping systems flushed out and treated					
Air removed from the system					
DHW systems activated					
CONTROLS					
Control wiring complete					
Control panels mounted and connected					
Thermostats, sensors, actuators, etc. installed					
End-to-end checks completed					
POWER					

Permanent electrical connections complete, including power to starters, rotation checks and overload sizes and settings checked					
Lighting					
Fire alarm system as per ULC					
Other tests and checks cited herein					

VERIFICATION READINESS CHECKLIST

	YES	NO	N/A	DATE	INITIALS
MECHANICAL					
Balancing complete					
Drive changes complete (as required)					
Applicable inspections by authorities having jurisdiction received					
FIRE PROTECTION					
Fire alarm installed and tested					
CONTROLS					
Control program installed, and verification checklist or de-bugging documentation completed with changes noted. Major changes copied to Departmental Representative for review					

.5 The General Contractor shall ensure that Training Plans are developed by the appropriate trades and sub-trades, and that they are submitted to Departmental Representative for review.

.6 The General Contractor shall ensure that Seasonal and Deferred Testing is performed and documented by the appropriate trades and sub-trades, and that the reports are submitted to the CxA for review.

4. THE COMMISSIONING AGENT IS RESPONSIBLE FOR:

.1 Witnessing reported results for tests done by others.

.2 Witnessing TAB and other tests.

.3 Providing basis of design data not included in the Contract Documents.

.4 Preparing an equipment inventory and all functional testing criteria and checklists, as required by the specification and Commissioning Plan for all features and systems requiring commissioning.

.5 Reviewing commissioning checklists and test forms to ensure applicability to the project and providing comments to the Commissioning Authority.

.6 Attending commissioning activities as required to certify the site adaptation and related work meet the design intent and the project requirements.

5. FACILITY MANAGER: REPRESENTS LEAD ROLE IN OPERATION PHASE AND ONWARDS AND IS RESPONSIBLE FOR:
   .1 Receiving facility on completion.

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

6. GENERAL CONTRACTOR`S DUTIES
   .1 The Mechanical Commissioning Agent (MCA) shall be engaged by the Mechanical Trade Contractor to execute the requirements set out by the CaGBC's documentation, and the Contract Documents. The Commissioning Agent shall perform the following tasks:
      .1 Prepare an MCA's Commissioning Plan outlining each of the following five phases involved in the Cx process:
         .1 Phase 1 - System readiness.
         .2 Phase 2 - System start-up, testing, balancing, and adjustment.
         .3 Phase 3 - Verification of system performance.
         .4 Phase 4 - Demonstration and instruction.
         .5 Phase 5 – Seasonal testing and verification.
      .2 Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plan for all features and systems requiring commissioning.
      .3 Submit all required testing documentation to the Commissioning Authority and Departmental Representative for review.
      .4 Attend all commissioning meetings as required by the Commissioning Authority or Departmental Representative.
      .5 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.
      .6 Coordinate with Trade Contractors regarding sequencing of work. For example, before manufacturer site start-up of AHUs, safety features must be in place, ductwork must be ready, "All Clean" must be declared, power must be connected, hydronics must be cleaned, filled and free of air, controls must have been tested, etc.. Manufacturer start-up must be done prior to air balance, and so on.
      .7 Record and document the verification of the specified Pre-Start checks, including but not limited to the following:

Compliant make and model,
CSA label,
no visible damage,
proper equipment installation as per specifications and manufacturer's recommendations,
mounting as specified,
seismic restraint as specified,
electrical connection safe and complete,
safety controls & interlocks functional,
operating controls connected and adequately functional,
pre-start safety checks (where applicable),
connection of other services complete,
supporting or related systems in place,
access for maintenance in place,
strainers/filters clean and firmly in place,
isolation valves, dampers or switches in place, set correctly and functional,

alignment of drives and components correct,
proper coil drain pan draining,
bypasses in place and appropriately positioned open or closed,
vibration isolation adjusted,
insulation as specified and full coverage,
lubrication complete,
penetrations through fire separations in place as specified,
purges and pressure/leak tests complete and passed,
environment (cleanliness, clearance, cooling, drainage, freeze protection, etc.) good,
water tightness of mechanical service roof and exterior wall penetrations,
air and water distribution cleaned degreased,
charges & pressures correctly set; proper air and water pressure relief in place.

.8 Record and document the verification of the specified Startup checks, including but not limited to the following:

pre-start test passed and conditions still in effect,
qualified personnel present,
confirmation of regulatory authorities' inspections, including reports,
manufacturer or vendor representative present,
factory technician test and start-up (where applicable),
correct rotation,
safety controls operate properly,
operating controls function properly
sequencing correct,
desired temperature/pressure/humidity maintained,
electrical characteristics conform to ratings,
no leaks,
noise as per ratings,
obtain certificates of approval and for compliance with regulations from Authorities Having Jurisdiction; include copies of certificates with startup reports.

.9 Immediately after start-up, submit Pre-start checklists and Start-up checklists, signed by the person performing the start-up, to the CxA.

.10 Prepare Functional performance test checklists containing the step-by-step procedures by which the functional requirements of a system, and its various components, will be confirmed. System's response is to be verified and clearly documented according to the respective manufacturer's written instructions, this plan, and the Contract Documents.

.11 The MCA is to prepare Functional Performance Test Checklists, including but not limited to the following:

.1 individual test procedures,
.2 the expected system response or acceptance criteria for each procedure,
.3 a place to record the actual response or findings,
.4 comments pertinent to the ongoing performance of the system and building.

.12 Each control sequence and strategy shall be tested, verified and documented by the Contractor, including:

.1 start-up, and shut down,

.2 modulation up and down over unit's range of capacity, and/or component staging,
.3 unoccupied and manual modes,
.4 power failure and backup/restart,
.5 abnormal or emergency modes,
.6 interlocks and alarms,
.7 sensor calibration.

.13 The checklists are to confirm the Owner's Project Requirements and design intent with respect to the following:
.1 electrical characteristics
.2 flows,
.3 pressures,
.4 temperatures
.5 overall system control programming and automatic performance and alarms.
The goal is to determine whether the installation functions properly under all specified conditions, not that it can be shown to function under one condition. Functional Performance Checklists, signed by the person performing the tests, must be submitted to the CxA immediately after testing.

.14 Participate in troubleshooting those systems that do not meet the functional testing criteria and provide all necessary follow-up testing and documentation.

.15 Submit completed functional test documentation to the Commissioning Authority and Mechanical Design Consultant for inclusion into the final Commissioning Report.

.16 Within 2 months of award, provide a preliminary Cx schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion to the Project Manager and the CxA. Update the schedule as appropriate. Submit information to the Project Manager on a monthly basis to refine the schedule for the commissioning phase of the work. Provide the following information:
.1 Building "All Clean"
.2 Equipment start-up schedule.
.3 Submission dates for the various documents required prior to substantial performance.
.4 Timing of the various phases of the commissioning, testing, balancing and training/demonstration process.

.17 Provide a certificate of building cleanliness: An "All Clean" declaration is to be signed by Departmental Representative and General Contractor. It shall signify that the building and ductwork is adequately clean to allow air distribution start-up without contaminating coils, controls, fan chambers, etc.

.18 Provide regular updates on project progress, of and witnessing of Cx. MCA to contact Cx Authority prior to Cx, and to provide 48 hours' notice of tests.

.19 Provide a Commissioning Report as specified in the contract documents and herein.

.20 Plan, coordinate and execute Owner and Building Operator training and demonstrations as set out in the specifications and Commissioning Plan.

.21 Provide two follow-up site visits to re-test and verify occupancy and seasonal-sensitive systems after the facility has been fully occupied. Coordinate seasonal performance verification with CxA. Tests must be done during normal (high) occupancy working hours, and at near winter design conditions, and near summer design conditions. Cx Agent shall review equipment operation, status of energy saving strategies. Submit a report of findings to CxA for each visit. Report to contain the following:
.1 Verification of whether conditions meet the Owner Requirements (as documented by Cx Authority), and whether equipment performance meets the design intent.
.2 List of out-of-tolerance conditions, and malfunctioning equipment, components and systems.

Recommendations addressing each problem that was identified.

Seasonal Test Report – **Mechanical Cx Agent** - Required Sections:

	WINTER		**SUMMER**
	Date: Time of visit: Outdoor Temperature: Outdoor Cloud Cover: Areas too hot: Areas too cold: Areas Humidity: Areas With High Noise:		Date: Time of visit: Outdoor Temperature: Outdoor Cloud Cover: Areas too hot: Areas too cold: Areas Humidity: Areas With High Noise:
	Air distribution equipment operating properly: Occupant Concerns Operator Concerns		Air distribution equipment operating properly: Occupant Concerns Operator Concerns
	Owner Requirements being met for plumbing. List of Equipment Functioning Improperly **Problems:**		*Owner Requirements* being met for plumbing. List of Equipment Functioning Improperly **Problems:**
1	Description: Solution: Recommendation:	1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:	2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:	3	Description: Solution: Recommendation:

.22 Depending on the details of the contractors' contracts among themselves, either the Mechanical Cx Agent, or the mechanical trade shall provide further Seasonal Testing as follows:

Seasonal Test Report – **Mechanical Contractor** Required Sections

	Six Months After Occupancy
	Date: Time of visit: Outdoor Temperature: Outdoor Cloud Cover: Areas too hot: Areas too cold: Areas Humidity: Areas With High Noise:
	Air distribution equipment operating properly: Filters not bypassing and clean Vibration/noise acceptable Leaks found and plugged Warranty Issues
	Owner Requirements being met (details) List of Equipment Functioning Improperly **Problems:**
1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:

Provide a report which describes problems, solutions, and suggested improvements revealed in the first months of operation (Word and Excel format).

7. TESTING & BALANCING AGENT DUTIES

.1 The Testing and Balancing Agent (TAB) shall be engaged by the Mechanical Trade Contractor to execute the contract requirements to meet the design intent and the Commissioning Authority. The TAB Agent must perform the following tasks:

.1 Prepare functional testing criteria (including specific documentation) as required by the Commissioning Plan for all features and systems requiring testing or balancing.

.2 Submit all required testing documentation to the Commissioning Authority and Mechanical Consultant for review, including schedule, proposed procedures, and sample forms.

.3 Visit the site prior to TAB to review adequacy (quantities, locations and types) of balance-related devices. Provide a pre-TAB report of findings to the CxA.

.4 Attend all commissioning meetings as required by the Commissioning Authority.

.5 Provide Cx Authority with 7 days' notice of TAB testing periods.

.6 Execute or delegate all TAB tasks as set out in the final functional testing criteria documents.

.7 Coordinate with trade contractors regarding sequencing of work. For example, before balancing, ductwork must be ready, safeties must be functioning, power must be connected, hydronics to be filled and free of air, controls to have been tested, and, in the case of air distribution, the "All Clean" status must have been granted. Manufacturer start-up must be done prior to air balance, and so on.

.8 Provide the following TAB Process Quality Assurance Review to the CxA 2 months prior to commencement of balancing:

PROJECT: **NRC HAA**
DATE: (Month)

	Test process	Test Equip	Equip Calibration	Test Staff	Staff Experience	Pass/Fail Criteria
AHU CFM			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Max/Min OAD Volumes			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
Exhaust Fan Flows			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Diffuser Flows			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
Pump Flows			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Heat Terminals			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
DX AC			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	heat, cool, air change, OA CFM, controls

.9 At the completion of balancing, and following review of the TAB report, visit the site with the CxA and retest a sampling of balanced air. The CxA could require that up to 5% of terminals be verified, depending on the results of initial tests.

.10 Participate in troubleshooting those systems that do not meet the functional testing criteria and provide all necessary follow-up testing and documentation.

.11 Submit completed functional test documentation to the Commissioning Authority and Departmental Representative for inclusion into the final Commissioning Report.

.12 Provide O&M Manuals as specified. Provide sections of O&M Manual for inclusion in Systems Recommissioning Manual to CxA, in Word and Excel file format, as required.

.13 Plan and execute demonstrations and training as set out in the Commissioning Plan or specifications.

.14 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done so that systems' performance is reviewed during both warm (summer) days and cold (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

Seasonal Test Report – TAB Agent- Required Sections:

Three, Six or Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:
Areas too hot:
Areas too cold:
Areas Humidity:
Areas With High Noise:

Air distribution equipment operating properly:
- Motor rotation
- Volumes still as per design intent
- Supply Air Temperatures appropriate and efficient
- Outdoor Air volumes minimal for heating, max for free cooling

Flow and ventilation Owner Requirements being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:

8. CONTROLS CONTRACTOR DUTIES

.1 The Controls Trade Contractor shall provide a Commissioning Agent (CCA) from their staff to:

.2 Prepare a CCA's Commissioning Plan outlining each of the following five phases involved in the Cx process:
- .1 Phase 1 - System readiness (clean, grounded, interlocked, mounted properly, accessible, etc.).
- .2 Phase 2 - System start-up, testing, balancing, and adjustment.
- .3 Phase 3 - Verification of system performance.
- .4 Phase 4 - Demonstration and instruction.
- .5 Phase 5 – Seasonal testing and verification.

.3 Prepare Functional Performance Test Checklists as a record that all controls provided have been inspected, checked and verified for proper installation and performance. Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plan for all features and systems requiring commissioning. Example checklists are as follows:

CONTROLLERS	**Controller**	**Card**	**Card**
ITEM INSPECTED	1	**Expansion Module 1**	**Expansion Module 2**
	Y/N/na	Y/N/na	Y/N/na
Shop drawings approved			
Software licensing in place			
QC inspection report reviewed and deficiencies corrected			
Device matches specified products			
Devices mounted and restrained properly			
Number of control panels & system architecture correct			
Number of points monitored is correct			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Devices and components tagged and identified at all terminations, splices, and junctions			
Point lists present inside panel			
Software and hardware alarms are in place			
Connection to EMCS Server DDC network is made			

CONTROLLERS	**Controller**	**Card**	**Card**
ITEM INSPECTED	1	**Expansion Module 1**	**Expansion Module 2**
	Y/N/na	Y/N/na	Y/N/na
Graphics accepted by ME & Owner			
BACnet interface between proprietary controls and DDC system are functioning properly			
Trend-log in place for all necessary inputs, outputs, variables			
Operating software complete, including energy strategies (weekly and annual schedules, economizers, optimized water and air set points, optimized motor speeds, etc.).			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

INPUT POINTS	**Card**	**Inputs**	
ITEM INSPECTED	**1**	1ip1	1ip2
		Y/N/na	Y/N/na
Shop drawings approved			
QC inspection report reviewed and deficiencies corrected			
Devices matches specified products			
Devices mounted and restrained properly			
Number of points monitored is correct			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Sensors and devices calibrated and verified			
Devices and components tagged and identified at all terminations, splices, and junctions			
Trend-log in place for all necessary (inputs, outputs, variables)			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

OUTPUT POINTS	**Card**	**Outputs**	
ITEM INSPECTED	**1**	1OP1	1OP2
	Y/N/na	Y/N/na	Y/N/na
Shop drawings approved			
Sequences of operation are understood and make sense			
QC inspection report reviewed and deficiencies corrected			
Devices matches specified products			
Devices mounted and restrained properly			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Sensors and devices calibrated and verified			
Devices and components tagged and identified at all terminations, splices, and junctions			
Software and hardware alarms are in place			
BACnet interface between proprietary controls and DDC system are functioning properly			
Trend-log in place for all necessary (inputs, outputs, variables)			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

.4 If a digital control, Building Automation System, or EMCS is not installed, then the requirements relating to servers, networks, graphics, BACnet, etc. are not applicable. However, other items listed above that are applicable to conventional controls shall be verified and documented.

.5 Submit all required testing documentation to the Commissioning Authority and Departmental Representative for review.

.6 Attend all commissioning meetings as required by the Commissioning Authority or Departmental Representative.

.7 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.

.8 Verify that systems are functionally meeting the design intent, and produce a Cx Report documenting this, and identifying where design intent is not being met.

.9 Controls Contractor to provide O&M Manual, including sequences of operation, network diagrams, graphics, shop drawings, recommended post-occupancy calibration, test and maintenance procedures, etc. to CxA. Submit in Word and Excel file format, as required.

.10 Controls Contractor to provide training and training materials for temperature controls, controls operation and reporting, energy conservation strategies, and other control items having an impact on building or system operation.

.11 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done during normal working hours, and so that systems' performance is reviewed during both warm (summer) days and cold (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

Seasonal Test Report – **Controls Contractor** - Required Sections:

Three, Six or Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:

Areas too hot:
Areas too cold:
Areas Humidity:
Areas With High Noise:

Control system operating properly:	Sequences in "auto" Minimal simultaneous heating and cooling Time Schedules correct

Owner Energy and Temp Control Requirements being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description:	Solution: Recommendation:
2	Description:	Solution: Recommendation:
3	Description:	Solution: Recommendation:

9. ELECTRICAL TRADE CONTRACTOR DUTIES

.1 The Electrical Trade Contractor shall provide a Commissioning Agent or Coordinator (ECA) to

.1 Prepare an ECA's Commissioning Plan outlining each of the following five phases involved in the Cx process:

.1 Phase 1 - System readiness (clean, grounded, interlocked, mounted properly, accessible, etc.).

.2 Phase 2 - System start-up, testing, balancing, and adjustment.

.3 Phase 3 - Verification of system performance.

.4 Phase 4 - Demonstration and instruction.

.5 Phase 5 – Seasonal testing and verification.

.2 Conduct and pay for tests of the following:

.1 Low voltage breaker set-up, calibration, testing and reporting.

.2 Testing protection and control DC supply, voltage, current and wiring systems.

.3 Megger testing

.4 Voltage testing

.5 Phase rotation testing

.6 Motors heaters and controls.

.7 Polarization testing of receptacles and utilization devices

.8 Lighting systems and controls

.9 Illumination testing

.10 Testing and reporting and certification of fire alarm and emergency alarm systems.

.11 Such additional testing as required for completion of the test forms laid out in 01 91 31

.3 Furnish manufacturer's certificate or letter confirming that entire installation relating to their product has been installed to manufacturer's instructions.

.4 Carry out tests in presence of the Commissioning Authority.

.5 Give advance notice of proposed time of tests so that the Commissioning Authority can be represented at the tests.

.6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.7 Submit test results for review by the Commissioning Authority.

.8 Test all systems in accordance with details in appropriate sections.

.9 Testing methods and test results: in accordance with CSA, CEC, NETA MTS, and regulations of the supply authority and other authorities having jurisdiction.

.10 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

.11 Remove and replace with new materials all conductors that are found to be shorted or grounded.

.12 With the systems completely connected and lamped, conduct and document the following tests on the power system:

.1 Control and Switching: test all circuits for the correct operation of devices, switches and controls.

.2 Polarity Tests: test all circuits for correct operation of devices, switches and controls.

.3 Voltage Tests: make a voltage test at the last outlet of each circuit. Maximum drop in potential permitted will be 2% on 120V, and 208V branch circuits. 2% on 208V feeder circuits, and 5% on 600V feeder circuits. Correct any deficiency in this respect.

.4 Phase Balance: measure the load on each phase at each switchboard, splitter, distribution panel board and lighting and power panel board. Report results in

writing to the Commissioning Authority. Re-arrange phase connections as necessary to balance the load on each phase as instructed by the Commissioning Authority with the re-arrangement being restricted to the exchanging of connections at the distribution points mentioned in this paragraph. After marking any such changes, make available to the Commissioning Authority, drawings or marked prints showing the modified connections.

.5 Supply Voltage: measure the line voltage of each phase at the load terminals of the main breakers and report the results in writing to the Commissioning Authority. Perform this test with the majority of electrical equipment in use.

.6 Motor Loading: measure the line current of each phase of each motor with the motor operating under load and report the results in writing to the Commissioning Authority. Upon indications of any imbalance or overload, thoroughly examine electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the Departmental Representative. Verify motor full load amps and overload relays are properly sized and adjusted accordingly.

.7 General Operations: energize and put into operation each and every electrical circuit and item. Make repairs, alterations, replacements, tests and adjustments necessary for a complete and satisfactory operating electrical system.

.13 Carry out tests covering "General Operation" at the time of acceptance of the work.

.14 Test all systems and obtain written confirmation from the manufacturer of each system that all components have been installed correctly and that the system is functioning as intended. Present separate certification for all systems including: fire alarm, power distribution, to the Commissioning Authority.

.15 Provide labour, instruments, apparatus and pay all expenses required for the tests. The Departmental Representative reserves the right to demand proof of the accuracy of all instruments used.

.16 When tests are performed, the Departmental Representative may require that equipment be opened and removed from their housings to examine interior of equipment, terminations and connections. Provide all required labour and tools.

.17 Co-ordinate the testing of motors with the trades providing the equipment driven by the motors so that they are carried out at the time the driven equipment is put on test. In addition to the motor loading tests, provide labour and instruments to take and record all motor load readings required to supplement the tests on the driven equipment through various load sequences, as required by the trades involved.

.18 Immediately prior to building occupancy, test the entire electrical system by performing a loss and return of utility power test. Demonstrate the operation of:

.1 High and low voltage service equipment and metering.

.2 User equipment shutdown and auto-restart.

.19 Prepare Functional Performance Test Checklists that will be a record that all electrical services provided have been inspected, checked and verified for proper installation and performance. Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plans for all features and systems requiring commissioning. The system list overview is; but not limited to the following:

	Cx Plans			Cx Execution			
CHECKLIST	**Submitted**	**Reviewed**	**Updated**	**Complete**	**Reviewed**	**Notes**	**Comments**
Molded Case Circuit Breakers							
Installation of Electrical Equipment: Conduits, trays Cables and Boxes							
Installation of Electrical Equipment: Utilization Devices – Outlets and Heating/Cooling							
Interior Lighting Systems							
Motor Control and Motor Starters							
Variable Frequency Drive							

Note: there may be Cx requirements in other sections of the specification.

.20 Submit all required testing documentation to the Commissioning Authority and Departmental Representative for review. For example:
- .1 Implementation of Coordination Study Settings
- .2 Certificates and/or Equipment Test Report
- .3 Equipment Spare Parts Report
- .4 Generic Acceptance Report
- .5 Final Acceptance Report.

.21 Attend all commissioning meetings as required by the Commissioning Authority or Departmental Representative.

.22 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.

.23 Verify that systems are functionally meeting the design intent, and produce a Cx Report documenting this, and identifying where design intent is not being met.

.24 Electrical Trade Contractor to provide O&M Manual, sequences of operation, recommended post-occupancy calibration, test and maintenance procedures, etc. to CXA for inclusion in Systems Recommissioning Manual. Submit in Word and Excel file format, as required.

.25 Electrical Trade Contractor to provide training and training materials

.26 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done during normal working hours, and so that systems' performance is reviewed during both long (summer) days and short (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

.27 Allow minimum 8 hours for each of two site visits for seasonal/deferred testing and reporting. 16 hours total.

Seasonal Test Report – **Electrical Contractor & Cx Agent** - Required Sections:

Three to Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:

Areas too dark:
Areas too bright:

Lighting

Interior light levels after sundown

Power equipment operating properly:

Labelling and cleanliness
Breakers holding
Motor starters in Auto
Power quality still good; phase output, phase to phase output, power factor, etc. acceptable
Line voltage controls by Elect operating properly

Owner Requirements for lighting and energy being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description:	Solution:
		Recommendation:
2	Description:	Solution:
		Recommendation:
3	Description:	Solution:
		Recommendation:

10. REQUIRED WRITTEN WORK PRODUCTS – DEPARTMENTAL REPRESENTATIVE, AND TRADES OTHER THAN CX AGENCIES, CONTROLS AND ELECTRICAL

.1 COMMISSIONING AUTHORITY

.1 Schematic design review.
.2 CxA'S Cx Plan (this document),
.3 Review of construction documents,
.4 Commissioning Binder, Systems Manual and 10 Month Warranty Report.

.2 DEPARTMENTAL REPRESENTATIVE

.1 Contract Documents clearly require that features, equipment and systems are to be installed in such a way that TAB and commissioning are facilitated. The documents shall also identify Trade Contractors' responsibilities for execution and documentation of the Commissioning Process.
.2 Shop drawing process:
.1 The contractor is to forward the shop drawings to Departmental Representative for review
.2 The Departmental Representative will forward shop drawings to the CxA..
.3 All Change Orders and Site Instructions are to be copied to the CxA. Departmental Representative to verify that changes are in keeping with the Project Requirements.
.4 Reviews and approvals of insulation, air barrier, walls, windows, roof and skylights by Departmental Representative to document that envelope assemblies control water and air leakage, and condensation properly - so that negative impact on energy required is minimized, and negative impact on IAQ is eliminated. CXA to receive copies of all such Field Reviews and test reports.
.5 Training overview material is required from Departmental Representative, including how the building keeps air and water out; what kind of envelope maintenance may be required and when; unusual items, etc. Design intents are required from the contract document.
.6 Reviews and acceptance of electrical power and lighting components and of proper system installation and operation.
.7 Reviews and acceptance of mechanical components, and of proper system installation and operation.
.8 Building "All Clean" certification is required to allow fan operation. The Departmental Representative and General Contractor shall jointly sign a letter declaring that the building and systems are clean enough to run the fans.
.9 Reviews of TAB and commissioning submittals and documents by Departmental Representative, with written acceptance forwarded to the CXA for inclusion in the Commissioning Report.

.3 TRADE CONTRACTORS

.1 Construction Schedule integrating all divisions of the work, and allowing adequate time for submittal reviews, commissioning of equipment, verification of systems' operation, and the demonstration to (and training of) the Owner, review of operating and maintenance and Cx manuals. The schedule shall include, but not be limited to, the following items:
.1 Installation and testing of piping systems and equipment, including protection of heat exchangers during cleaning.
.2 Installation and cleaning of air distribution systems and equipment.
.3 Connection of electrical services to equipment by electrical trade contractor.
.4 Chemical cleaning and treatment of water distribution systems.
.5 Control system installation.
.6 Pre-start checks.

.7 Start-up of equipment and systems.
.8 Air/Water balancing, including samples witnessed by CXA.
.9 Check-out of control systems.
.10 Commissioning of systems, including samples witnessed by CXA.
.11 Correction of deficiencies and retests.
.12 Demonstration of systems and equipment to Departmental Representative and other representatives of the project.
.13 Preparation of maintenance manuals and as-built drawings.
.14 Submission of the various documents required prior to substantial performance.
.15 Project closeout documents.

.2 Contractor Submittal Drawings and Equipment Data: Submittals will be reviewed by Departmental Representative and CXA to help verify that the systems and equipment being supplied are consistent with the required commissioning test procedures, and if not, that the variances are acceptable to the Team, and that commissioning checklists are revised accordingly.

.3 Approved Pre-start checklists and Start-up checklists must be completed prior to start-up of each specific system or piece of equipment. Checklists, signed by the person performing the start-up, must be submitted to the CXA immediately after start-up.

.4 Functional performance verifications for equipment and systems must be performed, and redone until proper system performance is verified.

.5 As-built drawings forwarded by installing contractors. The various trades shall mark-up the contract drawings to indicate design or layout changes that took place during construction.

.6 Training materials by sub-trades to meet the requirements of See Section 01 91 41.

.7 Reports on seasonal testing and documentation of proper operation during warrantee period.

.8 See other sections for specific MCA, ECA, CCA, and TAB Trade requirements and duties.

.9 The following tables provides a <u>partial</u> checklist of submittals required by each sub-trade:

DESCRIPTION	FORMAT			FROM			
	PDF	.doc .xls	sign-off	Consultant	Cx Agent	TAB	Mech Contractor
Cx Plan (5 Phases), Process, Inventories and Checklists		☐			☐	☐	☐
Cx Schedule (5 Phases)		☐			☐	☐	☐
Preliminary O&M Manual from Cx Agents		☐			☐	☐	☐
Reviewed TAB Report	☐	☐		☐			
TAB Report Test Performance Sheets	☐	☐			☐	☐	☐
Reviewed O&M Manual	☐		☐	☐			
System Descriptions and all sections described in Contract Doc's	☐	☐			☐	☐	
Validation Of Testing and Balancing			☐		☐	☐	
Training Plans		☐			☐	☐	☐
Validation of Fire Damper Operation			☐		☐	☐	
Training Materials and Validation of Owner's Training	☐	☐	☐	☐	☐	☐	☐
Deferred & Seasonal System Tests, Adjustments and Reports	☐				☐	☐	☐

DESCRIPTION	FORMAT				
	PDF	.doc .xls	sign-off	Mech Contractor	Controls Contractor
Controls Cx Plan (5 Phases), Inventories and Checklists		☐			☐
Cx Schedule (5 Phases)		☐			☐
Preliminary O&M Manual from Cx Agents		☐		☐	☐
Signed Commissioning Checklists	☐	☐		☐	☐
DDC & Other Controls Sequences of Operation	☐	☐			☐
Controls Checkouts	☐	☐			☐
Recommended Post-Occ Calib, Test & Maint Procedures		☐			☐
Training Plan	☐	☐		☐	☐
Training Materials and Validation of Owner's Training		☐	☐	☐	☐
Seasonal System Tests, Adjustments and Reports		☐		☐	☐

DESCRIPTION	FORMAT			FROM
	pdf	.doc .xls	Sign off	Electrical Contractor
Cx Plan (5 Phases) Inventories and Checklists				☐
Cx Schedule (5 Phases)				☐
Preliminary O&M Manual from Cx Agents		☐		☐
Validation of Power Systems Operation			☐	☐
Reviewed Commissioning Report	☐	☐		
Start-up and Operation Requirements – Electrical Systems			☐	☐
Signed Commissioning Checklists	☐	☐		☐
Reviewed O&M Manual	☐		☐	☐
System Descriptions	☐	☐		
Reviewed Controls Manual	☐	☐		
Line Voltage Controls Checkouts	☐	☐		☐
Electrical Training Plan				☐
Validation of Penetrations Through Separations			☐	☐
Validation of Seismic Restraint Installation			☐	☐
Validation of Vibration Isolation			☐	☐
Validation of Electrical System Demonstration			☐	☐
Training Materials and Validation of Owner's Training	☐	☐	☐	☐
Problems & Suggestions in First Few Months		☐		☐
Seasonal System Tests, Adjustments and Reports	☐			☐

DESCRIPTION	FORMAT			FROM
	PDF	.doc .xls	sign-off	Electrical Trade
Cx Schedule (5 Phases)				☐
Power Shop Drawings	☐			☐
Electrical Training Plan	☐			☐
Validation of Fire Stopping	☐		☐	☐
Letters of Assurance from Trades' Engineers	☐			☐
Validation of Items To Be Handed Over To Owner	☐		☐	☐
Validation of Electrical System Demonstration	☐		☐	☐
Training Materials and Validation of Owner's Training	☐	☐	☐	☐
Record Drawings	☐	☐	☐	☐

END OF SECTION 01 91 31

1.0 GENERAL

1.1 SUMMARY

.1 Section Includes:

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

1.2 INSTALLATION/START-UP CHECK LISTS

.1 Include the following data:

.1 Product manufacturer's installation instructions and recommended checks.

.2 Special procedures as specified in relevant technical sections.

.3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by 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 Management Manual (BMM) at completion of project.

.5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

.1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.

.2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

.1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

.2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

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

1.5 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Contractor provides project-specific Commissioning forms with Specification data included.

.2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.

.3 Confirm operation as per design criteria and intent.

.4 Identify variances between design and operation and reasons for variances.

.5 Verify operation in specified normal and emergency modes and under specified load conditions.

.6 Record analytical and substantiating data.

.7 Verify reported results.

.8 Form to bear signatures of recording technician.

.9 Submit immediately after tests are performed.

.10 Reported results in true measured SI unit values.

.11 Provide 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).

1.6 LANGUAGE

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

END OF SECTION 01 91 33

1.0 GENERAL

1.1 SUMMARY

.1 Section Includes:
This Section specifies roles and responsibilities of Commissioning Training.

.2 Related Sections:

.1	General Commissioning (Cx) Requirements	Section 01 91 13
.2	Commissioning (Cx) Plan	Section 01 91 31

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

.1 Engineer will provide:
- .1 Descriptions of systems.
- .2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
- .1 Start-Up, operation, shut-down of equipment, components and systems.
- .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
- .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

.3 Contractor and equipment manufacturer to provide instruction on:
- .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

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

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Training materials to include:
- .1 "As-Built" Contract Documents.
- .2 Operating Manual.
- .3 Maintenance Manual.

.4 Management Manual.
.5 TAB and PV Reports.

.3 Project Manager, 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 Agent will evaluate training and materials.

.3 Upon completion of training, provide written report, signed by Instructors, witnessed by Commissioning Agent.

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 hours including one half hour for breaks, and one person week shall be five person days.

.4 Submit sessions schedule and list of representatives to the Departmental Representative for approval 30 days prior to course starting date. Confirm attendance of course by written notification to all participants, followed by verbal confirmation just prior to course starting date.

.5 Submit final copies of record drawings and operating and maintenance manuals to Departmental Representative.

.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 8 hours of instruction to conduct systems training courses addressing the following topics:
- .1 Air Systems:
  - .1 Review operation of systems and equipment:
    - .1 Propane gas systems
    - .2 All exhaust systems
  - .2 Review equipment maintenance.
- .2 Site Services:
  - .1 Sanitary/storm/domestic water.

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 hours including one half hour for breaks, and one person week shall be five person days.

.4 Submit sessions schedule and list of representatives to the Departmental Representative for approval 30 days prior to course starting date. Confirm attendance of course by written notification to all participants, followed by verbal confirmation just prior to course starting date.

.5 Submit final copies of record drawings and operating and maintenance manuals to Departmental Representative. Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.

.6 Systems Course: Allow a minimum of 4 hours of instruction to conduct systems training courses addressing the following topics:
- .1 Standard Power Systems:
  - .1 Review operation of systems and equipment.

END OF SECTION 01 91 41

1.0 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 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, co-ordinate 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 manufacturer’s 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 Manufacturer's data and recommendations relating: 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 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 Ducting leakage test reports.

.4 TAB and PV reports.

.5 Charts of valves and steam traps.

.6 Copies of posted instructions.

.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 Assist Departmental Representative with preparation of BMM.

1.8 LANGUAGE

.1 Provide documentation in English only.

1.9 IDENTIFICATION OF FACILITY

.1 When submitting information to Departmental Representative for incorporation into BMM, use following system for identification of documentation:

.1 As advised by Departmental Representative.

1.10 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.

END OF SECTION 01 91 51

1.0 GENERAL

1.1 RELATED WORK

.1	Excavating, Trenching and Backfilling	Section 31 23 33.01
.2	Concrete Reinforcing	Section 03 20 00
.3	Cast-In-Place Concrete	Section 03 30 00

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
- .1 CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CSA-O86-14, Engineering Design in Wood.
- .3 CSA O121-08, Douglas Fir Plywood.
- .4 CSA O151-09, Canadian Softwood Plywood.
- .5 CSA O153-13, Poplar Plywood.
- .6 CAN/CSA-O325-07, Construction Sheathing.
- .7 CSA O437 Series-93 (R2006), Standards for OSB and Waferboard.
- .8 CSA S269.1- Falsework for Construction Purposes.
- .9 CAN/CSA-S269.3-M92 (R2003), 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.

1.3 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. Submit schedule B and C-B as per BCBC 2012.

.3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 33 – Health and Safety Requirements.

.4 Co-ordinate submittal requirements and provide submittals required by Section 01 33 00.

.5 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 and Comply with CAN/CSA-S269.3 for formwork drawings.

.6 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.

.7 Indicate sequence of erection and removal of formwork/falsework as directed by Departmental Representative.

.8 The contractor is responsible for the design of all formwork and shoring and for complying with all Workers' Compensation Board regulations pertaining to formwork construction,

design and inspection. Formwork and shoring shall be designed by a qualified professional engineer registered or licensed in British Columbia.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with Section 01 51 00 – Temporary Facilities.

.2 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 Materials and resources in accordance with Section 01 61 00 – Product Requirements.

.2 Formwork materials:

.1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121, CAN/CSA-O86, CSA O437 Series, CSA-O153.

.2 Rigid insulation board: to CAN/ULC-S701.

.3 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.

.4 Form liner:

.1 Plywood: high density overlay, medium density overlay, Douglas Fir to CSA O121, Canadian Softwood Plywood to CSA O151 or Poplar to CSA O153 grade, square edge, 20 mm thick.

.5 Form release agent: non-toxic, biodegradable, low VOC.

.6 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 70 and 110s Saybolt Universal 15 to 24 mm^2/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.

.7 Falsework materials: to CSA-S269.1.

.8 Sealant: to Section 07 92 00 – Joint Sealants.

3.0 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 Departmental 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 25 mm chamfer strips on external corners and/or 25 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, 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 Line forms for following surfaces:
- .1 Exposed faces of abutments, wingwalls, piers and pylons: do not stagger joints of form lining material and align joints to obtain uniform pattern. Secure lining taut to formwork to prevent folds.
- .2 Pull down lining over edges of formwork panels.
- .3 Ensure lining is new and not reused material.
- .4 Ensure lining is dry and free of oil when concrete is poured.
- .5 Application of form release agents on formwork surface is prohibited where drainage lining is used.
- .6 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
- .7 Cost of textile lining is included in price of concrete for corresponding portion of Work.

.13 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND SHORING

.1 Leave formwork in place for following minimum periods of time after placing concrete.
- .1 Three days for walls and sides of beams.
- .2 Three days for columns.
- .3 Twenty eight days for beam soffits, slabs, decks and other structural members, or one days when replaced immediately with adequate shoring to standard specified for falsework.
- .4 One day for footings and abutments.

.2 Remove formwork when concrete has reached 75% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.

.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 03 10 00

1.0 GENERAL

1.1 RELATED WORK

.1 Concrete Forming and Accessories — Section 03 10 00

.2 Cast-In-Place Concrete — Section 03 30 00

1.3 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 A143/A143M-03, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
- .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-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CSA-A23.3-14, Design of Concrete Structures.
- .3 CAN/CSA-G30.18-M92(R2002), Billet-Steel Bars for Concrete Reinforcement, A National Standard of Canada.
- .4 CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .5 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles, A National Standard of Canada.
- .6 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.

1.4 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 Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.

.5 Indicate sizes, 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 Class B tension lap splices where indicated unless otherwise indicated.

.5 When Chromate solution is used as replacement for galvanizing non-prestressed reinforcement, provide product description for review by Departmental Representative prior to its use.

.6 Quality Assurance: Provide the following to the Departmental Representative.

.1 Mill Test Report: upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.

.2 Upon request submit in writing to Departmental Representative proposed source of reinforcement material to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with Section 01 51 00 – Temporary Facilities.

.2 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 Materials and resources in accordance with Section 01 61 00- Product Requirements.

.2 Substitute different size bars only if permitted in writing by Departmental Representative.

.3 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.

.4 Reinforcing steel to be welded: weldable low alloy steel deformed bars to CAN/CSA-G30.18, grade 400W.

.5 Cold-drawn annealed steel wire ties: to ASTM A497/A497M.

.6 Deformed steel wire for concrete reinforcement: to ASTM A497/A497M.

.7 Welded steel wire fabric: to ASTM A185/A185M.

.1 Provide in flat sheets only.

.8 Welded deformed steel wire fabric: to ASTM A497/A497M.

.1 Provide in flat sheets only.

.9 Epoxy Coating of non-prestressed reinforcement for exterior roadway pavement: to ASTM A775/A775M.

.10 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.

.11 Mechanical splices: subject to approval of Departmental Representative.

.12 Plain round bars: to CSA-G40.20/G40.21.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

.1 ACI 315R unless indicated otherwise.

.2 Obtain Departmental Representative's approval for locations of reinforcement splices other than those shown on placing drawings.

.3 Upon approval of Departmental 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 Upon request, provide Departmental 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 Upon request inform Departmental Representative of proposed source of material to be supplied.

3.0 EXECUTION

3.1 PREPARATION

.1 Galvanizing to include chromate treatment.

.1 Duration of treatment to be 1 hour per 25 mm of bar diameter.

.2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A143/A143M.

3.2 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental Representative.

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

.3 Replace bars, which develop cracks or splits.

3.3 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.

.1 When paint is dry, apply thick even film of mineral lubricating grease.

.3 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement.

.4 Ensure cover to reinforcement is maintained during concrete pour.

.5 Protect epoxy and paint coated portions of bars with covering during transportation and handling.

3.4 FIELD TOUCH-UP

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

END OF SECTION 03 20 00

1.0 GENERAL

1.1 RELATED WORK

.1	Concrete Forming and Accessories	Section 03 10 00
.2	Concrete Reinforcing	Section 03 20 00
.3	Architectural Concrete	Section 03 33 00
.4	Concrete Finishing	Section 03 35 00

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C109-12, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or 50-mm Cube Specimens).ASTM D260-86 (2001), Standard Specification for Boiled Linseed Oil.
- .2 ASTM C309-11, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- .3 ASTM C332-09, Specification for Lightweight Aggregates for Insulating Concrete.
- .4 ASTM C827-10, Test Method for Early Volume Change of Cementitious Mixtures.
- .5 ASTM D1751-04(R2008), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).
- .6 ASTM D1752-04a(2008), Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .7 ASTM C 260 – 10a, Specifications for Air-Entraining Admixtures for Concrete.
- .8 ASTM C 494M – 13, Specifications for Chemical Admixtures for Concrete.

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-19.24-M90, Multicomponent, Chemical-Curing Sealing Compound.

.3 Canadian Standards Association (CSA International)
- .1 CSA-A23.1-14 Concrete Materials and Methods of Concrete Construction.
- .2 CSA-A23.2-14, Methods of Test for Concrete.
- .3 CAN/CSA-A3000-08, Cementitious Materials CompendiuM.
- .4 CSA-A3001-03, Cementitious Materials for Use in Concrete.
- .5 CAN/CSA-G30.18-M92(R2002), Billet-Steel Bars for Concrete Reinforcement.

1.3 CERTIFICATES

.1 Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CAN/CSA-A23.1.

.2 Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CAN/CSA-A23.1.

1.4 QUALITY ASSURANCE

.1 Minimum 2 weeks prior to starting concrete work, submit proposed quality control procedures for Departmental Representative's approval for following items:
- .1 Falsework erection.
- .2 Hot weather concrete.
- .3 Cold weather concrete.
- .4 Curing.
- .5 Finishes.
- .6 Formwork removal.
- .7 Joints.

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Concrete hauling time: maximum allowable time limit 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 the Departmental Representative and concrete producer as described in CSA A23.1/A23.2.

.2 Deviations to be submitted for review by the Departmental Representative.

.2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

1.7 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 Portland cement: to CAN/CSA-A3000.

.2 Supplementary cementing materials: with minimum 10% Type F fly ash replacement, by mass of total cementitious materials to CAN/CSA A3000.

.3 Water: to CAN/CSA-A23.1.

.4 Aggregates: to CAN/CSA-A23.1. Coarse aggregates to normal density.

.5 Air entraining admixture: to CAN/CSA-A3000.

.6 Chemical admixtures: to CAN/CSA-A3000. Departmental Representative to approve accelerating or set retarding admixtures during code and hot weather placing.

.7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents.

.1 Compressive strength: 50 MPa at 28 days.

.2 Consistency:

.1 Fluid: to ASTM C827. Time of efflux through flow cone (ASTM C939), under 30 s.

.2 Flowable: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portion) 125 to 145%.

.3 Plastic: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portions) 100 to 125%.

.4 Dry pack to manufacturer's requirements.

.7 Non premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 50 MPa at 28 days.

.8 Curing compound: to CAN/CSA-A23.1 white and to ASTM C309, Type 1-chlorinated rubber.

.9 Cushion pads: tough, resilient, weather, moisture, and oil resistant material that will not corrode or cause corrosion, consisting of either layers of approved cotton duck saturated

and bound together by approved rubber or synthetic compounds, or made from specially compounded synthetic materials.

.10 Ribbed waterstops: extruded PVC [Arctic Grade] of sizes indicated with welded corner and intersecting pieces:
- .1 Tensile strength: to ASTM D412, method A, Die "C", minimum 11.4 MPa.
- .2 Elongation: to ASTM D412, method A, Die "C", minimum 275%.
- .3 Tear resistance: to ASTM D624, method A, Die "B", minimum 48 kN/m.

.11 Premoulded joint filler:
- .1 Bituminous impregnated fibreboard: to ASTM D1751.
- .2 Sponge rubber: to ASTM D1752, Type I, flexible grade.

.12 Weep hole tubes: plastic.

.13 Dovetail anchor slots: minimum 0.6 mm thick galvanized steel with insulation filled slots.

.14 Dampproof membrane:
- .1 Kraft/polyethylene membrane:
  - .1 Plain: .05 mm thick polyethylene film bonded to 2.44 kg/m^2 asphalt treated creped kraft.
  - .2 Reinforced: two .05 mm thick polyethylene films bonded each side of 2.44 kg/m^2 asphalt treated creped kraft paper, reinforced with 13 x 13 mm fibreglass scrim.
  - .3 Membrane adhesive: as recommended by membrane manufacturer.

.15 Dampproofing: Emulsified asphalt, mineral colloid type, unfilled: to CAN/CGSB-37.2, and to Section 07 13 52 – Modified Bituminous Sheet Waterproofing.

.16 Polyethylene film: 0.25mm (10 mil) thickness to CAN/CGSB-51.34.

2.2 MIXES

.1 Proportion normal density concrete in accordance with CAN/CSA-A23.1, Alternative 1 to give the following properties:
- .1 Cement: Type GU Portland cement.

.2 Minimum compressive strength at 28 days, class of exposure and nominal size of coarse aggregate:

Member	minimum 28-days strength (MPa)	maximum aggregate size (mm)	exposure class	air content Category
Footings, Pilasters, Walls	25	25	F-2	2
Slab on grade (Interior)	25	20	N	-
Slab on grade (Exterior)	32	20	C-2	1
Roadway Pavement (Exterior)	32	20	C-2	1

.3 Slump at time and point of discharge: To CSA-A23.1 Clause 4.3.2.3. When super plasticizers are used, the slump may be increased by shall kept below the point where segregation will occur. The cost of super plasticizers shall be included in the cost of the concrete. Smaller aggregate size may be used where necessary to increase slump.

.4 Air content: To CSA-A23.1 Table 2 & 4 to suit appropriate exposure class.

.5 Chemical admixtures: following admixtures in accordance with to ASTM C494M. Admixtures shall contain no salts or acids.

.6 Concrete mix designs shall be submitted to a material testing agency for approval and to Departmental representative for review prior to any concrete work.

3.0 EXECUTION

3.1 PREPARATION

.1 Obtain Departmental Representative's approval before placing concrete. Provide minimum 24 h notice prior to placing of concrete.

.2 Pumping of concrete is permitted only after approval of equipment and mix.

.3 Ensure reinforcement and inserts are not disturbed during concrete placement.

.4 Prior to placing of concrete obtain Departmental Representative 's approval of proposed method for protection of concrete during placing and curing.

.5 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.6 In locations where new concrete is dowelled to existing work, drill holes in existing concrete. Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.

.7 Do not place load upon new concrete until authorized by Departmental Representative.

3.2 CONSTRUCTION

.1 Perform cast-in-place concrete work in accordance with CSA-A23.1.

.2 Sleeves and inserts.

.1 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by Departmental Representative.

.2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100 mm not indicated, must be approved by Departmental Representative.

.3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Departmental Representative before placing of concrete.

.4 Check locations and sizes of sleeves and openings shown on drawings.

.5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

.3 Anchor bolts.

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 With approval of Departmental Representative, grout anchor bolts in holes drilled after concrete has set. Drilled holes to be to manufacturer's recommendations.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

.4 Set bolts and fill holes with epoxy grout.

.5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

.4 Drainage holes and weep holes:

.1 Form weep holes and drainage holes in accordance with Section 03 10 00 - Concrete Forms and Accessories. If wood forms are used, remove them after concrete has set.
.2 Install weep hole tubes and drains as indicated.

.5 Dovetail anchor slots:
.1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
.2 Install continuous vertical anchor slots at [800] mm oc where concrete walls are masonry faced.

.6 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.

.7 Finishing:
.1 Finish concrete in accordance with CAN/CSA-A23.1.
.2 Use procedures acceptable to Departmental Representative or those noted in CAN/CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged.

.8 Waterstops:
.1 Install waterstops to provide continuous water seal. Do not distort or pierce waterstop in such a way as to hamper performance. Do not displace reinforcement when installing waterstops. Use equipment to manufacturer's requirements to field splice waterstops. Tie waterstops rigidly in place.
.2 Use only straight, heat sealed butt joints in field. Use factory welded corners and intersections unless otherwise approved by Departmental Representative.

.9 Joint fillers:
.1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Departmental Representative. When more than one piece is required for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
.2 Locate and form isolation, construction and expansion joints as indicated. Install joint filler.
.3 Use 12 mm thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to within 12 mm of finished slab surface unless indicated otherwise.

.10 Dampproof membrane:
.1 Install dampproof membrane under concrete slabs-on-grade inside building.
.2 Lap dampproof membrane minimum 150 mm at joints and seal.
.3 Seal punctures in dampproof membrane before placing concrete. Use patching material at least 150 mm larger than puncture and seal.

.11 Locations of construction joins shall be submitted to the departmental representative for review in advance and prior to commencement of construction.

.12 Supply and set anchor bolts, sleeves, pipe hangers, expansion joints and other inserts and openings as indicated in the structural drawings and specifications or in documents by other disciplines.

.13 All dowels, anchor bolts, embedded plates and other inserts shall be placed before the concrete is poured.

.14 Slab on grade joints shall be 35mm deep sawcuts spaced maximum 4500mm apart, layout of joins shall be approved by the Departmental representative, seal with flexible joint sealer to prevent ingress of water.

3.3 SITE TOLERANCE

.1 All horizontal surfaces shall meet the Class A Slab and Floor Finish classification (+/- 8mm) in accordance with Table 22 of CAN/CSA-A23.1 straight edge method.

.2 Tolerance closer than those specified in CSA-A23.1 may be required at certain locations for structural, architectural and construction requirements.

3.4 FIELD QUALITY CONTROL

.1 Inspection and testing of concrete and concrete materials will be carried out by a CSA certified Testing Laboratory designated by Departmental Representative in accordance with CAN/CSA-A23.1. Submit all concrete testing results to the departmental representative.

.2 Contractor will pay for costs of tests as specified in Section 01 11 55 – General Instructions.

.3 Departmental Representative will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.

.4 Non-destructive Methods for Testing Concrete shall be in accordance with CAN/CSA-A23.2.

.5 Inspection or testing by Departmental Representative will not augment or replace Contractor quality control nor relieve him 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 Departmental Representative and provide verification of compliance.

3.6 CLEANING

.1 Use trigger operated spray nozzles for water hoses.

.2 Designate cleaning area for tools to limit water use and runoff.

.3 Cleaning of concrete equipment to be done in accordance with Section 01 35 43: Environmental Procedures.

END OF SECTION 03 30 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

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

.2 Room Finish Schedule Section 09 06 00

1.2 REFERENCES

.1 Canada Green Building Council (CaGBC)
- .1 LEED Canada-NC 2009, LEED (Leadership in Energy and Environmental Design): LEED Canada Reference Guide for Green Building Design and Construction 2009.

.2 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.

.3 CSA International
- .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.4 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 Sandblasting installer operations shall conform to applicable codes and Regulations.

.3 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.

.4 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 and Departmental Representative 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 above135°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 Sandblasting materials shall conform to CPCA Manual, Chapter 9, Sandblasting.

.3 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 Krystobond" by Kryton International Inc.
- .4 "Fabribond-A" by Fabrikem Manufacturing Ltd.
- .5 Or approved alternative.

.4 Curing and Sealing Compound: Surface Sealer: to CAN/CGSB-25.20. Acrylic carnuba wax, Low VOC. Acceptable Products:
- .1 "Masterkure N-Seal" by Master Builder Company Limited.
- .2 "Cure and Seal" by Target Products Ltd.
- .3 "760 Clear Acrylic Sealer" by Elsro Construction Products.
- .4 "Buff Hard" by Symons Corporation.
- .5 Or approved alternative.

.5 Natural Hardener: Premixed, abrasion resistant non-metallic hardener (Type 1). Acceptable Products:
- .1 "Mastercron" by Master Builders Company Limited.
- .2 "Diamag 7" by Sternson Limited.
- .3 "Non-Metallic Floor Hardener" by Target Products Ltd.
- .4 "785 Genflor Non-Metallic Floor Hardener" by Elsro Construction Products.
- .5 Or approved alternative.

.6 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 Krystol Patch/Grout" by Kryton International Inc.
- .5 Or approved alternative.

.7 Densifier: Non-flammable non-toxic,water-based formulation used on Portland Cement materials utilizing Quartz-Litium based products. Acceptable Products:
- .1 "Crenz Protect" by Crenz Concrete.
- .2 "Pentra Sil" by Convergent Concrete.
- .3 "Euco Diamond Hard" by The Euclid Chemical Company.
- .4 "Liquihard Ultra" Surface Hardener
- .5 Or approved alternative.

.8 Seeding Aggregates: Aggregate shall be small round, brown pebbles size around 10 mm and be hard, sand, durable and free of all deleterious materials and staining quality.

2.2 FINISHES

.1 Trowelled finish for all concrete floor with surface hardener.

.2 Exposed aggregate finish for tactile warning strip at top of concrete stair landing.

3.0 EXECUTION

3.1 FINISHING-GENERAL

.1 Do concrete finishing work in accordance with CAN/CSA-A23.1-M01, unless otherwise indicated.

.2 Tops of Walls and Columns to be level and true. Allowable tolerance 6 mm in 3,000 mm.

3.2 FORMED SURFACES

.1 Inspect concrete surfaces for defects immediately after removal of formwork.

.2 Remove or cut back to a depth of 3/4" (19 mm) from the surface of the concrete all bolts, ties, nails, or other metal that is not required and repair immediately. Patch all cone and sleeve holes flush with concrete surface in strict accordance with manufacture's printed instructions. Grout all steel inserts in strict conformance with grout manufacturer's printed instructions.

.3 Remove imperfections such as bulges, fins, lips, and stains to permanently exposed surfaces as directed by Departmental Representative by chipping or grinding and patch to match adjacent surfaces. Do not proceed with grinding until the concrete has sufficiently hardened to prevent dislodgment of coarse aggregate particles. Allowable limits of grinding to be 1/16" so as to not expose aggregate.

.4 Repair to exposed surfaces or surfaces to receive paint type finishes: Repairs to be carried out under the direction of the Departmental Representative. Blend cement and aggregate so that, when dry, patching mortar will match colour of surrounding. Provide test areas at inconspicuous location to verify mixture and colour match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface. Patch and fill all concrete imperfections such as "blow holes", "honeycomb" and voids as directed.

.5 Strike off smooth and finish tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces with a texture matching the adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown.

3.3 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. Stairs and landings shall have positive slopes to provide complete water drainage with no ponding.

.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 Departmental Representative.

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 produces smooth burnished surface to within tolerance described in CAN/CSA-A23.1-M90, Cause 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 HARDENED 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 EXPOSED AGGREGATE CONCRETE

.1 The seeding operation shall start immediately after placement of concrete. The select aggregate shall be carefully and uniformly seeded by suitable means so that the entire surface is completely covered with one layer of stone. Stacked stone as well as slivery particles shall be removed. The aggregate shall be embedded by suitable means. When the concrete is hard enough to retain the embedded aggregate and the mortar is still soft enough to be removed by brushing, the surface shall be brushed and flushed out with water. The exposing operation of washing and brushing with stiff bristle broom is continued until the surface matches the approved sample panel. The final washing operation shall cease when the flush water runs clear and there is no noticeable cement film on the aggregate.

3.8 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 Departmental Representative at no additional cost to the owner.

3.9 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.

3.10 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 SECTIONS

.1 Cast-in-Place Concrete — Section 03 30 00

.2 Metal Fabrications — Section 05 50 00

.3 Air Barriers – Descriptive or Proprietary — Section 07 27 00.01.

1.2 REFERENCES

.1 CSA A179- 04 (R2009), Mortar and Grout for Unit Masonry

.2 CSA A370- 04 (R2009), Connectors for Masonry

.3 CSA A371- 04 (R2009), Masonry Construction for Buildings

.4 CSA A165-SERIES-04 (R2009), Standards for Concrete Masonry Units

.5 CSA-S304.1-14, Design of Masonry Structures

.6 ASTM C207 Lime

.7 ASTM C144 Quartzite Sand

.8 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Ensure that materials are delivered to job site in dry condition

.2 Keep materials dry until use.

.3 Store under waterproof cover on pallets of plank platforms held off ground by means of plank or timber skids.

1.4 SAMPLES

.1 Submit samples of mortar and masonry unit in accordance with Section 01 33 00 – Submittal Procedures.

1.5 COLD WEATHER REQUIREMENTS

.1 Comply with Clause 6.7 of CSA-A371.

.2 When air temperature is below 5°C take following precautions in preparing and using mortar:

- .1 Heat sand slowly and evenly. Do not use scorched sand, having a reddish cast, in mortar.
- .2 Heat water to 70°C maximum; 20°C minimum.
- .3 After combining heated ingredients maintain temperature of mortar between 5°C and 50°C until used.
- .4 Protect mortar from rain and snow

.3 Maintain dry beds for masonry and use dry masonry units only.

1.6 HOT WEATHER REQUIREMENTS

.1 Comply with Clause 4 6.7 of CSA A371.

.2 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

1.7 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 permanent construction.

.2 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.

.3 Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials 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, packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

2.0 PRODUCTS

2.1 MORTAR MATERIALS

.1 Mortar and grout: to CSA A179

2.2 MORTAR TYPES

.1 Mortar: to CSA A179.

.1 Concrete block masonry walls: Type S based on mortar proportion by volume

2.3 GROUT

.1 Grout: to Table 5 of CSA A179, minimum compressive strength 20 Mpa, 10 mm maximum sized aggregate and minimum slump of 200 mm.

.2 Concrete fill: minimum compressive strength 25 Mpa, 10 mm maximum sized aggregate and slump of 200 – 250 mm.

2.4 ACCESSORIES

.1 Masonry flashing: 1.5 mm thickness reinforced modified SBS asphalt membrane conforming to section 07 62 00 – Sheet Metal Flashing and Trim.

.2 Lap adhesive: recommended by manufacturer of flashing material.

2.5 REINFORCING AND TYING

.1 Metal ties bar type reinforcement, bolts and anchors: to CSA-S304.

.2 Horizontal joint reinforcement: ladder type to CSA-A370. Ladder type with tab or eye extensions to accept 3.8 mm diameter wire ties at walls with exterior wythe. Extensions spaced at 400 mm

.3 Corrosion protection: to Clause 5.2 and Table 5.1of CSA-A370, for metal ties and horizontal reinforcing in exterior walls, walls in shower areas and wet areas.

.4 Bar reinforcement to G30.18, Grade 400R.

2.6 MASONRY UNITS

.1 Standard concrete masonry units to CAN3 A165-SERIES-M1994.

.1 Classification: H/15/A/M.

.2 Size: Modular

.3 Special shapes: Provide purpose-made “H” shapes for lintels and bond beams. Provide additional special shapes as indicated.

3.0 EXECUTION

3.1 WORKMANSHIP

.1 Build masonry plumb, level and true to line, with vertical joints in proper alignment.

.2 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.2 TOLERANCES

.1 Conform to Clause 6.2 of CSA-S371

3.3 MEASUREMENT MIXING OF MORTAR

.1 Supplement Clause 6 of CSA A179 as follows:

.1 Mix grout to semi-fluid consistency.

.2 Prehydrate pointing mortar by mixing all ingredients dry, then mix again adding just enough water to produce damp unworkable mist that will retain its form when pressed into ball. Allow to stand for not less than 1 hour nor more than 2 hours then remix with sufficient water to produce mortar of the proper consistency for pointing.

3.4 MASONRY FLASHING

.1 Install flashings in masonry in accordance with Clause 12.4 of CSA-S371 and as follows:

.1 Under exterior masonry bearing on concrete foundation and over openings.

.2 Flashing material specified in section 07 62 00 – Sheet Metal Flashing and Trim.

.2 Lap joints 150 mm and seal with adhesive.

3.5 REINFORCING

.1 Horizontal Reinforcing:

.1 Install in all masonry walls continuous in every second course beginning at first course (200 mm above floor), horizontal truss or ladder type reinforcement comprising two 3.8 mm rods, each rod 25 mm from each face, and lapped 300 mm at each splice. Refer to structural drawings for ladder joint reinforcement spacing.

.2 Refer to structural drawings for horizontal bond beam requirements.

.2 Vertical Reinforcing

.1 See structural drawings.

.2 “Prior to erecting any reinforced masonry blockwork, the location of all wall base dowels placed in the foundations shall be paint marked on the main floor slab, vertical block reinforcing shall be paint match up with these dowels.”

.3 Refer to structural drawing for details and additional requirements for reinforcement in masonry walls.

3.6 ENGINEERED MASONRY

.1 Grout and reinforce engineered masonry in accordance with CSA-S304.1 and as indicated.

.2 Fill cores of masonry block walls with vertical reinforcing, full height where indicated.

3.7 REINFORCE BOND BEAMS

.1 Reinforce bond beams as indicated on drawing. Make joint in bond beams to match adjacent walls.

.2 Place grout and reinforcing in accordance with CSA-S304.

3.8 TEMPORARY BRACING

.1 Provide lateral support and anchorage in accordance with Clause 6.1.1 of CSA-A371.

3.9 BOLTS AND ANCHORS

.1 Embed bolts and anchors solidly in mortar or grout to develop maximum resistance to design forces.

3.10 EXPOSED MASONRY

.1 Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.

3.11 LAYING UNITS

.1 Bond: running stretcher for concrete block units

.2 Coursing height: 200 mm for one block and one joint.

.3 Jointing: concave where exposed or where paint or other finish coating is specified.

3.12 JOINTING

.1 Tool with round jointer to provide smooth, compressed, uniformly concave joints where concave joints are indicated. All interior exposed masonry units with concave joint.

.2 Strike flush all joints concealed in walls and joints in walls to receive insulation, ceramic tile, or other applied material except paint or similar thin finish coating.

3.13 JOINING OF WORK

.1 Where necessary temporarily stop horizontal runs of masonry, and in building corners:
  .1 Step-back masonry diagonally to lowest course previously laid.
  .2 Do not “tooth” new masonry.
  .3 Fill in adjacent courses before heights of stepped masonry reach 1200 mm.

3.14 CUTTING

.1 Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in object.

.2 Make cuts straight, clean and free from uneven edges. Use masonry saw where necessary to cut special shapes.

3.15 BUILDING-IN

.1 Build in items required to be built into masonry

.2 Prevent displacement of built-in items during construction. Check for plumb, alignment and correctness of position, as work progresses.

.3 Brace jamb frames to maintain plumb. Fill spaces between jambs and masonry with mortar. Build in jamb anchors, cell door frames, as indicated.

3.16 SUPPORT OF LOADS

.1 Refer to requirements on structural drawings.

3.17 CLEANING

.1 Allow mortar droppings on concrete masonry to partially dry then remove by means to trowel, followed by rubbing lightly with small piece of block and finally brushing.

3.18 TESTING

.1 Inspection and testing will be carried out by testing laboratory designated by Departmental Representative.

.2 Contractor will pay for costs of tests as specified in Section 01 11 55 – General Instructions.

END OF SECTION 04 05 00.1

1.0 GENERAL

1.1 RELATED SECTIONS

.1 Section 05 50 00 – Metal Fabrication.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)
- .1 ASTM A 36/A 36M-12, Specification for Carbon Structural Steel.
- .2 ASTM A 307-12, Specification for Carbon Steel Bolts and Studs, 60,000psi Tensile.
- .3 ASTM A 325-10e1, Specification for Structural Bolts, Steel, Heat Treated,120/105 ksi Minimum Tensile Strength.
- .4 ASTM A 325M-13, Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength Metric.

.2 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturer's Association (CPMA).
- .1 CISC/CPMA 1-73a, Quick-Drying, One-Coat Paint for Use on Structural Steel.
- .2 CISC/CPMA 2-75, Quick-Drying, Primer for Use on Structural Steel.

.3 Canadian Standards Association (CSA International)
- .1 CAN/CSA-G40.20-13, General Requirements for Rolled or Welded Structural Quality Steel.
- .2 CAN/CSA-G40.21-13, Structural Quality Steels.
- .3 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 CAN/CSA-S16-14, Design of Steel Structures.
- .5 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
- .6 CSA W48-06 (R2011), Electrodes.
- .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)

1.3 DESIGN OF DETAILS AND CONNECTIONS

.1 Design details and connections in accordance with requirements of CAN/CSA-S16 to resist forces, moments, shears and allow for movements indicated.

.2 If connection for shear only (standard connection) is required:
- .1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction".

.3 If shears are not indicated, select or design connections to support reaction from 120% maximum uniformly distributed load that can be safely supported by beam in bending (60% each end), provided no point loads act on beam.

.4 At the Departmental Representative's request, submit sketches and design calculations for non standard connections, stamped and signed by qualified professional engineer licensed in the Province of British Columbia, Canada.

1.4 SHOP DRAWINGS

.1 Submit shop drawings including fabrication and erection documents and materials list in accordance with Section 01 33 00 – Submittal Procedures.

.2 On erection drawings, indicate all details and information necessary for assembly and erection purposes such as, description of methods, sequence of erection, type of equipment used in erection and temporary bracings.

.3 All shop drawings to be signed, sealed by professional engineer licensed in British Columbia, Canada.

.4 The Professional Engineer responsible for the shop drawings shall inspect the installation of the work for conformance with the design and the shop drawings, and shall upon completion of the work submit to the Departmental Representative a completed Schedule S-B: Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional, and Schedule S-C: Assurance of Professional Field Review and Compliance by Supporting Registered Professional.

1.5 QUALITY ASSURANCE

.1 Submit 2 copies of mill test reports showing chemical and physical properties and other details of steel to be incorporated into work at least 2 weeks prior to fabrication of structural steel. Mill test reports shall be certified by metallurgists qualified to practice in British Columbia, Canada.

.2 Fabricator of structural steel shall, in addition, provide an affidavit stating that materials and products used in fabrication conform to applicable material and products standards called for by design drawings and specifications.

1.6 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 Structural steel: to CAN/CSA-G40.21 Grade as indicated on drawings.

.2 Anchor bolts: ASTM A307 unless noted otherwise on drawings.

.3 Bolts, nuts and washers: to ASTM A325.

.4 Welding materials: to CSA W48 Series and CSA W59 and certified by Canadian Welding Bureau.

.5 Shop paint primer: to CISC/CPMA 1.

.6 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 600 g/m^2.

.7 Galvanize touch-up primer: to CISC/CPMA 1.

.8 Shear studs: to CSA W59, Appendix H.

2.2 FABRICATION

.1 Fabricate structural steel in accordance with CAN/CSA-S16 and in accordance with reviewed shop drawings.

.2 Install shear studs in accordance with CSA W59.

.3 Continuously seal members that required by remediation with continuous field welds where appropriate. Grind smooth.

1.7 SHOP PAINTING

.1 Clean, prepare surfaces and field prime structural steel in accordance with CAN/CSA-S16 except where members to be encased in concrete.

.2 Clean members, remove loose mill scale, rust, oil, dirt and other foreign matter. Prepare surface according to SSPC SP7 brush off blast.

.3 Apply one coat of CISC/CMPD2-75 primer in shop to steel surfaces to achieve minimum dry film thickness of 3 to 4 mils, except:
- .1 Surfaces to be encased in concrete.
- .2 Surfaces to receive field installed stud shear connections.
- .3 Surfaces and edges to be field welded.
- .4 Faying surfaces of friction-type connections.
- .5 Below grade surfaces in contact with soil.

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.

.5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

3.0 EXECUTION

3.1 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.

3.2 CONNECTION TO EXISTING WORK

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

3.3 MARKING

.1 Mark materials in accordance with CAN/CSA G40.20/G40.21. Do not use die stamping. If 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.

3.4 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.

2.5 FIELD QUALITY CONTROL

.1 The Departmental Representative will not be responsible for inspection of the Contractor's work as described in Clause 7.12 of the CISC Code of Standard Practice for Structural Steel. The Contractor is responsible for the accuracy and completeness of his own work and shall verify that the structural steel has been fabricated, erected and finished in accordance with the contract specifications.

.2 Inspection and testing of materials and workmanship will be carried out by testing laboratory designated by Departmental Representative.

.3 Testing requirements are as follows:

.1 Visual Field Inspection and Bolt Torque Testing (Random 10% of Bolts) of all bolted connections.

.2 Non Destructive Testing of Welds:

- 100% of all welds to be visually inspected
- 10% of all moment connections to be ultrasonically tested.
- 10% of all full strength splice connections to be ultrasonically tested.

.3 Verify the certification and conformance of the steel fabricator and erector to any relevant CSA Standards.

.4 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by Departmental Representative.

.5 Submit test reports to Departmental Representative within 1 week of completion of inspection.

.6 Costs of tests will be borne by Contractor as specified in Section 01 11 00 – General Instructions.

2.6 FIELD PAINTING

.1 Paint in accordance with Section 09 91 13 – Exterior Painting and Section 09 91 23 – Interior Painting.

.1 Touch up all damaged surfaces and surfaces without shop coat with primer to MPI Product #76 except as specified otherwise. Apply in accordance with MPI system INT5.1A.

END OF SECTION 05 12 23

1.0 GENERAL

1.1 RELATED WORK

.1	Structural Steel for Buildings	Section 05 12 23
.2	Steel Decking	Section 05 31 00
.3	Metal Fabrications	Section 05 50 00
.4	Interior Painting	Section 09 91 23

1.1 REFERENCE STANDARDS

.1 American Society for Testing and Materials (ASTM)
- .1 ASTM A 36/A 36M-12, Specification for Carbon Structural Steel.
- .2 ASTM A325M-12 Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength Metric.
- .3 ASTM A 325-10e1, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

.2 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturer's Association (CPMA).
- .1 CISC/CPMA1-73b, Quick-Drying, One-Coat Paint for Use on Structural Steel.
- .2 CISC/CPMA2 -75, Quick-Drying, Primer for use on Structural Steel.

.3 Canadian Standards Association (CSA)
- .1 CAN/CSA-G40.20-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel.
- .2 CAN/CSA-G40.21-04 (R2009), Structural Quality Steels.
- .3 CAN/CSA-S16-09, Design of Steel Structures.
- .4 CAN/CSA-S136-07, North American Specification for the design of Cold Formed Steel Structural Members.
- .5 CSA-W47.1-09 Certification of Companies for Fusion Welding of Steel Structures.
- .6 CSA-W59-03 (R2008), Welded Steel Construction (Metal Arc Welding).

1.2 QUALITY ASSURANCE

.1 At least 4 weeks prior to fabrication of steel joists and accessories, submit 2 copies of mill test reports showing chemical and physical properties and other details of steel to be incorporated into work. Such mill test reports shall be certified by qualified metallurgists confirming that tests conform to requirements of CAN/CSA G40.20 and CAN/CSA G40.21.

.2 Fabricator of structural steel joists shall, in addition, provide an affidavit stating that materials and products used in fabrication conform to applicable material and products standards called for by design drawings and specifications.

1.3 DESIGN OF STEEL JOISTS AND BRIDGING

.1 Design steel joists, their connections, diagonal bracing and bridging and other associated components to carry loads as shown on drawings in accordance with CAN/CSA-S16-09, CSA-S136.

.2 Design joists and anchorages for uplift forces and snow built-up forces as per Building Code requirements unless otherwise indicated on the drawings.

.3 Ensure joists are manufactured to consider load effects due to fabrication, erection and handling.

.4 Limit roof joist deflection due to specified live load to 1/360 of span and camber all open web steel joists to satisfy the criteria as shown on the drawing.

.5 No drilling or cutting for hanger or support devised is permitted unless approved by the design engineer of the OWSJ supplier.

.6 Diagonal bracing shall be used.

.7 Joist fabricator shall coordinate duct runs with Mechanical Engineer and Architect. Openings in joists must line up to allow passage of mechanical ducting and other equipment.

.8 Joist shall bear on center lines of supporting members, unless noted otherwise on drawings or approved by departmental representative.

.9 Submit 5 copies of calculations and joist design drawings for typical joists for Departmental Representative review at least 4 weeks prior to fabrication and/or delivery.

1.4 SUBMITTALS

.1 Submit shop details and erection drawings in accordance with Section 01 33 00 - Submittals Procedures

.2 Submit drawings stamped and signed by qualified professional engineer registered or licensed in province of British Columbia, Canada.

.3 On erection drawings, indicate relevant details such as joist mark, depth, spacing, bridging lines, bearing, anchorage and details.

.4 Provide particulars, on shop drawings, relative to joist geometry, framed openings, splicing details, bearing and anchorage. Include member size, properties, specified and factored member loads, and stresses under various loadings, deflection and camber.

.5 The Professional Engineer responsible for the shop drawings shall inspect the installation of the work for conformance with the design and the shop drawings, and shall upon completion of the work, provide to the Departmental Representative a completed Schedules S-B: Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional, and Schedule S-C: Assurance of Professional Filed Review and Compliance by Supporting Registered Professional.

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 Structural steel: to CAN/CSA-G40.21 and CAN/CSA –S136.

.2 Welding materials: to CSA W59 and certified by the Canadian Welding Bureau.

.3 Shop paint primer: to CISC/CPMA 2.

.4 Shear studs: to CSA W59, Appendix H.

2.2 FABRICATION

.1 Fabricate steel joists and accessories as indicated in accordance with CAN/CSA-S16-09, CAN/CSA –S136 and in accordance with reviewed shop drawings.

.2 Weld in accordance with CSA_W59.

.3 Provide chord extensions where indicated.

.4 Provide diagonal and horizontal bridgings and anchorages in accordance with. CAN/CSA –S16-09.

2.3 SHOP PAINTING

.1 Clean, prepare and shop prime all surfaces of steel joists to CAN/CSA-S16-01.

.2 Clean all members of loose mill scale, rust, oil, dirt and other foreign matter. Prepare surfaces in accordance with SSPC SP 1 brush off blast.

.3 Apply one coat of CISC/CMPA-2 primer to all steel surfaces to achieve maximum dry film thickness of 3 mil to 4 mil except:

.1 Surfaces to be encased in concrete.
.2 Surfaces to receive field installed stud shear connectors.
.3 Surfaces and edges to be field welded.
.4 Faying surfaces of friction-type connections.
.5 Below grade surfaces in contact with soil.

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.

.5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.

.6 Strip paint bolts, nuts, sharp edges and corners before prime coat is dry.

3.0 EXECUTION

3.1 GENERAL

.1 Structural steel work: in accordance with CAN/CSA-S16, CAN/CSA –S136.

.2 Welding: in accordance with CSA W59.

.3 Companies to be certified under Division 2.1 of CSA W47.1 for fusion welding of steel structures.

.4 Provide certification that welded joints are qualified by Canadian Welding Bureau.

3.2 FIELD QUALITY CONTROL

.1 Inspection and testing of materials and workmanship will be carried out by testing laboratory approved by Departmental Representative.

.2 Testing laboratory will inspect representative joists for integrity, accuracy of fabrication and soundness of welds. Testing laboratory will also monitor test loading of joists used by manufacturer to verify design and check representative field connections. Departmental Representative will determine extent of and identify all inspections.

.3 Submit test report to Departmental Representative within 5 days after completion of inspection.

.4 Costs of tests will be borne by Contractor as specified in Section 01 11 55 – General Instructions.

3.3 ERECTION

.1 Erect steel joists and bridging as indicated in accordance with CAN/CSA-S16 and in accordance with reviewed erection drawings.

.2 Complete installation of all bridging and anchorages before placing construction loads on joists.

.3 Field cutting or altering joists or bridging that are not shown on shop drawings: to approval of Departmental Representative.

.4 Clean and touch up shop primer to bolts, welds, burned or scratched surfaces at completion of erection.

3.4 FIELD PAINTING

.1 Paint in accordance with Section 09 91 13 – Exterior Painting and Section 09 91 23 – Interior Painting.

.1 Touch up all damaged surfaces and surfaces without shop coat with primer to MPI Product #76 except as specified otherwise. Apply in accordance with MPI system INT5.1A.

END OF SECTION 05 21 00

1.0 GENERAL

1.1 RELATED WORK

.1 Structural Steel for Buildings Section 05 12 23

.2 Fire Stopping Section 07 84 00

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA)
- .1 CAN/CSA-S136-07, North American Specification for the design of Cold Formed Steel Structural Members.
- .2

.2 Canadian Sheet Steel Building Institute (CSSBI)
- .1 CSSBI 10M-08, Standard for Steel Roof Deck.

.3 American Society for Testing and Materials International, (ASTM)
- .1 ASTM A 653/A653M-11, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM A792/A 792M-05, Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

1.3 DESIGN REQUIREMENTS

.1 Design steel deck using limit states design in accordance with CSA S136 and, CSSBI 10M and CSSBI 12M.

.2 Steel deck and connections to steel framing to carry dead, snow, live and other loads including uplift as indicated.

.3 Deflection under specified live load not to exceed 1/240 of span, except that when gypsum board ceilings are hung directly from deck, live load deflection not to exceed 1/360 of span.

1.4 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .1 Indicate deck plan, profile, dimensions, base steel thickness, metallic coating designation, connections to supports and spacings, projections, openings, reinforcement details and accessories.

.2 Submit drawings stamped and signed by qualified professional engineer registered or licensed in Provinces of British Columbia, Canada.

.3 Submit design calculations if requested by Departmental Representative.

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 Zinc-iron Alloy (ZF) coated steel sheet: to ASTMA653/A653M structural quality Grade 230, with ZF75 coating, for interior surfaces not exposed to weather, unpainted finish, 0.91mm minimum base steel thickness.

.2 Decks to be painted: zinc-iron alloy coated decks suitable for finish painting.

.3 Zinc (Z) coated steel sheet: to ASTMA653/A653M structural quality Grade 230, with Z275, coating, regular spangle surface, not chemically treated for paint finish, for exterior surfaces exposed to weather, 0.91mm minimum base steel thickness.

.4 Aluminum-zinc alloy (AZ) coated steel sheet: to ASTMA 792/A 792M structural quality grade 230, with AZ 150 coating, surface not chemically treated for paint finish, for exterior surfaces exposed to weather, 0.91mm minimum base steel thickness.

.5 Closures: as indicated.

.6 Coverplates, deck flute closures and flashings: steel sheet with minimum base steel thickness of 0.91 mm. Metallic coating same as deck material.

.7 Primer: zinc rich, ready mix to MPI #200.

.8 Caulking: to Section 07 92 00 Joint Sealants.

.9 Fire stopping: to Section 07 84 00 Fire stopping.

2.2 TYPES OF DECKING

.1 Roof deck: 0.91 mm minimum base steel thickness, 38 mm deep profile, non-cellular overlapping side laps.

.2 Composite steel floor deck: 0.91 mm minimum base steel thickness, 38mm deep profile, non-cellular, upright embossed fluted profile, overlapping side laps.

3.0 EXECUTION

3.1 GENERAL

.1 Structural steel work: in accordance with CAN/CSA-S136 and CSSBI 10M.

.2 Unless noted on the drawings, Mechanical Fastener to be HiltiX-ENP2K or X-EDN 22 fasteners or approved equivalent spaced at 300mm maximum on center to structural members and edge angles and side laps with 1-#10 self drilling screws at maximum 300mm on center. Refer to structural drawings for mechanical fastener specific requirements.

3.2 ERECTION

.1 Erect steel deck as indicated and in accordance with CSSBI 10M and in accordance with reviewed erection drawings.

.2 Where possible, supply and install decking in length that will permit continuity over a minimum of three spans.

.3 Butt ends: to 1.5 to 3 mm gap. Install steel cover plates over gaps wider than 3 mm.

.4 Lap ends: to 50 mm minimum.

.5 Immediately after deck is permanently secured in place, touch up metallic coated top surface with compatible primer where burned by welding.

.6 Prior to concrete placement, steel deck to be free of soil, debris, standing water, loose mil scale and other foreign matter.

.7 Unless noted otherwise, all members designated as diaphragm chord members and all perimeter edge angles shall be connected by full strength grove welds or by full strength splice plates on each leg to form continuous compression and tension members. Weld edge angles and chords to Beams, joists and shear connectors and weld deck to angles chords and structural members as shown on drawings or as detailed by decking contractor.

3.3 OPENINGS AND AREAS OF CONCENTRATED LOADS

.1 No reinforcement required for openings cut in deck which are smaller than 150 mm square.

.2 For larger openings, detail framing as follows:

Location	Opening Size (In any direction)	Reinforcing
Roof/Floor	>150mm but < 500mm	L51x51x6.4 running perpendicular to Flutes and welded to minimum two flutes Each side of opening
Roof/Floor	>500mm but < 1000mm	L76x76x6.4 all around and extending to Structural members
Roof/Floor	>1000mm	See special details.

Unless noted otherwise, provide 1.2mm closure angles around all openings which are not framed with angles.

3.4 CONNECTIONS

.1 Install connections in accordance with CSSB1-10M.

END OF SECTION 05 31 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1	Cast-in-Place Concrete	Section 03 30 00
.2	Rough Carpentry	Section 06 08 99
.3	Exterior Painting	Section 09 91 13
.4	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 2018 or Model Schedule B and C-B.
.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, stair stringers and pipe rails: 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 Security fasteners: screws and bolts with spanner type heads to prevent removal except with special tools; non-corrosive type.

.9 Shop coat primer: to CAN/CGSB-1.40M.

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

.11 Stair treads- Galvanized welded steel stair tread with checkered plate noising maximum spacing between bearing bars to be 13mm, cross bar spacing to be about 100mm, serrated.

.12 Cat Walk and Stair landing Bar Grating- Galvanized welded steel bar grating for stair landing, maximum spacing between bearing bars to be 13mm, cross bar spacing to be about 100mm, serrated.

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 Galvanizing: hot dipped galvanizing with zinc coating 610 g/m² to CAN/CSA-G164, for all exposed exterior structural steel and metal fabrication, including but not limited to stair, guard, railing, gates, ladders, cages, and bollards.

.2 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 RAILINGS AND GUARDRAILS

.1 Steel fabrications: formed to shapes and sizes as indicated.

.2 Galvanize exterior pipe railings 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 RAILINGS & GUARDRAILS

.1 Install steel railings and guardrails and 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 Architectural Woodwork — Section 06 40 00

.3 Modified Bituminous Membrane Roofing — Section 07 52 00

.4 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 SECTIONS

.1	Wood Treatment	Section 06 05 73
.2	Rough Carpentry	Section 06 10 00
.3	Cross Laminated Timber (CLT)	Section 06 18 12

1.2 REFERENCES

.1 Canadian Standards Association

.1 CSA B111-1974 (R1998), Wire Nails, Spikes and Staples. (Withdrawn)
.2 CAN/CSA-G40.21-13, Structural Quality Steels.
.3 CAN/CSA-G164-M92 (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
.4 CAN/CSA-O80 Series-08, Wood Preservation.
.5 CAN/CSA-O86-14, Engineering Design in Wood.
.6 CSA O112.9-10 Evaluation of Adhesives for Structural Wood Products (Exterior Exposure).
.7 CSA O112.10-08 Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).
.8 CAN/CSA-O122-06, Structural Glued-Laminated Timber.
.9 CAN/CSA-O177-06, Qualification Code for Manufacturers of Structural Glued-Laminated Timber.
.10 CAN/CSA-S16-14, Design of Steel Structures.
.11 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel Structures.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.40-M89, Primer, Structural Steel, Oil Alkyd Type.

.3 American Society for Testing and Materials (ASTM)

.1 ASTM A 36/A36M-05, Specification for Carbon Structural Steel.
.2 ASTM A 47M-99 (2004), Specification for Ferritic Malleable Iron Castings.
.3 ASTM A 307-14, Specification for Carbon Steel Bolts and Studs, 60,000psi Tensile Strength.
.4 ASTM A 653/A653M-05a, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.3 SHOP DRAWINGS

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

.2 Submit erection drawings in accordance with CAN/CSA-S16.

.3 Shop drawings for members to indicate stress grade, service grade and appearance grades, shop applied finishes, camber, cuts, ledgers, holes and connection details.

.4 Each erection and shop drawing submission shall bear signature and stamp of qualified professional engineer registered or licensed in province of British Columbia, Canada, for items designed by fabricator or manufacturer. The Professional Engineer shall, upon completion of the work, submit to the Departmental Representative a completed Schedule S-B: Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional, and Schedule S-C: Assurance of Professional Field Review and Compliance by Supporting Registered Professional.

1.4 **QUALIFICATIONS**

.1 Manufacture structural glued-laminated members in plant certified by CSA as meeting requirements of CAN/CSA-O177, Class 1 (interior) and Class X (exterior) members.

.2 Submit certificate in accordance with CAN/CSA-O177, Appendix B at completion of fabrication.

.3 Fabricator for welded steel connections to be certified in accordance with CSA W47.1.

.4 Place authorization labels on glued-laminated members indicating manufactured in CSA certified plant.

.5 Certification of material protective sealer.

1.5 DELIVERY AND HANDLING

.1 Apply protective sealer to glued-laminated units before shipping unless specified otherwise.

.2 Wrap [quality] [commercial] grade members prior to leaving plant with a moisture resistant wrapping.

.3 Use padded, non-marring slings for handling glued-laminated members.

.4 Protect corners with wood blocking.

.5 Slit underside of membrane covering during storage at site. Do not deface member.

.6 Store glued-laminated units and protect from weather, block off ground and separate with stripping, so air may circulate around all faces of members.

.7 Cover glued-laminated units with opaque moisture resistant membrane if stored outside.

.8 Make adequate provision for delivery and handling stresses.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

.5 Divert unused paint material from landfill to official hazardous material collections site approved by Departmental Representative.

.6 Do not dispose of unused paint materials or preservative material into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.

.7 Do not dispose of preservative treated wood through incineration.

.8 Do not dispose of preservative treated wood with materials destined for recycling or reuse.

.1 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.

.9 Dispose of unused wood preservative material at official hazardous material collections site approved by Departmental Representative.

.10 Divert unused wood materials from landfill to recycling, reuse, composting facility approved by Departmental Representative.

2.0 PRODUCTS

2.1 MATERIALS

.1 Laminating stock: Douglas Fir-Larch, Hem Fir and Douglas Fir-Larch to CAN/CSA-O122.

.2 Adhesive: to CSA O112 Series, to grade of service required in accordance with CAN/CSA-O122.

.3 Sealer for glued-laminated members: penetrating type, clear, non-yellowing liquid.

.4 Fastenings:

.1 Split ring connections: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
.2 Shear plate connections.
.1 Pressed steel type: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
.2 Malleable iron type: to ASTM A47M, grade 350.
.3 Lag screws: to CSA B34.
.4 Bolts: to ASTM A 307.
.5 Side plates: to CAN/CSA-G40.21 or ASTM A 36.
.6 Drift pins: to ASTM A 307.
.7 Glued-laminated rivets: [hot dip galvanized] to CAN/CSA-G40.21 or ASTM A 36.
.8 Nails and spikes: to CSA B111.
.9 Truss plates: light gauge galvanized sheet steel to ASTM A 653, grade A or B.

.5 Shop coat primer for steel connections: to CAN/CGSB-1.40.

.6 Galvanizing: to CAN/CSA-G164, hot dipped, minimum zinc coating of 610 g/m2.

2.2 FABRICATION

.1 Fabricate members to following classifications:

.1 Stress grade: as specified on drawings.
.2 Service grade: "Interior ".
.3 Appearance grade: “Commercial".

.2 Mark laminated members for identification during erection. Marks not to be visible in final assembly.

.3 Do not apply sealer to areas which are to receive stained finish or preservative treatment.

.4 Unless specifically detailed, design connections to CAN/CSA-O86.1, and CAN/CSA-S16, to resist shears, moments and forces indicated. Fabricate in accordance with CAN/CSA-S16.

.5 Prime paint with EcoLogo certified primer connections after fabrication.

3.0 EXECUTION

3.1 PRESERVATIVE TREATMENT

.1 After fabrication, pressure treat indicated members with preservativein accordance with CAN/CSA-O80 Series.

3.2 ERECTION

.1 Ensure protective sealer is not damaged before erection. If damaged, touch up on site before erection.

.2 Erect glued-laminated members in accordance with reviewed erection drawings.

.3 Brace and anchor members until permanently secured by structure.

.4 Make adequate provisions for erection stresses.

.5 Splice and join only at locations as indicated on reviewed erection drawings.

.6 Do not field cut or alter members without Departmental Representative's approval. If approved, preservative treat all cut ends.

.7 Collect waste wood pieces from cutting for reuse where appropriate.

END OF SECTION

1.0 GENERAL

1.1 RELATED SECTIONS

.1	Rough Carpentry	Section 06 08 99
.2	Glued-Laminated Structural Units	Section 06 18 10
.3	Interior Painting	Section 09 91 23

1.2 REFERENCES

.1 Canadian Standards Association

.1 CSA B111-1974 (R1998), Wire Nails, Spikes and Staples. (Withdrawn)
.2 CAN/CSA-G40.21-13, Structural Quality Steels.
.3 CAN/CSA-G164-M92 (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
.4 CAN/CSA-O80 Series-08, Wood Preservation.
.5 CAN/CSA-O86-14, Engineering Design in Wood.
.6 CSA O112.9-10 Evaluation of Adhesives for Structural Wood Products (Exterior Exposure).
.7 CSA O112.10-08 Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).
.8 CAN/CSA-O122-06, Structural Glued-Laminated Timber.
.9 CAN/CSA-O177-06, Qualification Code for Manufacturers of Structural Glued-Laminated Timber.

.2 APA – The Engineered Wood Association

.1 APA Standard for Performance Rated CLT ANSI/APA PRG 320/2012.

1.3 SHOP DRAWINGS

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

.2 Prior to submission of shop drawings, contractor to provide a fully accurate three-dimensional (3D) model of the interfaces (supports, etc.), CLT panels, secondary timber members, plus all connections prior to submission of shop drawings. 3D model to use as-built foundation X, Y, Z coordinates for CLT panel bases.

.3 Shop drawings for members to indicate stress grade, service grade, appearance grade, connection details, shop applied finishes, shop and erection details, including cuts, holes, fastenings, camber and connection hardware.

.4 Submit shop drawings showing all applicable details and material specifications to the Departmental Representative for review prior to fabrication. Shop drawings shall be accompanied by a certificate of conformance to manufacturing standard

.5 Each erection and shop drawing submission shall bear signature and stamp of qualified professional engineer registered or licensed in province of British Columbia, Canada, for items designed by fabricator or manufacturer. The Professional Engineer shall, upon

completion of the work, submit to the Engineer of Record a completed Schedule S-B: Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional, and Schedule S-C: Assurance of Professional Field Review and Compliance by Supporting Registered Professional.

1.4 QUALIFICATIONS

.1 Manufacture structural glued-laminated members in plant certified by CSA as meeting requirements of CAN/CSA-O177, Class 1 (interior) and Class X (exterior) members.

.2 Submit certificate in accordance with CAN/CSA-O177, Appendix B at completion of fabrication.

.3 Glued-laminated members bonded with polyurethane resin (white) adhesive meeting the requirements of ANSI A190.1-1992, DIN 68 141 and EN 301 and 302

.4 Fabricator for welded steel connections to be certified in accordance with CSA W47.1.

.5 Place authorization labels on glued-laminated members indicating manufactured in CSA certified plant.

.6 Certification of material protective sealer.

1.5 DELIVERY AND HANDLING

.1 Apply protective sealer to glued-laminated units before shipping unless specified otherwise.

.2 Wrap members prior to leaving plant with a moisture resistant wrapping.

.3 Use padded, non-marring slings for handling glued-laminated members.

.4 Protect corners with wood blocking.

.5 Slit underside of membrane covering during storage at site. Do not deface member.

.6 Store CLT panels and protect from weather, block off ground and separate with stripping, so air may circulate around all faces of members.

.7 Cover CLT panels with opaque moisture resistant membrane if stored outside.

.8 Make adequate provision for delivery and handling stresses.

.9 Affix authorized label to all panels supplied. Also identify each panel with mark number.

.10 Maintain protection of CLT panels during construction.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

.5 Divert unused paint material from landfill to official hazardous material collections site approved by Departmental Representative.

.6 Do not dispose of unused paint materials or preservative material into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.

.7 Do not dispose of preservative treated wood through incineration.

.8 Do not dispose of preservative treated wood with materials destined for recycling or reuse.

.1 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.

.9 Dispose of unused wood preservative material at official hazardous material collections site approved by Departmental Representative.

.10 Divert unused wood materials from landfill to recycling, reuse, composting facility approved by Departmental Representative.

2.0 PRODUCTS

2.1 MATERIALS

.1 Laminating stock for CLT panels: Douglas Fir-Larch, Spruce Pine and Douglas Fir-Larch to CAN/CSA-O122.

.2 Adhesive: to CSA O112 Series and Sections 2.1.3 and 3.3 (ASTM D7247 heat durability) of AITC 405, to grade of service required in accordance with CAN/CSA-O122.

.3 Fastenings:

.1 Split ring connections: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
.2 Shear plate connections.
.1 Pressed steel type: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
.2 Malleable iron type: to ASTM A47M, grade 350.
.3 Lag screws: to CSA B34.
.4 Bolts: to ASTM A 307.
.5 Side plates: to CAN/CSA-G40.21 or ASTM A 36.
.6 Drift pins: to ASTM A 307.
.7 Glued-laminated rivets: hot dip galvanized to CAN/CSA-G40.21 or ASTM A 36.
.8 Nails and spikes: to CSA B111.
.9 Truss plates: light gauge galvanized sheet steel to ASTM A 653, grade A or B.

.4 Shop coat primer for steel connections: to CAN/CGSB-1.40.

.5 Galvanizing: to CAN/CSA-G164, hot dipped, minimum zinc coating of 610 g/m2.

2.2 FABRICATION

.1 Fabricate Cross Laminated Timber (CLT) panels in accordance with ANSI/APA PRG320/2012 except where specified otherwise and to following classifications. Use multiple layers of 19mm (¾ in) minimum to 38mm (1½ in) maximum thick laminations. Exceptions only with written consent of the Departmental Representative.

.2 CLT grade: as indicated on drawings and referenced by APA/PRG 320 and APA PR-L314C.

Appearance Classification:

a. Non-Exposed – where panels are concealed.
- Shake and checks allowed, shall not exceed 915mm or ¼ the length
- Heart or Blue Stain allowed, not limited
- Knots – firm and tight (NLGA #2)
- Pitch streaks not limited
- Minimal wane on face
- Side pressure on exposed face not required

b. Exposed – where panels are in view in final construction. Exposed face to utilize
"J" grade
SPF
lumber, or
L3&Btr D.
fir
- Shake and checks allowed up to 610mm (24 in) long, none through
- Up to a maximum of 5% Blue stain allowed, heart stain permitted.
- Knots – firm and tight (NLGA #2)
- Pitch streaks not limited
- Wane on face not permitted
- Side pressure on exposed faces required

.3 Visual grade Cross Laminated Timber (CLT) panels to be fabricated with chamfers, Non-Visual grade panels can be supplied without chamfers (90° corners).

.4 Cross Laminated Timber (CLT) panels to be joined at edges using a continuous spline. All required fastener and spline geometry by manufacturer. To be pre-approved by Departmental Representative prior to fabrication.

.5 Mark panels for identification during erection, ensure that marks will be concealed in final assembly for appearance grade panels. Clearly mark top surface.

.6 All structural steel connecting CLT panels to each other and to supporting panels shall be detailed, supplied and test fitted in the shop by the CLT supplier.

3.0 EXECUTION

3.1 EXAMINATION

.1 Prior to fabrication, check all dimensions relating to this section of work. Report any discrepancies to Departmental Representative.

.2 Prior to site erection, examine all site conditions and ensure an acceptable condition.

3.2 ERECTION

.1 Erect CLT panels in accordance with final reviewed shop drawings.

.2 Make adequate provision for possible erection stresses. Set panels level and plumb to correct positions. Securely brace panels and anchor in place to maintain plumb until permanently secured by finished structure.

.3 Fit CLT panels closely and accurately, without trimming, cutting or other modifications, unless approved in writing by Departmental Representative.

.4 Site cutting or boring of CLT panels, other than shown on shop drawings not permitted without written consent of Departmental Representative.

.5 Splice and join only at locations as indicated on reviewed erection drawings.

.6 Collect waste wood pieces from cutting for reuse where appropriate.

END OF SECTION 06 18 12

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Rough Carpentry — Section 06 08 99

.2 Architectural Woodwork — Section 06 40 00

.3 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/m^3.
.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.

2.2 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 08 99

.2 Finish Carpentry Section 06 20 00

.3 Joint Sealants Section 07 92 00

1.2 REFERENCES

.1 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
- .1 Architectural Woodwork Quality Standards Illustrated, latest edition.

.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 33 - 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: Not applicable.

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 19 - 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 bid 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.

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/m^2, FSC certified.
- .1 Medium density fibreboard performance requirements to: ANSI/NPA A208.2.
- .2 MDF resin to contain no added urea-formaldehyde.

.10 Nails and staples: to CSA B111.

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

.12 Splines: metal.

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

.14 Stainless: Grade 316, 18 gauge.

2.2 COUNTERTOP

.1 Stainless countertop with edge drip, backsplash and apron – 18 gauge, grade 316 stainless steel, customer fabrication to size as per drawing.

.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.

2.3 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 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.

.6 Cutouts for accessories shall be smooth and uniform without saw marks. The top and bottom of openings shall be finished smooth.

.7 Set nails and countersink screws apply stained wood filler to indentations, sand smooth and leave ready to receive finish.

.8 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.9 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

.10 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 Screws should not come in contact with solid surface material, as this may cause cracking of countertop.

.11 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 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – 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/m^2 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 INCLUDES

.1 Insulation and moisture protection as indicated on the drawings and specified herein.

1.2 RELATED SECTIONS

.1	Rough Carpentry	Section 06 08 99
.2	Finish Carpentry	Section 06 20 00
.3	Sprayed Polyurethane Insulation	Section 07 21 29
.4	Metal Wall Panels	Section 07 42 13
.5	Modified Bituminous Membrane Roofing	Section 07 52 00
.6	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./ft^3 density, compressive strength of 140 Kpa (20 psi) minimum and meet ULC S704. Facers must not have organic matter.

.2 Interior Wall Assembly Batt: Mineral Wool Insulation. Comply Type 1 CAN/ULC - S702.

.3 Exterior insulation to foundations and underslab: below grade shall be closed cell Type 4 polystyrene insulation. Exterior insulation above grade shall either be protected with an asphalt impregnated protection board.

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 Batt insulation installation for interior wall

.1 Install batt insulation for acoustic separations so as to press on drywall over entire surface area.

.2 Cut and trim insulation neatly, to fit spaces. Use batts free of ripped backs and/or edges. Butt edges and ends tightly.

.2 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 For insulation over waterproofing membrane, use only adhesion method. Do not penetrate any below grade waterproofing.

.4 Extend insulation under floor slab for a minimum of 610 mm wide.

.3 Roof insulation installation

.1 Apply adhesive to rigid insulation board at applied thickness as recommended by manufacturer at all areas indicated on drawings.

.2 Butt joints tightly, offset vertical joints. Use insulation boards free from chipped or broken edges.

.3 Install material in accordance with manufacturer's instructions.

3.4 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 04 05 00.01 Masonry Short Form

.2 07 27 00.01 Air Barriers – Descriptive or Proprietary

.3 09 21 16 Gypsum Board Assemblies

1.2 REFERENCES

.1 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 Guide For Commercial Interiors.

.2 Canadian Urethane Foam Contractors' Association Inc. (CUFCA)

.3 Green Seal Environmental Standards
- .1 Standard GC-03- 93, Anti-Corrosive Paints.
- .2 Standard GS-11- 97, Architectural Paints.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

.5 South Coast Air Quality Management District (SCAQMD), California State
- .1 SCAQMD Rule 1113- 06, Architectural Coatings.

.6 Underwriters' Laboratories of Canada (ULC)
- .1 CAN/ULC-S101-04, Fire Endurance Tests of Building Construction and Materials.
- .2 CAN/ULC-S102-03, 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 Requirement.

.5 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.

.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.

1.4 QUALITY ASSURANCE

.1 Applicators to conform to CUFCA Quality Assurance Program.

.2 Qualifications:

.1 The contractor performing work under this section must be licensed under the CUFCA (Canadian Urethane Foam Contractors Association) Quality Assurance Program.

.2 Installer: person specializing in sprayed insulation installations with 10 years documented experience approved by manufacturer. Installer (Applicators) must be Licensed under the CUFCA Quality Assurance Program. The installer shall be trained and certified by CUFCA/NECA (National Energy Conservation Association)/PSDI (Professional Skills Development Institute for Building Systems) in accordance with the training requirements outlined.

.3 The Licensed installer shall conduct the on-site daily testing as required by the CAN/ULC S705.2-02 Installation Standard. The Licensed Installer shall complete the Daily Work Report as required by the CAN/ULC S705.2-02 Installation Standard. The Licensed Contractor shall forward to the Owner, copies of the Daily Work Record upon request. The Licensed Contractor shall submit copies of the Daily Work Records or a monthly summary sheet to the CUFCA office, on a monthly basis, as required by the CUFCA Quality Assurance Program.

.4 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 Mock-up:

.1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.

.2 Construct mock-up 10 m² minimum, of sprayed insulation including one inside corner and one outside corner, door window openings .

.3 Mock-up may be part of finished work.

.4 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with sprayed insulation work.

.4 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.

.5 To ensure isolation of the immediate spray area and non-interference with other trades a pre-installation meeting shall be held one week before the commencement of spray operations.

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 Utilities.

.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.

1.8 ENVIRONMENTAL CONDITIONS

.1 Apply materials when chemical, atmospheric and cavity/surface temperatures are within the limitations required by the standard CAN/ULC S705.2-00 and as recommended by the manufacturer.

1.9 SEQUENCING AND SCHEDULING

.1 Co-ordinate this work with the work of all sections referencing this work.

.2 All foam insulation closures and substrates shall be completed and secure before the work of this section commences.

1.10 WARRANTY

.1 Warrant work under this section against defects in workmanship or material for a period of two years from date of substantial completion.

.2 Promptly rectify, at contractors expense, defects or deficiencies that become apparent during the warranty period.

.3 All work to be covered by the third party warranty program as set forth by the CUFCA Quality Assurance Program.

2.0 PRODUCTS

2.1 MATERIALS

.1 Insulation: closed cell medium density spray applied rigid polyurethane foam insulation and air

barrier to CAN/ULC-S705.1. (in checking amendments 1 and 2).

.2 Primers: in accordance with manufacturer's recommendations for surface conditions.
.1 Maximum VOC limit 100 g/l to SCAQMD Rule 1113.

.3 Test report from a certified testing laboratory indicating product meets the requirements of ULC S705.1-00 to be on file in the CUFCA office.

.4 Material containers shall be labeled with the approval number of the certifying agency.

.5 Physical Properties:

Property	**Value Metric (Imperial)**	**Test Method**
Density (Core)	29 kg/m^3 (1.8 lb/ft^3)	ASTM D1622
Compressive	186 kPa (27.0 psi)	ASTM D1621
Tensile Strength	241 kPa (35.0 psi)	ASTM D1623
Open Cell Content	8.0%	ASTM D2856
Water Absorption	1.2 % by volume	ASTM D2842
Water Vapour Permeance 25mm sample	63 ng/Pa·s·m^2 (1.05 Perms) 42 ng/Pa·s·m^2 (0.70 Perms)	ASTM E96
Dimensional Stability	Volume Change (%) after 28 days -0.0 @ -20°C (-29°F) 1.5 @ 70°C (158°F) @ 97± 3% RH 0.4 @ 80°C (176°F)	ASTM D2126
Flame Spread Classification**	Flame Spread <500 and Smoke Developed	CAN/ULC-S102 Including S127
Time to	24 Hours	CAN/ULC-S774
Initial Thermal Resistance (50	RSI: 2.45 m^2·K/W (R: 13.9 ft^2·hr·°F / BTU)	ASTM C518
Hot-Surface Performance	Passed when exposed to 93°C for 96 hours	ASTM C 411
Fungi Resistance	After 28 day incubation - no fungal growth	ASTM C1338

.4 Long-Term Thermal Resistance:
Test Method: CAN/ULC-S770

Thickness mm (inches)	R Value ft2·hr·°F / BTU	RSI m2·K/W
50.0 (1.97)	11.07	1.95
50.8 (2.00)	11.24	1.98
63.5 (2.50)	14.31	2.52
75.0 (2.95)	17.03	3.00
76.2 (3.00)	17.32	3.05
88.9 (3.50)	20.55	3.62
100 (3.94)	23.39	4.12
102 (4.00)	23.73	4.18

.5 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

.6 LEED Compliance
- .1 Min of 4.5% pre-consumer recycled / 3% rapidly renewable content based on weight.
- .2 VOC level of the finished product is less than 1%.

.7 Products that meet the preceding requirements:
- .1 BASF Walltite
- .2 Demilec Inc/Cornell Heatlok 0240/Airmetic 0223/
- .3 GNI/Insul-Barrier
- .4 PFSI Polar Foam 7300

2.2 EQUIPMENT

.1 Spray equipment to be in accordance with ULC S705.2-00 and manufacturer recommendations for type application.

.2 Equipment settings to be recorded daily as required by the Quality Assurance Program

.3 Each proportioner to supply only one spray gun.

3.0 EXECUTION

3.1 INSTALLERS

.1 Spray applied urethane foam installers must be trained and certified by CUFCA/NECA (National Energy Conservation Association) in accordance with CAN/ULC S705.2-00.

3.2 EXAMINATION

.1 Verify that surfaces and conditions are suitable to accept work as outlined in this section.

.2 Prior to commencement of work report in writing to the Departmental Representative any defects in surfaces or conditions that may adversely affect the performance of products installed under this section.

.3 Commencement of work outlined in this section shall be deemed as acceptance of existing work and conditions.

3.3 PREPARATION

. 1 PROTECTION
- .1 Mask and cover adjacent areas to protect from over spray.
- .2 Ensure any required foam stop or back up material are in place to prevent over spray and achieve complete seal.
- .3 Cover ventilation equipment and rig temporary ducting and fans to ensure control of fumes.

.2 SURFACE PREPARATION
- .1 Surfaces to receive foam insulation shall be free of frost, oil, and rust or other foreign matter that may impair the adhesion of the urethane foam to the substrate.
- .2 Ensure that all work of other trades that penetrates through the thermal insulation is in place and complete.
- .3 Ensure that surface preparation and any primers required conform to the manufacturers instructions.

3.4 APPLICATION

.1 Spray-application of polyurethane foam shall be performed in accordance with CAN/ULC

S705.2-00 and the manufacturers instructions.

.2 Apply only when surfaces and environmental conditions are within limits prescribed by the material manufacturer.

.3 Apply in consecutive passes as recommended by manufacturer to thickness as indicated on drawings.

.4 Do not install insulation within 75 mm of heat emitting devices such as light fixtures and chimneys.

.5 Finished surface of foam insulation to be free of voids and imbedded foreign objects.

.6 Remove masking materials and over spray from adjacent areas immediately after foam surface has hardened. Ensure cleaning methods do not damage work performed by other sections.

.7 Trim, as required, any excess thickness that would interfere with the application of cladding/covering system by other trades.

.8 Thickness of insulation shall be such as to provide a thermal resistance of R-20.

3.5 FIELD QUALITY CONTROL

.1 SITE TESTS

.1 The certified installers/apprentices shall routinely inspect and test their work and complete daily work sheets in accordance with CAN/ULC S705.2-00 and the CUFCA Quality Assurance Program.

.2 The daily worksheets shall be kept on site for routine inspection and monthly summaries sent to CUFCA on a monthly basis as required by the Quality Assurance Program.

.3 The costs of these requirements are to be borne by the Licensed Contractor.

.2 INSPECTION

.1 Arrange for third party testing by Contractors Warranty Corporation, providers of the Quality Assurance Program insurance. Cost of testing to be borne by the Licensed Contractor.

.2 Testing shall verify conformance with the requirements specified in this section, the standard CAN/ULC S705.1 and .2-00 and the Quality Assurance Program.

.3 Testing shall be carried out at 5%, 50% and 95% of completion. Written test results shall be forwarded to the Owner's representative and the Licensed Contractor within 3 working days of the test being performed.

.4 If defects are revealed Licensed Contractor shall immediately rectify all such defects at his cost.

3.6 TOLERANCES

.1 Maximum variation from indicated thickness(es): minus (-) 6 mm ($^1/_4$"); plus (+) 10 mm (3/8")

3.7 PROTECTION

.1 Thermal Barrier if required.

.2 The spray polyurethane foam shall be covered with a thermal barrier when installed on the interior of the building.

3.8 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	Modified Bituminous Membrane Roofing	Section 07 52 00
.2	Thermal Insulation	Section 07 21 00
.3	Sprayed Insulation Polyurethane Foam	Section 07 21 29
.3	Sheet Metal Flashing & Trim	Section 07 62 00
.4	Metal Doors and Frames	Section 08 11 00

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 72 hours 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 Provide manufacturer’s warranty for sealant and sheet materials for 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-AC38/3.3.4.
- .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 gypsum wall board and concrete masonry unit 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 Waterproofer's 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 on gypsum board or concrete masonry block 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 SECTIONS

.1	Rough Carpentry	Section 06 08 99
.2	Thermal Insulation	Section 07 21 00
.3	Sprayed Insulation Polyurethane Foam	Section 07 21 29
.4	Air Barriers	Section 07 27 00.01
.5	Sheet Metal Flashing and Trims	Section 07 62 00
.6	Joint Sealants	Section 07 92 00
.7	Metal Doors & Frames	Section 08 11 00
.8	Gypsum Board Assemblies	Section 09 21 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 Model Schedule B and Schedule C confirming the work is designed and installed in conformance with the structural design criteria.

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 (24ga) 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 PVDF/Kynar finish.

.2 Profile:
- .1 Vicwest CL 7040 – 935mm x 40mm Profiled Metal Cladding PVDF/Kynar finish or equivalent profile.
- .2 Colour: 3 different colours as shown on drawings to match the followings :
  - .1 MC-1 Vicwest 56073 Dark Green
  - .2 MC-2 Vicwest 56156 Pacific Turquoise
  - .3 MC-3 Vicwest 56065 Mist Green
- .3 Alternative acceptable color combination is as follows :
  - .1 MC-1 Vicwest 56073 Dark Green
  - .2 MC-2 Vicwest 56083 Deep Water Green
  - .3 MC-3 Vicwest 56156 Pacific Turquoise

.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.

.9 Fasteners to have a minimum 2000hr salt spray rating.

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, escept 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.

END OF SECTION 07 42 13

1.0 GENERAL

1.1 SUMMARY OF WORK

.1 Work of this section includes provision of a 2 ply torch applied SBS membrane over insulation sheathing over steel deck.

1.2 RELATED REQUIREMENTS

.1	Rough Carpentry for Minor Works	Section 06 08 99
.2	Thermal Insulation	Section 07 21 00
.3	Air Barriers	Section 07 27 00.01
.4	Sheet Metal Flashing and Trim	Section 07 62 00
.5	Joint Sealants	Section 07 92 00
.6	Gypsum Board Assemblies	Section 09 21 16

1.3 REFERENCES

.1 ASTM International Inc.
- .1 ASTM C1177/C1177M-08, Standard Specification for Glass Mat Gypsum Substrate for use as Sheathing.
- .2 ASTM D 6164-05 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.

.2 Canadian General Standards Board (CGSB)
- .1 CGSB 37-GP-9Ma-, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
- .2 CGSB 37-GP-56M-80b (A1985), Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.

.3 Roofing Contractors' Association of British Columbia R.C.A.B.C. RGC Roofing Practices Manual, guarantee standards.

.4 Canadian Standards Association (CSA International)
- .1 CSA-A123.3-05, Asphalt Saturated Organic Roofing Felt.
- .2 CSA-A123.4-04, Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems.
- .3 CSA O121-08, Douglas Fir Plywood.
- .4 CSA O151-04, Canadian Softwood Plywood.

.5 Factory Mutual (FM Global)
- .1 FM Approvals - Roofing Products.

.6 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

.7 Underwriters Laboratories' of Canada (ULC)
- .1 CAN/ULC-S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Convene pre-installation meeting two week prior to beginning waterproofing Work, with roofing contractor's representative, membrane manufacturer's representative, and Departmental Representative in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review installation instructions and warranty requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide two copies of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements, and indicate VOC content for primers.

.3 Provide shop drawings:

.1 Indicate flashing, control joints and tapered insulation details.

.2 Provide layout for tapered insulation.

1.6 QUALITY ASSURANCE

.1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with minimum 5 years' experience.

.2 Inspection Authority:

.1 Selected from RCABC Approved list of Roofing Inspectors.

.2 The presence of an Inspector shall in no way excuse the Contractor from performing the Work in accordance with the contract Documents and keeping with the best practices of the trades.

.3 The Inspector will not be responsible for or have control or charge over safety precautions and programs required for the Work in accordance with the applicable construction safety legislation, other regulations or general construction practice, the acts or omissions of the contractor, his subcontractors or their agents, employees or other persons performing any of the Work.

.4 The Contractor shall inform the Inspection Agency seven (7) days prior to commencement of work.

1.7 FIRE PROTECTION

.1 Fire Extinguishers:

.1 Maintain one cartridge operated type with shut-off nozzle, on roof per torch applicator, within 6 m of torch applicator.

.2 ULC labelled for A, B and C class protection.

.2 Maintain fire watch for 1 hour after each day's roofing operations cease.

1.8 DELIVERY, STORAGE, AND HANDLING

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

.2 Storage and Handling Requirements:

.1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.

.2 Provide and maintain dry, off-ground weatherproof storage.

.3 Store rolls of membrane in upright position. Store membrane rolls with salvage edge up.

.4 Remove only in quantities required for same day use.

.5 Place plywood runways over completed Work to enable movement of material and other traffic.

.6 Store sealants at +5 degrees C minimum.

.7 Store insulation protected from daylight and weather and deleterious materials.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.9 SITE CONDITIONS

.1 Ambient Conditions

.1 Do not install roofing when temperature remains below -18 degrees C for torch application, or -5 degrees C for mop application.

.2 Minimum temperature for solvent-based adhesive is -5 degrees C.

.2 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.

1.10 WARRANTY

.1 Upon completion of work, this Contractor shall furnish Owners with a 10-YEAR R.C.A.B.C. Roof Star Guarantee on all work of this section.

.2 Provide for inspection in accordance with specifications and with R.C.A.B.C. Standards. Inspection fees shall be included in this contract.

.3 Upon Total Performance of the Contract submit a Ten (10) year Labour and Materials Warranty issued by the manufacturer of the roofing membrane.

2.0 PRODUCTS

2.1 PERFORMANCE CRITERIA

.1 Compatibility between components of roofing system is essential. Provide written declaration to Departmental Representative stating that materials and components, as assembled in system, meet this requirement.

2.2 DECK COVERING

.1 Gypsum board sheathing: to ASTM C1177/C1177 M-08 Standard 15.9 mm thick Glass Mat Gypsum Sheathing.

2.3 DECK PRIMER

.1 Asphalt primer: to CGSB 37-GP-9Ma.

2.4 VAPOUR RETARDER

.1 Base sheet vapour retarder: to CGSB 37-GP-56M, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, polyester reinforcement, weighing 180 g/m².

.1 Top and bottom surfaces: sanded/thermofusible.

2.5 MEMBRANE

.1 Base sheet: to CGSB 37-GP-56M polyester fibres to ASTM D 6164.

.1 Styrene-Butadiene-Styrene (SBS) elastomeric polymer prefabricated sheet, polyester reinforcement, having nominal weight of 180 g/m².

.2 Type 1, torch on.

.3 Grade 1 - standard service.

.4 Top and bottom surfaces:

.1 Thermofusible.

.5 Base sheet membrane properties: to CGSB 37-GP-56M.

.1 Strain energy (longitudinal/transversal): 9.0/7.0 kN/m.

.2 Breaking strength (longitudinal/transversal): 17.0/18.0 N/5 cm.

.3 Ultimate elongation (longitudinal/transversal): 60/70.

.4 Tear resistance: 85 N.

.5 Cold bending at -30 degrees C: no cracking.

.6 Softening point: ò 110 degrees C.

.7 Static puncture resistance: > 400.

.8 Dimensional Stability: -0.3 / 0.3 %.

.6 ULC certification: Class A.

.2 Cap sheet membrane: to CGSB 37-GP-56M polyester fibres to ASTM D 6164.

.1 Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, polyester reinforcement, having nominal weight of 250 g/m².

.2 Type 1, torched on.

.3 Class A-granule surfaced.

.1 Colour for granular surface: red.

.4 Grade 1-standard service.

.5 Bottom surface: thermofusible.

.6 Cap sheet membrane properties: to CGSB 37-GP-56M.

.1 Strain energy (longitudinal/transversal): 13.0/10.0kN/m.

.2 Breaking strength (longitudinal/transversal): 25.0/16.0 kN/m.

.3 Ultimate elongation (longitudinal/transversal): 63/73 60/65 %.

.4 Tear resistance: 80 N.

.5 Cold bending at -30 degrees C: No cracking.

.6 Softening point: ò 110 degrees C.

.7 Static puncture resistance: > 400 370 .

.8 Dimensional Stability: -0.2 / 0.2 %.

.9 ULC certification: Class A.

.10 White colour high reflective surface.

2.6 OVERLAY BOARD

.1 Overlay Board: 6mm thick asphalt impregnated fiberboard.

.1 Install over insulation to provide torch safe surface.

2.7 BITUMEN

.1 Asphalt: to CAN/CSA A123.4 ASTM D 312 , Type 2 3 .

2.8 POLYISOCYANURATE INSULATION

.1 Typical flatboard polyisocyanurate foam to ULC S704, Minimum 141mm thick equivalent to thermal resistance of R28, at any point of the roof. Refer to Section 07 21 00 Thermal Consultation.

.2 Create cricket around roof mechanical unit as required to divert water away from mechanical equipment.

.3 Tapered insulation to create slope as required and as shown on drawing to divert water towards the roof drain.

2.9 SEALERS

.1 Sealing compound: rubber asphalt type.

.2 Caulking - see Section 07 92 00 - Joint Sealants.

2.10 WALKWAYS

.1 Walkways to consist of one additional ply of cap sheet membrane. Colour to be different from field membrane as selected by Departmental Representative.

2.11 CARPENTRY

.1 Refer to Section 06 08 99 - Rough Carpentry – For Minor Works.

2.12 FASTENERS

.1 Covering to steel deck: No. 10 flat head, self-tapping, Type A or AB, cadmium plated screws. Recommend FM Approved screw and plate assemblies.

.2 Insulation to deck: coated insulation fasteners and galvanized plates must meet FM Approval for wind uplift and corrosion resistance, as recommended by insulation manufacturer.

3.0 EXECUTION

3.1 QUALITY OF WORK

.1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and RCABC Roofing Specification Manual to meet specified Guarantee standards, particularly for fire safety precautions.

.2 Do priming in accordance with manufacturers written recommendations.

.3 The interface of the walls and roof assemblies will be fitted with durable rigid material providing connection point for continuity of air barrier.

.4 Assembly, component and material connections will be made in consideration of appropriate design loads.

3.2 EXAMINATION OF ROOF DECKS

.1 Verification of Conditions:

.1 Inspect with Departmental Representative deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.

.2 Evaluation and Assessment:

.1 Prior to beginning of work ensure:

.1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.
.2 Curbs have been built.
.3 Roof drains have been installed at proper elevations relative to finished roof surface.
.4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.

.3 Do not install roofing materials during rain or snowfall.

3.3 PROTECTION OF IN-PLACE CONDITIONS

.1 Cover walls, walks and adjacent work where materials hoisted or used.

.2 Use warning signs and barriers. Maintain in good order until completion of Work.

.3 Clean off drips and smears of bituminous material immediately.

.4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.

.5 Protect roof from traffic and damage. Comply with precautions deemed necessary by Departmental Representative.

.6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.

.7 Metal connectors and decking will be treated with rust proofing or galvanization.

3.4 DECK SHEATHING

.1 Mechanically fasten to steel deck Gypsum Board Sheathing with screws to steel deck's upper rib surfaces, spaced 400 mm on centre each way.

.2 Place with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.5 VAPOUR RETARDER

.1 Install peel and stick continuous over installed gypsum sheathing. Extend up vertical surfaces as shown and tie into air/vapour barrier as indicated or required.

3.6 CONVENTIONAL MEMBRANE ROOFING

.1 Insulation: Refer to Section 07 21 00

.2 Tapered insulation application:
.1 Install tapered insulation as second insulation layer, in accordance with shop drawings. Stagger joints between layers 150 mm minimum.

.3 Overlay Board:
.1 Place boards in parallel rows with end joints staggered, mechanically fastened as per manufacturer’s recommendation.

.4 Base sheet application:
.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and reroll from

both ends.

.2 Unroll and torch base sheet onto substrate taking care not to burn membrane or its reinforcement or substrate.

.3 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

.4 Application to be free of blisters, wrinkles and fishmouths.

.5 Cap sheet application:

.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and reroll from both ends.

.2 Unroll and torch cap sheet onto base sheet taking care not to burn membrane or its reinforcement.

.3 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum from those in base sheet.

.4 Application to be free of blisters, fishmouths and wrinkles.

.5 Do membrane application in accordance with manufacturer's recommendations.

.6 Flashings:

.1 Complete installation of flashing base sheet stripping prior to installing membrane cap sheet.

.2 Torch base and cap sheet onto substrate in 1 metre wide strips.

.3 Lap flashing base sheet to membrane base sheet minimum 150 mm and seal by mopping or torch welding.

.4 Lap flashing cap sheet to membrane cap sheet 250 mm minimum and torch weld.

.5 Provide 75 mm minimum side lap and seal.

.6 Properly secure flashings to their support, without sags, blisters, fishmouths or wrinkles.

.7 Do work in accordance with Section 07 62 00 - Sheet Metal Flashing and Trim.

.7 Roof penetrations:

.1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details.

3.7 WALKWAYS

.1 Install additional cap sheet in contrasting colour as walkway membrane in accordance with manufacturer's instructions and as indicated.

.1 Apply primer to cap sheet membrane and torch apply, ensuring selvage edge is removed.

.2 Install concrete paver at cat ladder landing and foot path as indicated on roof plan. Level on insulation pads, as indicated.

3.8 FIELD QUALITY CONTROL

.1 Inspections:

.1 Inspection and testing of roofing systems and application will be carried out by testing laboratory designated by Departmental Representative.

.2 Inspection will be carried out during the entire roof installation procedure.

.3 Manufacturer’s Representative to complete review of basesheet installation prior to cap sheet installation.

.4 Manufacturer’s Representative to complete review of cap sheet installation.

3.9 CLEANING

.1 Remove bituminous markings from finished surfaces.

.2 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of

surfaces for cleaning advice and complying with their documented instructions.

.3 Repair or replace defaced or disfigured finishes caused by work of this section.

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

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

.2 Ensure emptied containers are sealed and stored safely.

.3 Unused adhesive, sealant and asphalt 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.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

.5 Dispose of unused sealant material at official hazardous material collections site approved by Departmental Representative.

.6 Divert unused gypsum materials from landfill to recycling facility as reviewed by Departmental Representative.

END OF SECTION 07 52 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Air Barriers — Section 07 27 00.01

.2 Metal Wall Panels — Section 07 42 13

.3 Modified Bituminous Membrane Roofing — Section 07 52 00

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 5 year R.C.A.B.C. guarantee work of this section.

.3 Provide for inspection in accordance with specifications and RCABC's guarantee requirement. 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 Zinc coated steel sheet: 0.61 mm (24ga) thickness, commercial quality to ASTM A 792, with Z275 designation zinc coating, finish enamel coated factory applied coating to CGSB 93-GP-3m Class F29, color to match profiled metal panels as shown on drawing.

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	Gypsum Board Assemblies	Section 09 21 16
.3	Non-Structural Metal Framing	Section 09 22 16
.4	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: F rating to match floor or wall assemblies.

.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	Metal Doors and Frames	Section 08 11 00
.5	Gypsum Board Assemblies	Section 09 21 16
.6	Resilient Floor for Minor Works	Section 09 65 99
.7	Exterior Painting	Section 09 91 13
.8	Interior Painting	Section 09 92 13
.9	Mechanical	Divisions 21-23
.10	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.

DOOR SCHEDULE

DOOR							FRAME				RATING	REMARKS	LOCATION
No.	Door W (mm)	Opening H (mm)	Type	Mat'l	Finish	Glass Type	Type	Mat'l	Finish	Glass Type			
101A	1220	2440	D1	HM	PTD	-	F1	PSS	PTD	-	-	#1, #2	INTEGRATION AREA WEST
101B	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	-	#1, #2	INTEGRATION AREA EAST
101C	10,000	10,000	-	RD	-	-	-	-	-	-	-	#1, #3	INTEGRATION AREA WEST
102	915	2134	-	-	-	-	-	-	-	-	-	#4	CLEAN ROOM
103	915	2134	-	-	-	-	-	-	-	-	-	#4	COLD ROOM
104	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	-	#5	UNIVERSAL W/R
105	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	-	#1, #2	ELECTRICAL ROOM
106	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	1-1/2 hr	#1, #2	MECHANICAL ROOM
201	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	-		SSC COMM. ROOM
203	915	2134	D1	HM	PTD	-	F1	PSS	PTD	-	-	#5	UNISEX W/R

LEGEND

PSS PRESSED STEEL FRAME
HM HOLLOW METAL DOOR
PTD PAINT FINISH
RD RUBBER DOOR (Refer Spec 08 37 03)

Remarks

#1 Refer Exterior Elevation drawings
#2 Insulated Exterior Door
#3 10m x 10m overhead door
#4 Provided by others as part of the equipment
#5 Door Grille (refer Mech.)

END OF SECTION 08 06 10

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1	Concrete Unit Masonry	Section 04 22 00
.2	Rough Carpentry	Section 06 08 99
.3	Finish Carpentry	Section 06 20 00
.4	Door Hardware	Section 08 71 00
.5	Non-Structural Metal Framing	Section 09 22 16
.6	Exterior Painting	Section 09 91 13
.7	Interior Painting	Section 09 91 23

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 CGSB 41-GP-19Ma-84, Rigid Vinyl Extrusions for Windows and Doors.

.2 Canadian Standards Association (CSA International)
- .1 CSA-G40.20-04/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 CSA W59-03, Welded Steel Construction (Metal Arc Welding).

.3 Canadian Steel Door Manufacturers' Association (CSDMA)
- .1 CSDMA, Recommended Specifications for Commercial Steel Doors and Frames, 2000.
- .2 CSDMA, Selection and Usage Guide for Commercial Steel Doors, 1990.

.4 National Fire Protection Association (NFPA)
- .1 NFPA 80-2007, Standard for Fire Doors and Fire Windows.
- .2 NFPA 252-2012, Standard Methods of Fire Tests of Door Assemblies.

.5 South Coast Air Quality Management District (SCAQMD), California State
- .1 SCAQMD Rule 1113-04, Architectural Coatings.
- .2 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.

.6 Underwriters' Laboratories of Canada (ULC)
- .1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .2 CAN/ULC-S702-09, Standard for Thermal Insulation, Mineral Fibre, for Buildings.
- .3 CAN/ULC-S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.
- .4 CAN4-S104-M80, Standard Method for Fire Tests of Door Assemblies.
- .5 CAN4-S105-M85, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN4-S104.

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:
- .1 Provide fire labeled frames for openings requiring fire protection ratings. Test products in

conformance with CAN4-S104, and listed by nationally recognized agency having factory inspection services and to ULC fire protection rating.

1.4 SUBMITTALS

.1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed, arrangement of hardware and fire rating and finishes.

.2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and finishes.

.3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

.1 Hot dipped galvanized steel sheet: to ASTM A 653M, ZF75, minimum base steel thickness in accordance with CSDMA Table 1 - Thickness for Component Parts.

.2 Reinforcement to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A 653M, ZF75.

.3 Exterior and Interior Door Frames: 16ga typical, 12ga for oversized door frame.

2.2 DOOR CORE MATERIALS

.1 Honeycomb construction:

.1 Structural small cell, 24.5 mm maximum kraft paper 'honeycomb', weight: 36.3 kg per ream minimum, density: 16.5 kg/m³ minimum sanded to required thickness.

.2 Stiffened: doors to be reinforced with 0.8mm (20 gauge) hat shaped steel stiffeners welded to inside of face sheets. Stiffeners to be located a maximum 152mm (6”) on center and welded to face sheet on 100mm(4”) centers. Areas between stiffeners to be filled with fiberglass insulation.

.3 All exterior doors and acoustic doors are to be insulated.

2.3 ADHESIVES

.1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.

.1 Adhesive: maximum VOC content 50 g/L to SCAQMD Rule 1168.

.2 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity, and sealant/adhesive.

2.4 PRIMER

.1 Touch-up prime CAN/CGSB-1.181.

.1 Maximum VOC limit 50 g/L to GC-03.

2.5 PAINT

.1 Field paint steel doors and frames in accordance with Sections 09 91 13 – Exterior Painting and 09 91 23 - Interior Painting. Protect weatherstrips from paint. Provide final finish free of scratches or other blemishes.

.1 Maximum VOC emission level 50 g/L to GS-11 to SCAQMD Rule 1113.

2.6 ACCESSORIES

.1 Door silencers: single stud rubber/neoprene type.

.2 Exterior and interior top and bottom caps: rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma.

.3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.

.4 Metallic paste filler: to manufacturer's standard.

.5 Fire labels: metal riveted.

.6 Sealant:

.1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.

2.7 FRAMES FABRICATION GENERAL

.1 Fabricate frames in accordance with CSDMA specifications.

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

.3 Interior frames: 1.2 mm welded type construction.

.4 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.

.5 Prepare frame for door silencers, 3 for single door, 2 at head for double door.

.6 Manufacturer's nameplates on frames and screens are not permitted.

.7 Conceal fastenings except where exposed fastenings are indicated.

.8 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

2.8 FRAME ANCHORAGE

.1 Provide appropriate anchorage to floor and wall construction.

.2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.

.3 Provide 2 anchors for rebate opening heights up to 1520 mm and 1 additional anchor for each additional 760 mm of height or fraction thereof.

2.9 FRAMES: WELDED TYPE

.1 Welding in accordance with CSA W59.

.2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.

.3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.

.4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.

.5 Securely attach floor anchors to inside of each jamb profile.

.6 Weld in 2 temporary jamb spreaders per frame to maintain proper alignment during shipment.

2.10 DOOR FABRICATION GENERAL

.1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.

.2 Fabricate doors with longitudinal edges welded. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.

.3 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.

.4 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.

.5 Reinforce doors where required, for surface mounted hardware. Provide flush steel top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.

.6 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.

.7 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

.8 Manufacturer's nameplates on doors are not permitted.

2.13 DOORS: HONEYCOMB CORE CONSTRUCTION

.1 Form face sheets for exterior and interior doors from 1.2 mm sheet steel with honeycomb or laminated under pressure to face sheets.

2.14 HOLLOW STEEL CONSTRUCTION

.1 Form face sheets for interior doors from 1.2mm sheet steel.

.2 Reinforce doors with vertical stiffeners, securely welded to face sheets at 150 mm on centre maximum.

.3 Fill voids between stiffeners of interior doors with honeycomb core.

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 INSTALLATION GENERAL

.1 Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise.

.2 Install doors and frames to CSDMA Installation Guide.

3.3 FRAME INSTALLATION

.1 Set frames plumb, square, level and at correct elevation.

.2 Secure anchorages and connections to adjacent construction.

.3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.

.4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.

.5 Caulk perimeter of frames between frame and adjacent material.

.6 Maintain continuity of air barrier and vapour retarder.

3.4 DOOR INSTALLATION

.1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Door Hardware.

.2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.

.1 Hinge side: 1.0 mm.
.2 Latchside and head: 1.5 mm.
.3 Finished floor: 13 mm.

.3 Adjust operable parts for correct function.

.4 Install window.

3.5 FINISH REPAIRS

.1 Touch up with primer finishes damaged during installation.

.2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

END OF SECTION 08 11 00

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Structural Steel for Buildings — Section 05 12 23

.2 Metal Fabrications — Section 05 50 00

.3 Gypsum Board Assemblies — Section 09 21 16

.4 Non-Structural Metal Framing — Section 09 22 16

1.2 REFERENCES

.1 American Society for Testing and Materials (ASTM)

.2 National Electrical Manufacturer's Association (NEMA)

.3 Underwriters Laboratories, Inc. (CUL)

1.3 SYSTEM DESCRIPTION

.1 Electrical Motor operated unit with manual override in case of power failure.

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 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

.3 Provide general construction, component connections and details, electrical equipment and operation instructions.

.4 Samples: Submit color samples of door panels.

.5 Manufacturer's Installation: Indicate installation sequence and procedures, adjustment and alignment procedures.

1.5 REGULARTORY REQUIREMENTS

.1 National Building Code 2015

.2 BC Building Code 2012

.3 Electrical components UL listed.

.4 Electrical enclosure NEMA approved.

1.6 PERFORMANCE REQUIRMENTS

.1 Provide High Wind Loading Option: Equipped with wind gussets.

1.7 QUALITY ASSURANCE

.1 Furnish high-speed roll doors and all components and accessories by one manufacturer.

.2 Manufacturer's and Supplier's representative.

1.8 FIELD MEASUREMENTS

.1 Verify field measurements are as indicated on shop drawings.

1.9 COORDINATION

.1 Coordinate the work with installation of electric power and locations and sizes of conduit.

1.10 WARRANTY

.1 High speed rubber door fabric for the life of the door, labor limited to one (1) year.

.2 EDPM fabric for five (5) years, labor limited to one (1) year.

.3 One (1) year parts and labor limited warranty.

2.0 PRODUCTS

2.1 MATERIALS

.1 Door Panel:

.1 Fabric:

.1 2 layers of Styrene Butadiene Rubber (SBR) each 1/8" (0.8mm) thick, 60 durometer; sandwiched with 1-ply, 110plw (50kg) polyester cord center.

.2 Complete with bonded SBR bevelled continuous windlocks, providing normal resiliency and flexibility at temperatures ranging from -40° F to +180°F (-40°C to +85°C).

.2 Characteristics:

.1 Breaking strength 1100 lbs/in/ply

.3 Standard color Black EPDM

.2 Door Header:

.1 Door roll

.1 Fabricate minimum 12" (219 mm) diameter, steel tube from 0.188" (4.75 mm) steel complying with ASTM A513

.2 Drum tube deflection shall not exceed 0.03" per foot (2.5mm / M) of opening width

.3 Drive barrel shafts are constructed of 2 1/2" (63.5 mm) diameter 1045 bolt-on steel shafts

.4 Drive barrel shafts for doors 40' wide and wider is 16" (406.4 mm) in diameter

.2 Idler Barrel

.1 Fabric guiding barrel shall be constructed of minimum 6 5/8" (168 mm) O.D. round tubing with a minimum wall thickness of 0.25" (6 mm) and supported by 2 3/4(70 mm) diameter 1018 steel shafts.

.2 Idler Barrel configuration for doo sizes 40' wide and wider is split with 2" diameter 1018 shafts.

.3 Top plates

.1 Constructed of minimum ¼" (6 mm) hot-rolled steel laser-cut plates with heavy-duty, self-aligning bearings with cast iron housings to support both the spring and idler barrels.

.2 To include top roll alignment plates for installation.

.4 Counterbalance System
.1 Torsion springs shall be connected by chain and sprocket to drive barrel.

.3 Side Frames:
.1 Frames
.1 Frame assemblies shall be constructed of steel members to form a slot of sufficient depth to allow the thicker edges of the rubber curtain windloks to move freely in the guides at all times. Steel members are to be of sufficient thickness and rigidity to maintain the windloks within the guides while enabling the windloks to break away during impact.
.2 Wind Resistance
.1 Wind resistant capabilities shall include a windlok rubber component on each side of the curtain fabric and guide gussets The windlok feature runs the full height of the door curtain and is contained in the side frames to secure the door under wind pressure and to decrease air infiltration.
.3 Paint
.1 Painted with durable, chemical and corrosion resistant coating
.2 Color: orange
.4 Side frames covers shall be hinged to allow easy curtain access.

.4 Control Panel:
.1 Panel enclosure shall be NEMA-4
.2 Wiring shall be completed by manufacturer and shall be UL listed (File E103891).
.3 Drive system shall be controlled by programmable logic controller (PLC).
.4 Control functions determined by manufacture's preparation of programmable logic controller.
.5 Optional custom designed control system and/or components.
.6 Control panel shall be adjustable using a minimum of the following items: automatic closing timer, emergency stop, two actuating push buttons and a cycle counter.

.5 Drive:
.1 Electric door operators shall be CSA/UL approved, Model FDGH, heavy-duty gearhead type c/w pre-wired, coded cables to manufacturer's standard.

.6 Spring:
.1 100,000 cycle torsion spring.

.7 Electrical Motor:
.1 Motor to be T.E., high-starting torque, flange & foot mount, hoist-type, operating through a parallel helical gear reducer mechanism. The gear reducer is mounted on a heavy-duty base of 1/4" steel.
.2 Motor and sprocketing to be of capacity to operate door at maximum speeds of up to 18" per second, depending on door size to manufacturer's standard, rated for up to 5HP.
.3 Provide high-starting torque, reversible intermittent duty, enclosed non-ventilated electric motor, sized to move door in either direction, from any position.
.4 Power Supply:
.1 Primary Voltage: Coordinate wiring requirements and current characteristics of door electrical system with building electrical system. Supply shall be rated at ** 220**460**575** volt,
.2 (3) phase, 60 Hz, up to 20 FLA (full loaded amps).

.8 Operator:
- .1 Operator shall be equipped with rotary screw-type limit switches to control open and close door positions as well as an electro-mechanical brake system to stop and hold door in any position to manufacturer's standards.
- .2 Operator shall be equipped with built-in manual emergency chain hoist. Built-in electrical interlock shall prevent motor operation during use of manual chain hoist. The stop switches shall be integrated at the head to avoid breakage due to environmental problems (limit switch).

.9 Bottom Bar:
- .1 Bottom bar shall extend the full width of the curtain, sufficient to maintain the bottom edge of the curtain parallel to the door threshold at all times. The bottom bar shall be constructed of a steel angle and flat bar bolted together and shall have a breakaway center section to reduce risk of damage during accidental impacts and provide ease of straightening, allowing for simple re-assembly.
- .2 6" tall weatherproof rubber loop made of EPDM able to seal uneven finished floors
- .3 Door to be provided with failsafe electric safety edge. No pneumatic edges allowed.

.10 Safety Features:
- .1 Provide fuses to protect from power line overcurrent and from secondary control voltage.
- .2 Provide chain host switch to electrically disconnect control circuitry during manual operations.
- .3 Running timer shall be provided to protect drive unit from motor run-on.
- .4 Safety Edge:
  - .1 Safety edge system shall continuously monitor and prevent door from closing if a fault is detected.
  - .2 Electric edge pressure contacts shall reverse the door to full open position, on contact with foreign object(s).
  - .3 Electric edge shall be fail safe.
  - .4 Electric Edge protective cover shall be a 7" tall and 1/8" thick weather proof rubber loop made of EPDM.
- .5 Provide emergency stop feature to instantly stop door in any position.
- .6 Provide start-up protection to ensure there is not movement of door when system detects a failure (power on/off/on, E stop…).
- .7 Provide inline thru beam photocell in proximity to door line.

.11 Speed:
- .1 Door to operate at a variable speed up to 9" per second in the up direction depending on door size.

.12 All components furnished by factory.

3.0 EXECUTION

3.1 EXAMINATION
.1 Verify that opening sizes, tolerances and conditions are acceptable.

3.2 INSTALLATION
.1 Install door assembly in accordance with manufacturer's instructions.

.2 Use anchorage devices to securely fasten assembly to wall constructions and building framing without distortion or stress.

.3 Fit and align assembly including hardware; level and plumb to provide smooth operation.

.4 Coordinate installation of electrical service. Complete wiring from disconnect to unit components.

.5 Touch-up paint on frame and other painted surfaces in accord with painting section.

.1 Upon completion of installation, including work by other trades, lubricate, test and adjust doors to operate in accordance with manufacturer's product data. Final adjustments shall be made by manufacturer's authorized representative.

.2 Protect finished installations until Date of Substantial Completion. Repair damage to door panel, hardware and operators.

3.3 ADJUSTING

.1 Adjust door and operating assemblies.

.2 Test and adjust door, if necessary, for proper operations.

3.4 CLEANING

.1 Progress Cleaning: Clean in accordance with Section 01 74 11 – Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.5 PREPARATION

.1 Protect the installed product and components from damage during construction.

END OF SECTION 08 37 03

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Finish Carpentry — Section 06 20 00

.2 Metal Doors & Frames — Section 08 11 00

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.

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 Door 101a
.1 4 Ea. Hinges A1
.2 1 Ea. Lock set B2
.3 2 Ea. Cylinder B1
.4 1 Ea. Closer C1
.5 1 Ea. Kick Plate J1
.6 1 Set Seals M1-2height x 1 width
.7 1 Ea. Threshold M2-width

.2 Door 101b
.1 3 Ea. Hinges A1
.2 1 Ea. Lock set B2
.3 2 Ea. Cylinder B1
.4 1 Ea. Closer C1
.5 1 Ea. Kick Plate J1
.6 1 Set Seals M1-2height x 1 width
.7 1 Ea. Threshold M2-width

.3 Door 101c, 102 & 103
.1 H1

.4 Door 104
- .1 3 Ea. Hinges A2
- .2 1 Ea. Privacy Set B4
- .3 1 Ea. Closer C1
- .4 1 Ea. Kick Plate J1

.5 Door 105
- .1 3 Ea. Hinges A1
- .2 1 Ea. Lock set B3
- .3 1 Ea. Cylinder B1
- .4 1 Ea. Closer C1
- .5 1 Ea. Kick Plate J1
- .6 1 Set Seals M1-2height x 1 width
- .7 1 Ea. Threshold M2-width

.6 Door 106
- .1 3 Ea. Hinges A1
- .2 1 Ea. Lock set B3
- .3 1 Ea. Cylinder B1
- .4 1 Ea. Closer C1
- .5 1 Ea. Kick Plate J1
- .6 1 Set Seals M1-2height x 1 width
- .7 1 Ea. Threshold M2-width

.7 Door 201
- .1 3 Ea. Hinges A2
- .2 1 Ea. Lock set B3
- .3 1 Ea. Cylinder B1
- .4 1 Ea. Closer C2
- .5 1 Ea. Stop F1

.7 Door 203
- .1 3 Ea. Hinges A3
- .2 1 Ea. Privacy Set B4
- .3 1 Ea. Stop F1
- .4 1 Ea. Kick Plate J1

3.7 DOOR HARDWARE TYPE

.1 HINGES:

A1 – Hinge 5 Knuckle-.180 gauge- 114mm x 101mm x Non Removable Pin x 630 – A5111
A2 – Hinge 5 Knuckle-.134 gauge-114mm x 101mm x Non Removable Pin x 652 – A5111

.2 LOCKS:

B1 - Cylinder Type x length x cam to suit 626
B2 - Lock set ANSI F09 626
B3 - Lock set ANSI F07 626
B5 - Privacy set ANSI F19 with Occupancy Indicator 626

.3 CLOSERS:

Note: Include thru-bolts and grommet nuts fasteners.
C1 – Closer Institutional, non sized, compression spring buffer arm x del x 689 – C02031
C2 - Closer Institutional, non sized, regular arm x delayed action x 689 – C02031

.4 AUXILIARY HARDWARE:
F1 - Wall stop Solid Cast with concave bumper x 626

.5 ARCHITECTURAL DOOR TRIM:
J1 – Kick Plate 254mm x width less 38mm x 630

.6 THRESHOLDS, SEALS, DOOR BOTTOMS, ASTRAGAL
M1- Seals Triple fin design adhesive backing x 2/height x 1 width
M2 –Threshold Thermal Barrier -free latching panic exit Saddle 127mm x 6.4mm x 6.4 stop strip x ThemoSeal 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.

.7 Notes:
H1 All Hardware by door supplier

END OF SECTION 08 71 00

ROOM FINISH SCHEDULE

				WALLS					REMARKS
NO.	ROOM NAME	FLOORS	BASE	WEST WALL	NORTH WALL	EAST WALL	SOUTH WALL	CEILING	
101	INTEGRATION AREA	EP	EB	PT	PT	PT	PT	EXP	
102	CLEAN ROOM	EP	-	-	-	-	-	-	#1
103	COLD ROOM	EP	-	-	-	-	-	-	#1
104	UNIVERSAL W/R	SV	CB	PT	PT	PT	PT	GWB	
105	ELECTRICAL ROOM	CONC	RB	PT	PT	PT	PT	EXP	
106	MECHANICAL ROOM	CONC	RB	PT	PT	PT	PT	EXP	
201	COMM. ROOM	VT	RB	PT	PT	PT	PT	EXP	
202	MECH./ELEC. EQUIPMENTS	CONC	RB	PT	PT	PT	PT	EXP	
203	UNISEX W/R	SV	CB	PT	PT	PT	PT	GWB	

LEGENDS

FLOOR		BASE		WALLS		CEILINGS	
CONC	Sealed Concrete	CB	Sheet Vinyl Flashed Coved Base	PT	Painted	EXP	Painted Exposed Ceiling
VT	Anti-Static Vinyl Tile	EB	Epoxy Base (200 mm high)			GWB	GWB Ceiling Paint Finish
SV	Sheet Vinyl Flooring	RB	Rubber Base				
EP	Epoxy Flooring						

GENERAL NOTES

.1 All wall finishes and wall base to be continuous behind all wall fixtures
.2 Vertical bulkheads/down drops to be finished same as horizontal U.O.N.
.3 Return wall finishes into window frames at jambs and head U.O.N.
.4 Wall finishes to extend down to floor with applied base over.
.5 All exposed services to be painted as adjacent wall and ceiling U.O.N.
.6 All change of flooring in hallways must extend to the room side of the door frame U.O.N.
.7 Make good existing wall to paintable condition prior to applying new painting.
.8 All finishes indicated are new U.N.O.
.9 Paint all interior wall surfaces exposed to view.

REMARKS

#1 Pre-fabricated unit supplied by owner.

1.1 GENERAL

1.2 RELATED REQUIREMENTS

.1	Cast-in-Place Concrete	Section 03 30 00
.2	Concrete Finish	Section 03 35 00
.3	Resilient Flooring for Minor Works	Section 09 65 99

1.3 SYSTEM DESCRIPTION

.1 Roller applied 100% solids epoxy primer, followed by an extreme impact and abrasion resistant troweled mortar, consisting of 100% solids epoxy and proprietary fillers containing several gradations of steel, 100% solids epoxy grout coat, and optional topcoat(s) of chemical resistant, 100% solids epoxy and/or high performance aliphatic urethane, to achieve a nominal total floor thickness of 1/4".

.2 This system shall be applied to the prepared substrate(s) as defined by the plans strictly in accordance with the manufacturer's recommendations.

1.4 SUBMITTALS

.1 Product Data

.1 Current edition of manufacturer's product literature including physical data, chemical resistance, surface preparation, and application instructions.

.2 Samples

.1 A hard sample of the proposed system shall be submitted to represent the finished floor. Allow submission of 3 samples of different colour and texture.

.2 Sample to be minimum 300 mm x 300 mm.

.3 Warranty

.1 Manufacturer's standard warranty

.2 Applicator's standard warranty

1.5 QUALITY ASSURANCE

.1 Qualifications

.1 The manufacturer shall have a minimum of ten (10) years' experience in the production, sales, and technical support of polymer-based floor coatings.

.2 The applicator shall have a minimum of three (3) years' documented experience in the application of polymer floor coatings to concrete floors.

.3 Proposed suppliers products shall provide certification that they have ten (10) years' experience in the production of polymer floor coatings and be required to meet all provisions of this specification as well as provide evidence for compatibility between components to the satisfaction of the Architect.

.4 Provide mockup for review of colour and texture. Area of mockup to be selected by Departmental Representative.

.2 Packing and Shipping

.1 All materials are to be delivered to the job site in the manufacturer's original packaging. The product code and other identification marks should be clearly marked and visible.

.3 Storage and Protection
.1 All material is to be stored in a cool, dry place out of the direct sunlight and away from any ignition sources. The applicator should refer to the manufacturer's literature and Material Safety Data Sheets for more information.
.2 Material Safety Data Sheets are to be kept on site and made readily available for all personnel.
.3 Keep containers sealed and ready for use.

1.6 PROJECT CONDITIONS
.1 Environmental Requirements
.1 Optimum air and substrate temperature for product application is between 55° F (13° C) and 95° F (35° C). For temperatures outside of this range, consult the manufacturer for product application suggestions.
.2 Verify the work environment is properly equipped with vapor barriers and perimeter drains.
.3 Maintain proper lighting throughout the work environment; the lighting should be comparable to the final lighting level of the space.
.4 Store and dispose of any waste in accordance with regulations of local authorities.

.2 Safety Requirements
.1 "No Smoking" signs shall be posted throughout the work area prior to application.
.2 The owner shall be responsible for removing any foodstuffs from the work area.
.3 Open flames, spark producing tools/items, and ignition sources shall be removed from the work area prior to application.
.4 Only work-related personnel shall be allowed within the work area.

1.7 WARRANTY
.1 Provide workmanship and material warranty for one year against fading, cracking, flanking, and other defects in material.

2.1 PRODUCTS

2.2 MATERIALS
.1 Joints
.1 Saw cut joints and fill with semi-rigid, impact resistant elastomeric coating:.

.2 Primer
.1 The primer shall be a 100% reactive, epoxy-based, penetrating primer that exhibits chemical resistance as per manufacturer's recommendation.

.3 Mortar (Matrix Coat)
.1 The mortar shall consist of a 100% solids epoxy, activator, and graded aggregates.

.4 Grout Coat
.1 Grout with a 100% solids epoxy.

.5 Topcoat(s)
.1 Topcoat with 100% solids, chemical resistant.

2.3 PROPERTIES

.1 The coating system should meet the following physical properties:

.1 Cured System Properties

Compressive Strength, ASTM C579	14,200 psi
Tensile Strength, ASTM D2370	7,300 psi
Flexural Strength, ASTM C790	4,600 psi
Flexural Modulus of Elasticity, ASTM C580	2.0×10^6 psi
Indentation, MIL-D-3134F	No Indentation
Impact Resistance, ASTM D4226	> 160 in/lb.
Shore Hardness, ASTM D2240	90
Water Absorption, ASTM C413	0.20%
Bond Strength, ACI Comm. 503, pgs.1139-41	>400 psi
Abrasion Resistance, ASTM D4060, CS 17 Wheel, 1000 gm load, 1000 cycles	30 mg
Heat Resist. Limit., Continuous Exposure	140^0 F/60^0 C
Coefficient of Friction, ASTM D2047	0.6 Minimum
Flammability, ASTM D635	Self-Extinguishing
Thermal Coefficient of Linear Expansion, ASTM C531	1.8×10^{-5} in/in/^{0} F

3.1 EXECUTION

3.2 INSPECTION

.1 General

.1 Examine the areas and conditions where epoxy mortar is to be installed and notify the Departmental Representative of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the Departmental Representative.

3.3 PREPARATION

.1 General

.1 Consult the manufacturer's recommendations for concrete substrate preparation before proceeding.

.2 Patching and Joint Preparation

.1 Before application, the floor shall be examined for spalls, pits, holes, cracks, non-functional joints, etc. These must be treated after preparation and before application with the suitable Florock products. For functional or expansion joints, these shall be treated with 100% solids elastomeric resin having a minimum elongation of 150%: Florock System 6500.

.3 Concrete Surfaces

.1 Shot-blast, diamond grind or power scarify as required to obtain clean, open, porous concrete. Remove sufficient material to provide a sound surface, free of

laitance, glaze, efflorescence, and any bond-inhibiting curing compounds or form release agents. Remove grease, oil, and other penetrating contaminants. Repair damaged and deteriorated concrete to acceptable condition; leave surface free of dust, dirt, laitance, and efflorescence.

.4 Materials

.1 Mix components when required, and prepare materials according to flooring system manufacturer's instructions.

3.4 APPLICATION

.1 General

.1 The system shall be installed in the order described below:

.1 Substrate Preparation
.2 Priming
.3 Mortar (Matrix Coat) Applications
.4 Grout Coat Application
.5 Optional Topcoat Applications

.2 Concrete surfaces on grade shall have been constructed with a vapor barrier to protect against the effects of vapor transmission and possible delamination of the system. Refer to manufacturer's concrete preparation instructions for additional recommendations.

.3 The surface should be dry prior to application of any of the aforementioned steps. Furthermore, the substrate shall always be kept clean, dry, and free of any contaminants. All joints should be saw cut and filled with 6500.

.4 The handling and mixture of any material associated with the installation of the system shall be in accordance with the manufacturer's recommendations and approved by the Architect.

.5 The system shall follow the contours of the substrate unless otherwise specified by the Architect.

.6 A neat finish with well-defined boundaries and straight edges shall be provided by the applicator.

.2 Priming

.1 All areas considered for the application shall be primed with the manufacturer's primer to seal and penetrate the substrate in preparation for applying the basecoat (matrix coat) and grout coat.

.2 Porous concrete substrates may require additional applications of primer.

.3 Mortar

.1 The mortar coat shall consist of the manufacturer's approved resin and aggregates to resurface the floor, seal the surface and give the floor impact and chemical resistance.

.4 Grout Coat and Optional Topcoat(s)

.1 The grout coat and topcoat(s) shall be consistent with the manufacturer's recommended epoxy grout coat and urethane topcoat for the system.

.2 traffic or equipment shall be permitted on the floor during the curing period.

3.5 FIELD QUALITY CONTROL

.1 Tests & Inspection

.1 The following tests shall be performed by the applicator and recorded during application to submit to the Departmental Representative:

.1 Temperature during Installation

.1 Air

.2 Substrate

.3 Dew Point

3.6 CLEANING

.1 Disposal

.1 Properly remove and dispose of any excess materials.

END OF SECTION 09 07 16

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1	Rough Carpentry	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 — 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 Model Schedule B and C.
- .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 minimum1.23 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.

Gypsum Board Thickness	Maximum Furring Spacing
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 Departmental Representative 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.

3.4 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.

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 Cast-in-Place Concrete Section 03 33 00

.2 Concrete Finishing Section 03 35 00

.3 Gypsum Board Assemblies Section 09 21 16

1.2 REFERENCES

.1 ASTM International
- .1 ASTM F 1700-13, Standard Specification for Solid Vinyl Floor Tile.
- .2 ASTM F 1861-08 (2012) e1, Standard Specification for Resilient Wall Base.
- .3 ASTM F 150-06 (2013) Standard Test Method for Electrical Resistance of Conductive and Static Dissapative Resilient Flooring.
- .4 ASTM E 648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

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

.3 National Floor Covering Association (NFCA) Specification Manual.

.4 Electrical Overstress/Electrostatic Discharge Association (EOS/ESD):
- .1 EOS/ESD-S7.1 1994 Floor Material Resistive Characterization of Materials.

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 flooring, adhesive, primer, sealer, and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements, Section 01 35 43 - Environmental Procedures.

.3 Samples:
- .1 Submit manufacturer’s standard color range for selection, review and acceptance of each unit.
- .2 Submit duplicate full size samples of each type of tile based on selected colors.
- .3 Submit 300 mm long base and edge strips based on selected colors.
- .4 Samples will be returned for inclusion into work.

.4 Low-Emitting Materials:
- .1 Submit listing of adhesives primers used in building, showing compliance with VOC and chemical component limits or restriction requirements.

.5 Quality Assurance Submittals: Submit the following:
- .1 Certification of compliance: Letter of compliance signed by manufacturer certifying materials comply with specified performance characteristics and criteria, and physical requirements.

.2 Manufacturer's Instructions: Manufacturer's installation instructions.

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 resilient flooring for incorporation into manual.

.3 Extra Materials.

.1 Provide 10% extra materials of each colour, pattern, and type flooring materials required for project maintenance use.

.2 Extra material to be in the same container and from same production run as installed materials.

.3 Clearly identify each container of tile flooring and each container of adhesive.

.4 Deliver to Departmental Representative upon completion of the work of this Section.

.5 Store where directed by 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect resilient flooring from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 SITE CONDITIONS

.1 Ensure high ventilation rate, with maximum outside air, during installation.

.1 Vent directly to outside.

.2 Do not let contaminated air recirculate through a district or whole building air distribution system.

.3 Maintain extra ventilation for 1 month minimum after building occupation.

2.0 PRODUCTS

2.1 RESILIENT TILE FLOORING MATERIALS

.1 Solid Vinyl Tile; to ASTM F1700

.1 **VT**

1 Category: Conductive/Static Dissipative vinyl tile to ASTM F1700, Class I (monolithic) Type A-smooth surface.

.2 Minimum Binder Content: 34% each ply or layer

.3 Size: 615 mm x 615 mm

.4 Gauge: 2.0 mm

.5 Fire Test Data: ASTM E648, Class I, ASTM E662, Smoke Developed 450 or less.

.6 Static Load Limit: ASTM F970, 250 psi (1500 lb/in^2)
.7 Slip Resistance: ASTM D2047, 0.6 for flat surface
.8 Electrical Resistance: ASTM F150, 1x10^6 - 10^8 ohms surface to ground.
.9 Recycled Content: 51% pre- consumer
.10 Non-directional Pattern, color: dark grey.

.2 Sheet Flooring - SV
.1 Homogeneous Linoleum Sheet Flooring to ASTM F2034 for commercial application
.2 Width: 2 meters
.3 Length: 32 meters
.4 Gauge: 2.5 mm overall & wear layer
.5 Static Load Limit: ASTM F-970 – 450 PSI
.6 Fire Performance: ASTM E 648 – Class 1; ASTM E 662 less than 450
.7 Slip Resistance: ASTM D-2047 – more than 0.6 COF

2.2 ACCESSORIES

.1 Resilient base (**RB**): to ASTM F1861, type TP, Group 1, continuous, top set, complete with premoulded end stops and external corners, toe type: toe.
.1 Type: rubber, 3.175 mm thick.
.2 Style: cove.
.3 Height: 152 mm.
.4 Lengths: cut lengths minimum 2400 mm.
.5 Color: dark grey.

.2 Primers and adhesives: of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade.
.1 Adhesives: VOC limit 50 g/L maximum to SCAQMD Rule 1168.
.2 Primer: in accordance with manufacturer's recommendations for surface conditions:
.1 VOC limit: 100 g/L maximum to SCAQMD Rule 1113

.3 Sub-floor filler and leveller: white premix latex requiring water only to produce cementitious paste as recommended by flooring manufacturer for use with their product.

.4 Accessories:
.1 Metal Schluter transition / reducing & edge strips tapered to meet abutting materials, colour as selected by Departmental Representative.
.2 Cove caps and 1” radius flash cove filler strips for 152 mm cove base for sheet flooring areas.

.5 Sealer and wax: type recommended by resilient flooring material manufacturer for material type and location.
.1 Coating: VOC limit 50 g/L maximum to SCAQMD Rule 1113.

3.0 EXECUTION

3.1 EXAMINATION

.1 Examine conditions, substrates and work to receive work of this Section, co-ordinate with Section 01 71 00 - Examination and Preparation.

.2 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for product 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 Ensure concrete floors are clean and dry by using test methods recommended by flooring manufacturer.

3.2 PREPARATION

.1 Prepare for installation in accordance with manufacturer's written recommendations.

.2 Remove sub-floor ridges and bumps and fill low spots, cracks, joints, holes and other defects with sub-floor filler.

.3 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface.
.1 Prohibit traffic until filler is completely cured and dry.

.4 Seal concrete slab as recommended by resilient flooring manufacturer's written instructions.

3.3 APPLICATION - FLOORING

.1 Install flooring as per manufacturer’s written instructions.

.2 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive that can be covered by flooring before initial set takes place.

.3 Resilient tile flooring:
.1 Lay flooring with joints parallel to building lines to produce symmetrical tile pattern.
.2 Border tiles: half tile width minimum.
.3 Install flooring to square grid pattern with joints aligned.

.4 As installation progresses, and after installation roll flooring with 45 kg minimum roller to ensure full adhesion.

.5 Cut flooring neatly around fixed objects.

.6 Continue flooring over areas which will be under built-in furniture.

.7 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.

.8 Terminate resilient flooring at centreline of door in openings where adjacent floor finish or color is dissimilar.

.9 Grounding Strap: A minimum of one (1) grounding strap should be installed for every 2,000 square feet of uninterrupted tile.

.10 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.4 APPLICATION - BASE

.1 Install base as per manufacturer’s written instructions.

.2 Lay out base to keep number of joints at minimum.

.3 Clean substrate and prime with one coat of adhesive.

.4 Apply adhesive to back of base.

.5 Set base against wall and floor surfaces tightly by using 3 kg hand roller.

.6 Install straight and level to variation of 1:1000.

.7 Scribe and fit to door frames and other obstructions. Use pre-moulded end pieces at flush door frames.

.8 Cope internal corners using pre-moulded corner units for right angle external corners and formed straight base material for external corners of other angles.

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.
- .1 Remove excess adhesive from floor, base and wall surfaces without damage.
- .2 Clean, seal and wax floor and base surface to flooring manufacturer's printed instructions.

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

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Protect new floors in accordance with manufacturer's printed instructions.

.3 Repair damage to adjacent materials caused by resilient flooring installation.

END OF SECTION 09 65 99

1.0 GENERAL

1.1 RELATED REQUIRMENTS

.1 Metal Fabrications Section 05 50 00

.2 Metal Doors and Frames Section 08 11 00

1.2 REFERENCES

.1 Environmental Protection Agency (EPA)
- .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

.3 The Master Painters Institute (MPI)
- .1 Architectural Painting Specification Manual – November 2007.
- .2 Standard GPS-1- 05, MPI Green Performance Standard for Painting and Coatings.

.4 National Fire Code of Canada 2010.

.5 Society for Protective Coatings (SSPC)
- .1 Systems and Specifications, SSPC Painting Manual 2005.

1.3 QUALITY ASSURANCE

.1 Qualifications:
- .1 Contractor: to have a minimum of five years proven satisfactory experience. When requested, provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
- .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
- .3 Apprentices: may be employed provided they work under direct supervision of qualified journeyperson 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 Departmental Representative, 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 Standard of Acceptance:
- .1 Wall: No defects visible from a distance of 1000mm at 90° to surface.
- .2 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.9 Mock-Ups:
- .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
  - .1 Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.
  - .2 Mock-up will be used:
    - .1 To judge workmanship, substrate preparation, operation of equipment and material application and workmanship to MPI Architectural Painting Specification Manual standards.
  - .3 Locate where directed.
  - .4 Allow 24 hours for inspection of mock-up before proceeding with work.
  - .5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

.10 Pre-Installation Meeting:
- .1 Convene pre-installation meeting one week prior to beginning work of this Section and 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 Coordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.

.11 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 approval. 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 in and about building.

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 33 00 – Submittal Procedures. Indicate VOCs during application.

.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 1 mm plate steel for finishes over metal surfaces.

.3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

.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 & HANDLING

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

.1 Deliver and store materials in original containers, sealed, with labels intact.

.2 Labels: to indicate:
- .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 Provide and maintain dry, temperature controlled, secure storage.

.5 Observe manufacturer's recommendations for storage and handling.

.6 Store materials and supplies away from heat generating devices.

.7 Store materials and equipment in well-ventilated area with temperature range 7 degrees C to 30 degrees C.

.8 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.9 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Departmental Representative. After completion of operations, return areas to clean condition to approval of Departmental Representative

.10 Remove paint materials from storage only in quantities required for same day use.

.11 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.

.12 Fire Safety Requirements:
- .1 Provide one 9 kg Type ABC dry chemical 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 the National Fire Code of Canada.

.2 Waste Management and Disposal:
- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) 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.
- .3 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .4 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- .5 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the following procedures shall be strictly adhered to:
  - .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 an approved legal manner in accordance with hazardous waste regulations.
  - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
- .6 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.7 Set aside and protect surplus and uncontaminated finish materials: Deliver to or arrange collection by employees, individuals, or organizations for verifiable re-use or re-manufacturing.

.8 Close and seal tightly partly used sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.

1.9 AMBIENT CONDITIONS

.1 Heating, Ventilation and Lighting:

.1 Perform no painting work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted. Adequate lighting facilities to be provided by General Contractor.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer, perform no painting work when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is over 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.

.4 Relative humidity is above 85 % or when dew point is less than 3 degrees C variance between air/surface temperature.

.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.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 noted herein.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Apply paint finishes when conditions forecast for entire period of application fall within manufacturer's recommendations.

.5 Do not apply paint when:

.1 Temperature is expected to drop below 10 degrees C before paint has thoroughly cured.

.2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.

.3 Surface to be painted is wet, damp or frosted.

.6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.

.7 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.

.8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

.9 Paint occupied facilities in accordance with approved schedule 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 either the local MPI Accredited Quality Assurance Association's two (2) year guarantee, or, alternatively, a 100% two (2) year Maintenance Bond – both in accordance with MPI Painting Manual requirements. The Maintenance Bond shall warrant that all painting work has been performed in accordance with MPI Painting Manual requirements

.2 All painting and decorating work shall be in accordance with MPI Painting Manual requirements and shall be inspected by the local MPI Accredited Quality Assurance Association's Paint Inspection Agency (inspector), whether using either the MPI Accredited Quality Assurance Association's guarantee, or the Maintenance Bond option. The cost for such inspections, and for either the local MPI Accredited Quality Assurance Association's Guarantee, or the Maintenance Bond, shall be included in the Base Bid Price.

.3 Painting and decorating Subcontractors choosing the Maintenance Bond option shall provide a maintenance bond consent from a reputable surety company licensed to do business in Canada. Cash or certified check are not acceptable in lieu of surety consent.

2.0 PRODUCTS

2.1 MATERIALS

.1 Paint materials listed in latest edition of MPI Approved Products List (APL) are acceptable for use on this project.

.2 Paint materials for paint systems: to be products of single manufacturer.

.3 Only qualified products with E2 "Environmentally Friendly" ratings are acceptable for use on this project.

.4 Use only MPI listed materials.

.5 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids, to be as follows:
- .1 Be water-based.
- .2 Be non-flammable biodegradable.
- .3 Be manufactured without compounds which contribute to ozone depletion in upper atmosphere.
- .4 Be manufactured without compounds which contribute to smog in the lower atmosphere.
- .5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.

.6 Water-borne surface coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products arising therefrom, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada.

.7 Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavelant chromium or their compounds.

.8 Water-borne surface coatings and recycled water-borne surface coatings must have flash point of 61.0 degrees C or greater.

.9 Both water-borne surface coatings and recycled water-borne surface coatings must be made by a process that does not release:
- .1 Matter in undiluted production plant effluent generating a 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking

secondary treatment.

.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.

.10 Recycled water-borne surface coatings must contain 50 % post-consumer material by volume.

.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 50.0 ppm weight/weight total product.
- .3 Cadmium in excess of 1.0 ppm weight/weight total product.
- .4 Hexavelant 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.

.12 The following must be performed on each batch of consolidated post-consumer material before surface coating is reformulated and canned. These tests must be performed at a laboratory or facility which has been accredited by the 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.

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.

2.3 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed only with Departmental Representative's written permission.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Add thinner to paint manufacturer's recommendations. Do not use kerosene or organic solvents to thin water-based paints.

.4 Thin paint for spraying according in accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Departmental Representative.

.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 EXTERIOR PAINTING SYSTEMS

.1 Structural Steel and Metal Fabrications:

.1 EXT 5.1B - Waterborne light industrial, gloss level 6 coating (over inorganic zinc).

.2 Galvanized Metal: not chromate passivated

.1 EXT 5.3G - Waterborne light industrial, gloss level 6 coating.

.3 Concrete Horizontal Surfaces (stair)

.1 EXT 3.2A latex floor paint, low gloss level.

.4 Plastic (PVC Rain Water Lead)

.1 EXT 6.8 D High Performance Architectural Latex (gloss level 5)

.5 All paint systems to be MPI Premium Grade 3 coat system.

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 EXISTING CONDITIONS

.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.

3.3 EXAMINATION

.1 Exterior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency minimum of one week prior to commencement of work and provide copy of project repainting specification and Finish Schedule.

.2 Exterior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Departmental Representative in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.

.3 Where assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.

3.4 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 such 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 building.

.5 Remove light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Store items and re-install after painting is completed.

.6 Move and cover exterior furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.7 As painting operations progress, place "WET PAINT" signs in pedestrian and vehicle traffic areas to approval of Departmental Representative.

3.5 APPLICATION

.1 Method of application to be as approved by Departmental Representative. Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:

.1 Apply paint in a uniform layer using brush and/or roller of types 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 shall be free of roller tracking and heavy stipple unless approved by Departmental Representative.

.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 properly 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 a uniform layer, with overlapping at edges of spray pattern.
.4 Brush out immediately runs and sags.
.5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Departmental Representative.

.5 Apply coats of paint as 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 projecting ledges.

.9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ELECTRICAL EQUIPMENT

.1 Unless otherwise specified, paint exterior exposed conduits, piping, hangers, duct work and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as noted otherwise.

.2 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.3 Do not paint over nameplates.

.4 Paint fire protection piping red.

.5 Paint steel electrical light standards. Do not paint outdoor transformers and substation equipment.

3.7 RESTORATION & CLEANING

.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 spatter 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.

.6 Proceed in accordance with Section 01 74 11 - Cleaning.

.1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.

3.8 COLOUR SCHEDULE

.1 Metal doors / frames and metal stair and handrails – dark grey.

END OF SECTION 09 91 13

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
.4	Metal Doors & Frames	Section 08 11 00
.5	Room Finish Schedule	Section 09 06 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 Departmental Representative, 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 Mock-Ups:

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

.1 Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.

.2 Mock-up will be used:

.1 To judge workmanship, substrate preparation, operation of equipment and material application and workmanship to MPI Architectural Painting Specification Manual standards.

.3 Locate where directed.

.4 Allow 24 hours for inspection of mock-up before proceeding with work.

.5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

.9 Pre-Installation Meeting:

.1 Convene pre-installation meeting one week prior to beginning work of this Section and 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 Coordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.10 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 either the local MPI Accredited Quality Assurance Association’s two (2) year guarantee, or, alternatively, a 100% two (2) year Maintenance Bond – both in accordance with MPI Painting Manual requirements. The Maintenance Bond shall warrant that all painting work has been performed in accordance with MPI Painting Manual requirements

.2 All painting and decorating work shall be in accordance with MPI Painting Manual requirements and shall be inspected by the local MPI Accredited Quality Assurance Association’s Paint Inspection Agency (inspector), whether using either the MPI Accredited Quality Assurance Association’s guarantee, or the Maintenance Bond option. The cost for such inspections, and for either the local MPI Accredited Quality Assurance Association’s Guarantee, or the Maintenance Bond, shall be included in the Base Bid Price.

.3 Painting and decorating Subcontractors choosing the Maintenance Bond option shall provide a maintenance bond consent from a reputable surety company licensed to do business in Canada. Cash or certified check 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 Hexavelant 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	More than 85	

-High Gloss Finish		

.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, steel deck:
.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: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.
.1 INT 5.3M - High Performance Architectural Latex gloss level 3 coating (over waterborne primer).

.5 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:
.1 INT 9.2B - High Performance Architectural Latex gloss level 3 finish for wall, gloss level 1 for wall typical, gloss level 1 for ceiling.

.6 Concrete Horizontal Surfaces (stair):
.1 INT 3.2 – Latex Floor enamel (low gloss)

.7 All paint systems to be MPI Premium Grade 3 coat systems.

2.6 INTERIOR REPAINTING SYSTEMS

.1 Concrete masonry units: smooth and split face block and brick:
.1 RIN 4.2K – High Performance Architectural Latex gloss level 3 finish.

.2 Structural Steel and Metal Fabrications:
.1 RIN 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 RIN 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.

.4 Galvanized Metal: doors, frames, railings, misc steel, pipes, overhead decking, ducts, etc.
.1 RIN 5.3J – High Performance Architectural Latex gloss level 3 coating.

.5 Concrete: vertical surfaces (including ceiling)
.1 RIN 3.1J High Performance Architectural Latex, gloss level 1 finish.

2.7 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 patter 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 metal doors / frames and metal handrails – dark grey (same as exterior).

.2 All concrete masonry units, expressed ceiling, steel structure, steel joist, metal deck and gypsum wall board – off-white.

END OF SECTION 09 91 23

1.0 GENERAL

1.1 RELATED REQUIREMENTS

.1 Rough Carpentry Minor Work — Section 06 08 99

.2 Finish Carpentry — Section 06 20 00

1.2 REFERENCES

.1 ASTM International

.1 ASTM A 167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM B 456-03, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

.3 ASTM A 653/A 653M-09, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM A 924/A 924M-09, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

.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-1.81-M90, Air Drying and Baking Alkyd Primer for Vehicles and Equipment.

.2 CAN/CGSB-1.88-92, Gloss Alkyd Enamel, Air Drying and Baking.

.3 CGSB 31-GP-107MA-90, Non-inhibited Phosphoric Acid Base Metal Conditioner and Rust Remover.

.4 CSA International

.1 CAN/CSA-B651-04, Accessible Design for the Built Environment.

.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 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 and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars.

.5 Sustainable Standards Certification:

.1 Low-Emitting Materials: submit listing of laminate adhesives used in building, verifying that they contain no urea-formaldehyde.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 78 00 - Closeout Submittal

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Tools:

.1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 78 00 - Closeout Submittals.

.2 Deliver special tools to Departmental Representative.

1.6 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:

.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect toilet and bathroom accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 – Waste Management and Disposal.

2.0 PRODUCTS

2.1 MATERIALS

.1 Sheet steel: to ASTM A 653/A 653M with ZF001 designation zinc coating.

.2 Stainless steel sheet metal: to ASTM A 167, Type 304, with satin finish.

.3 Sustainability Characteristics:

.1 Laminate Adhesives.

.1 Urea Formaldehyde Free.

.4 Stainless steel tubing: Type 304, commercial grade, seamless welded 1.2 mm wall thickness.

.5 Fasteners: concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.2 INTERIOR FINISH MATERIAL & COLOUR SCHEDULE

.1 This schedule will be issued as a separate document and my list specific manufacturers related to style and quality upon which the scheme for the project is based.

.2 The following component specifications, which are prescriptive in nature, are presented in order to establish a quality of product upon which a price can be tendered.

.3 The Departmental Representative will consider substitute Products which meet or exceed the properties of the specified Product and are similar in material, construction, thickness, colour, texture, and overall quality, provided that proposals are submitted to the Departmental Representative complete with samples and whatever other data the Departmental Representative may require in order to evaluate the proposed substitute Product. If the Departmental Representative

approves the proposed substitute Product, the Contractor will have the option of providing Product listed in the Finish schedule or an approved alternative.

2.3 COMPONENTS

.1 Toilet tissue dispenser: (TTD) side by side double roll type, surface mounted, brushed stainless steel frame, capacity of 3000 double ply sheets, transfer paddle, locking dispenser for coreless roll use, one (1) for each washroom.

.2 Surface mounted waste Receptacle (WR): Surface mounted waste receptacle shall be type 304 stainless steel, satin finish. Furnished with heavy-gauge vinyl liner; removable for servicing. Size 14" wide x 18" high and 6" deep. One (1) for each washroom.

.3 Napkin Disposal (ND): Surface mounted, stainless steel construction, self-closing sloped top, service door at bottom required with key operated latch and full length stainless steel piano hinge. One (1) for each washroom.

.4 Grab Bars (GB): 30/32 mm dia x 1.6 mm wall tubing of stainless steel, 38 mm diameter wall flanges, concealed screw attachment, flanges welded to tubular bar, provided steel back plates and all accessories. Knurl bar at area of hand grips. Grab bar material and anchorage to withstand downward pull of 2.2kN. Configurations and sizes as indicated.

.1 GB1 (Toilet Side Wall Grab Bar): 915mm L horizontal bar, for universal washroom only.

.5 Sanitary Napkin Disposal (ND): Stainless Steel Type 304 recessed Type with coverall door, removable leak proof plastic waste bin. Self-closing counter balanced door secured to recessed body. Recessed body to be corrosion resistant galvanized steel. One for each washroom.

.6 Mirror (MR)

.1 For Each Washrooms: One-piece channel frame is 13 x 13 x 9.5 mm with bright polished finish and mitred corners. No.1 quality, 6mm glass mirror electrolytically copper plated; guaranteed against silver spoilage for 10 years. Mirror corners and back protected by shock absorbing material. Back is galvanized steel, secured to concealed wall hanger with two theft-resistant locking screws.

.7 Shelf (SH): 11 gauge, Type 304, 18-10 stainless steel with surface treatment to minimize finger marks. Size to be 120 x 600mm, complete with mounting hardware. One (1) for each washroom.

.8 Paper Towel Dispenser (PTD): Satin-finish stainless steel recessed (4" depth) paper towel dispenser. Dispenser 350 C-fold or 475 multi-fold towels. One (1) for each washroom.

2.4 FABRICATION

.1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.

.2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.

.3 Brake form sheet metal work with 1.5 mm radius bends.

.4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.

.5 Back paint components where contact is made with building fini;;shes to prevent electrolysis.

.6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CAN/CSA-G164.

.7 Shop assemble components and package complete with anchors and fittings.

.8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.

.9 Provide steel anchor plates and components for installation on studding and building framing.

2.5 FINISHES

.1 Chrome and nickel plating: to ASTM B 456, satin finish, U.O.N.

.2 Manufacturer's or brand names on face of units not acceptable.

3.0 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrates and surfaces to receive toilet and bathroom accessories previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's instructions prior to toilet and bathroom accessories installation.

.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 from Departmental Representative.

3.2 INSTALLATION

.1 Install and secure accessories rigidly in place as follows:
- .1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.
- .2 Hollow masonry units, existing plaster or drywall: use toggle bolts drilled into cell or wall cavity.
- .3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.
- .4 Toilet and shower compartments: use male to female through bolts.

.2 Install grab bars on built-in anchors provided by bar manufacturer.

.3 Use tamper proof screws/bolts for fasteners.

.4 Fill units with necessary supplies shortly before final acceptance of building.

.5 Install mirrors in accordance with Section 08 80 50 - Glazing.

3.3 ADJUSTING

.1 Adjust toilet and bathroom accessories components and systems for correct function and operation in accordance with manufacturer's written instructions.

.2 Lubricate moving parts to operate smoothly and fit accurately.

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.
  .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by toilet and bathroom accessories installation.

3.6 SCHEDULE

.1 Locate accessories where indicated on drawings. Exact locations to be confirmed by Departmental Representative.

END OF SECTION 10 28 10

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Should inconsistencies exist, such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the Departmental Representative in writing during the bidding period.

.4 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.5 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Departmental Representative at no extra cost.

.6 Install equipment to provide access and ease of maintenance.

.7 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test.

.8 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.9 Provide seismic restraints for all required equipment, piping and ductwork.

.10 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of twelve (12) months from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.11 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.12 'Provide' shall mean; supply and install'.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Tender Price Breakdown

.1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Departmental Representative.

.2 As a minimum, include the following in the tender price breakdown:

.1 Fire protection Start Up Documentation: labour

.2 Fire protection: Equipment, materials, labour

.3 Fire protection close out: labour

1.4 Progress Claims

.1 Submit a Progress Summary and a Detailed Price Breakdown with each Progress Claim. The Summary and Breakdown shall include all Change Orders issued.

1.5 Alternate Materials and Equipment

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List. If no acceptable manufacturer has been listed, refer to approved equivalents below.

.2 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted to the Departmental Representative no later than seven (10) working days prior to the closing date of tender, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum.

.3 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Departmental Representative. In the event that the product has been approved as "Alternate Only", this shall be stated in the quotation, and the contractor shall bear any and all costs for design/system modifications to accommodate the “alternate” equipment.

.4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such work.

1.6 Drawings and Specifications

.1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Departmental Representative, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.7 Equipment Protection & Cleanup

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.8 Substantial & Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the contractor to have a substantial completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Valve tagging and equipment identification is complete.

.4 Warranty forms have been mailed to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.5 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.6 Draft Operating/Maintenance Manuals have been submitted.

.7 Operating and Maintenance demonstrations have been provided to the Owner.

.8 Record drawings have been submitted.

.9 All seismic restraint devices have been installed.

.10 All previously identified deficiencies have been corrected.

.3 The following shall be an outline checklist of the minimum requirements to be met by the contractor prior to the Departmental Representatives' Substantial Performance by the contractor.

Inspection:

☐ Complete Commissioning Checklists

- ☐ Final Sprinkler Materials and Test Certificate
- ☐ Final Backflow Prevention test reports for all backflow devices
- ☐ Fire alarm test certificate (via DIV.16)
- ☐ Fire stopping and Fire Damper test certificate by commissioning agent
- ☐ Seismic Engineers inspection of all Seismic restraints and schedule C letters of assurance
- ☐ Sprinkler Contractors Engineer of record inspection and Schedule C letter of assurance
- ☐ Final As-Built Drawings ready for review
- ☐ Maintenance and operation manuals, ready for review

.4 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:

.1 Submit final operating and maintenance manuals.

.5 The Departmental Representative shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required, shall be at the expense of the Contractor.

.6 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.9 Maintenance

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals and as follows:

.2 Additional spare parts shall also be included as outlined in their appropriate sections.

1.10 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 Shop drawings to show:

.1 Hydraulic Calculation signed and sealed by a registered professional engineer.

.2 Detailed head layout

.3 Details of window sprinklers

.4 Equipment cut sheets

.4 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 70 00 - Closeout Submittals.

.2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.

.3 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.

.4 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.

.5 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.

.6 Approvals:

.1 Submit 2 copies 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.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 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.

.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.

.9 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 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.11 Quality Assurance

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.12 Maintenance

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 70 00 - Closeout Submittals.

.2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.13 Delivery, Storage, and Handling

.1 Waste Management and Disposal:

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

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

.2 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Departmental Representative two (2) months prior to final inspection.

.3 Provide four (4) 216 mm x 280 mm capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine.

.4 Index binder according to the following system:

.1 Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

.2 Tab-1.1 List of Mechanical Drawings:

.3 Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with code equivalencies or other special design considerations.

.4 Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

.5 Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from shop drawings.

.6 Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

.7 Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

.8 Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.5 The divider tabs shall be laminated Mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Record Drawings

.1 Refer to Division 1.

.2 The Contractor shall keep on site, available to the Departmental Representative at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.3 Provide record drawings which identify location of dampers, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include in general, items that are significant or are hidden from view and items of major importance to future operations and maintenance, and to future alterations and additions including cleanouts and isolation valves.

.4 Each “AS BUILT” shall be marked: "We hereby certify that these drawings represent the building, as built" with signatures immediately below of authorized personnel of this Sub-Contractor.

3. EXECUTION

3.1 Painting Repairs and Restoration

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.2 Record Drawings:

.1 Enter dimensions from building line to all buried services, including coordinates and depth elevations of manholes, tanks, outside shut-off valves, and other similar elements.

.2 At substantial completion, employ a competent (CADD) drafts person to transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, on a copy of tender CADD files. From these files plot a set of as-built mylars. Drafting quality shall be same as original drawings.

The CADD disks may be borrowed from the Departmental Representative. Each "as-built" shall bear the Contractor's identification, the date of record and the notation "We hereby certify that these drawings represent the As-Built Record of Construction." The Contractor's signature and company seal shall be placed below that notation. Contractor to sign release agreement before Departmental Representative shall provide drawings.

.3 The cost per drawing sheet for transferring information to the record drawings by the Departmental Representative shall be $400.00 per drawing. Should the Contractor undertake major re-routing of services where the original layout is appropriate or should major changes in the scope of work occur, additional charges may apply. Costs for printing are not included.

3.3 Demonstration

.1 Contractor will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 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.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Contractor will record these demonstrations on video tape for future reference.

3.4 Protection

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Provide a complete fire protection system as a design build format for the entire facility in conformance to the BC Building Code, NFPA and Building By-Laws. The plans and specifications indicate the minimum requirements for the project only and should not be consider as the complete scope.

.2 The design build contractor shall retain, on behalf of the owner, a registered professional engineer in the Province of British Columbia for the complete design in accordance with all codes and standards. The Contractor's Engineer shall be the "Registered Professional of Record" for the fire suppression systems (Part 5 of the Letters of Assurance).

.3 The building code report forms an integral part of the fire suppression system and shall form part of the contractor's scope of work related to the fire suppression.

.4 The contractors engineer shall review all work on a minimum of a monthly basis and provide field review reports with 10 days of the review. Review reposts shall be made available to the owner's Departmental Representative team and Certifying Professional (CP).

.5 The entire building shall be fully sprinklered.

.6 Provide piping, sprinkler heads, alarm check valve, zone valves, excess pressure pump and all other devices and accessories required to provide a completely functional system.

.7 Tender documents do not contain complete sprinkler drawings. The sprinkler contractor shall prepare his own drawings. Where sprinkler head locations are shown, this is to indicate general intent only. It is the responsibility of the contractor to allow for in his bid and to install all heads required to satisfy the code. In laying out sprinkler system, the contractor shall review the contract documents and site conditions to ensure that piping systems do not conflict with other building elements. Any serious interference shall be reported to the Departmental Representative prior to commencement of work.

.8 Sprinkler system shall be hydraulically designed by the sprinkler subtrade with shop drawings (sealed and signed by a professional engineer practicing in the Province of BC and assuming full responsibility for the installed system) submitted showing all piping and sprinkler head locations. The contractor shall submit detailed installation drawings and design calculations for approval to the authorities having jurisdiction and to the Departmental Representative to review, prior to commencing work. No work shall commence prior to obtaining approved drawings from authorities having jurisdiction. The sprinkler contractor shall supply letters of assurance for the fire protection systems, and submit same to the Departmental Representative as well as the local authorities.

.9 Contractor to confirm the flow and pressure available by conducting a hydrant flow test. Sprinkler system design to be based on the final flow test information.

.10 Provide dry sprinkler systems/heads in areas subject to freezing temperature.

.11 Provide glycol loops where indicated on drawings for remote access subject to freezing.

.12 Provide pre-action systems where indicated on drawings.

.13 Provide signed and sealed letters of assurance, as required by the authority having jurisdiction, taking responsibility for the seismic restraints.

1.2 Intent

.1 The fire suppression system information shown on the provided plans are for general scope of work and coordination during design. The system is a design-build contract as outlined here.

.2 Provide complete, fully tested and operational fire protection (sprinklers, standpipes, pre-action systems, extinguishers, etc.) systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.3 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish minimum scope, material and installation quality and are not detailed installation instructions.

.4 Should inconsistencies exist such as the drawings disagreeing within themselves, or with the specifications, the better quality and/or greater quantity of work or of materials shall be estimated upon, performed and furnished unless otherwise ordered by the Departmental Representative in writing during the bidding period.

.5 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.6 Install equipment generally in locations and routes shown. Run piping close to building structure, parallel to building lines to maximize head room, and with minimum interference with other services and free space. Remove and replace improperly-installed equipment to satisfaction of the Departmental Representative at no extra cost.

.7 Install equipment to provide access and ease of maintenance.

.8 Provide seismic restraints for all required equipment and piping.

.9 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of twelve (12) months from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.10 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.11 'Provide' shall mean; 'supply and install'.

1.3 General Requirements

.1 Run piping concealed above furred ceilings and in joist to minimize obstructions. Expose only heads.

.2 A combined sprinkler - standpipe is to be provided. Refer to Section 21 12 01 for Standpipe Specifications.

.3 Prior to preparing shop drawings, sprinkler contractor shall review contract drawings of all disciplines and site conditions to ensure the piping systems do not conflict with other building systems. Report any serious interferences to Departmental Representative prior to commencement of work.

.4 All inspections and tests required by the Authorities shall be arranged and paid for by the contractor.

1.4 Related Sections

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 35 23 – Health and Safety

.3 Section 01 45 00 – Quality Control

.4 Section 01 74 19 – Construction Waste Management and Disposal.

.5 Section 01 78 10 – Closeout Submittals

.6 Section 23 08 04 – Building Management Manual

.7 Section 21 05 10 – Fire Extinguishers

.8 Section 21 13 13 – Wet Sprinkler Systems

.9 Section 21 13 16 – Dry Pipe Sprinkler Systems

1.5 Alternate Materials and Equipment

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List. If no acceptable manufacturer has been listed, refer to approved equivalents below.

.2 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted to the Departmental Representative no later than seven (10) working days prior to the closing date of tender, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum.

.3 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Departmental Representative. In the event that the product has been approved as "Alternate Only", this shall be stated in the quotation, and the Contractor shall bear any and all costs for design/system modifications to accommodate the alternate equipment.

.4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended and conform to the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of anything other than the specified materials or equipment. Extras will not be approved to cover such work.

1.6 Drawings and Specifications

.1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Departmental Representative, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

.4 Where sprinkler heads are shown on the provided drawings, changes in location require approval from the Departmental Representative.

.5 Sprinkler heads are to be coordinated with access panels and lighting in areas with no T-bar ceiling. The Contractor is to provide shop drawings for access panels including location with respect to sprinklers, lighting, and diffusers/grilles.

1.7 Quality Assurance

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 23 - Health and Safety.

.3 The Contractor's Engineer will provide field reviews and written reports on a monthly basis throughout the project.

.4 NFPA: conform to the BC Building Code and NBC referenced edition of the NFPA standards. The stricter version shall apply. If no direct reference exists the requirements stated in the latest edition of the NFPA standards shall apply.

1.8 Submittals

.1 Submittals are to be in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit preliminary layout showing only head locations for review by the Departmental Representative and Departmental Representative. Refer to architectural plans for ceiling coordinated head locations, space all others to Code Standards.

.3 Submitted shop drawings are to be stamped and signed by a professional engineer registered or licensed in the Province of British Columbia, Canada.

.4 Shop drawings must be accompanied by the following:

.1 Hydraulic Calculation signed and sealed by a registered professional engineer.

.2 Detailed piping and head layout.

.3 Schematic drawing of sprinkler system showing equipment, piping, and zone configurations.

.4 Details of special sprinkler systems (window, water curtains, glycol, pre-action system, deluge, etc.).

.5 Equipment product data sheets.

.6 Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

.5 Closeout Submittals to satisfy the following:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 Operation and maintenance manual is to be approved by, and final copies deposited with, the Departmental Representative before final inspection. A minimum of $2,500 shall be retained for As-Built Drawings and $2,500 for Maintenance Manuals until final submittals are provided.

.3 Operation data to include

.1 Description of systems and their controls.

.2 Description of operation of systems.

.3 Operation instruction for systems and components.

.4 Description of actions to be taken in event of equipment failure.

.5 Valves schedule and flow diagram.

.6 Colour coding chart.

.4 Maintenance data to include

.1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.2 Schedules of tasks, frequency, tools required, and task time.

.5 Performance data to include

.1 Equipment performance verification test results.

.2 Special performance data as specified.

.6 Approvals

.1 Submit five (5) copies of draft Operation and Maintenance Manual (OMM) to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make and record changes, as required, and resubmit, as directed by Departmental Representative.

.7 Additional data

.1 Prepare and insert additional data into OMM, when needed, during specified demonstrations and instructions.

.8 Site records

.1 Provide one (1) set of white prints, as required. This set of prints is to be dedicated for recording the work. Mark changes as work progresses and as changes occur.

.2 Transfer information weekly to show work as actually installed.

.3 Use a coloured, waterproof ink.

.4 Make the site records available for reference purposes and inspection.

.9 Record Drawings

.1 Finalize production of As-Built drawings prior to testing.

.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 Submit completed reproducible As-Built drawings with OMMs.

.5 Refer to Clause 2.1 of this Section for additional requirements.

.10 Submit copies of As-Built drawings for inclusion in final OMM.

1.9 Progress Claims

.1 Submit a Progress Summary and a Detailed Price Breakdown with each Progress Claim. The Summary and Breakdown shall include all Change Orders issued.

1.10 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to architectural, plumbing, mechanical, structural and electrical drawings when setting out work. Consult with respective trades in setting out locations for equipment, and piping, so that conflicts are avoided and symmetrical, even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.11 Delivery, Storage, and Handling

.1 Waste Management and Disposal

.1 Separate construction waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management and Disposal.

1.12 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management and Disposal.

.2 Collect and separate the following for disposal: paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal materials from landfill to metal recycling facility.

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

1.13 Equipment Protection & Cleanup

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Thoroughly clean piping and equipment of dirt, cuttings, and other foreign substances.

.4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion.

1.14 Substantial & Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Valve tagging and equipment identification is complete.

.4 Draft OMMs have been submitted.

.5 Operating and maintenance demonstrations have been provided to the Owner.

.6 Record (As-Built) drawings have been submitted.

.7 All seismic restraint devices have been installed.

.8 All previously-identified deficiencies have been corrected.

.3 The following is an outline checklist of the minimum requirements to be met by the Fire Protection Contractor prior to the Departmental Representative's Substantial Performance by the Contractor:

Inspection

- ☐ Complete Commissioning Checklists
- ☐ Final Sprinkler Materials and Test Certificate (above and below ground)
- ☐ Final Backflow Prevention Test Reports for all backflow devices
- ☐ Fire Alarm Test Certificate (via DIV.16)
- ☐ Fire Stopping Test Certificate by Commissioning Agent
- ☐ Seismic engineer's inspection of all seismic restraints and Schedule C Letter(s) of Assurance
- ☐ Sprinkler Contractor's Engineer of Record inspection and Schedule C Letter(s) of Assurance
- ☐ Final As-Built Drawings ready for review
- ☐ Maintenance and Operation Manuals, ready for review

.4 Prior to Total Performance Inspection, provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:

.1 Submit final operating and maintenance manuals.

.5 The Departmental Representative shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations, if required, shall be at the expense of the Contractor.

.6 The Contractor shall provide qualified personnel in appropriate numbers to operate the Facility until substantial performance is declared.

1.15 Maintenance

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 10 - Closeout Submittals.

2. PRODUCTS

2.1 Operating and Maintenance Manuals (OMM)

.1 Refer to Section 23 08 04 – Building Management Manual.

.2 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Departmental Representative two (2) months prior to final inspection.

.3 Where the fire protection system forms part of a plumbing/fire protection/HVAC contract, the fire protection operating and maintenance information shall be incorporated into the overall project OMM. The location of the fire protection information shall be in accordance with the overall project requirements.

.4 Where the fire protection system is the primary project scope, provide four (4) 216 mm x 280 mm capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine.

.5 Index binder according to the following system:

.1 Tab-1.0 Fire Protection Systems:

.1 Title page with clear plastic protection cover.

.2 Tab-1.1 List of Fire Protection Drawings:

.3 Tab-1.2 System Descriptions:

.1 Provide complete description of the operating sequence for all systems. Include detailed system description, with code equivalencies or other special design considerations.

.4 Tab-1.3 Operating Division:

.1 Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

.5 Tab-1.4 Maintenance and Lubrication Division:

.1 Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as valves, backflow protection devices, air compressors, drives, motors, etc. Compile this information for equipment and separate from shop drawings.

.6 Tab-1.5 List of Equipment Suppliers and Contractors:

.1 Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

.7 Tab-Certification (2.0, 2.1, ...):

.1 Include copy of test data on testing of the fire protection systems, hydrostatic or air tests performed on piping systems, equipment verification certificates (BFP test, etc.), copy of valve tag identification and pipe color code, inspection approval certificates for fire protection system, fire protection design engineer's Letters of Assurance (LOA's), seismic engineers LOA's, fire stopping certificate.

.8 Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

.1 Provide materials received in compliance with clause "Shop Drawings".

.6 The divider tabs shall be laminated mylar plastic and their colouring should be as follows: Fire Protection Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Record Drawings

.1 Refer to Section 23 08 04 – Building Management Manual.

.2 The Contractor shall keep on site, available to the Departmental Representative at all times and particularly for each regularly-scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.3 Provide record drawings which identify location of access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include, in general, the following:

.1 Items that are significant or are hidden from view.

.2 Items of major importance to future operations and maintenance.

.3 Future alterations and additions including cleanouts and isolation valves.

.4 Each “As Built” shall be marked, "We hereby certify that these drawings represent the building, as built" with signatures immediately below of authorized personnel of this Sub-Contractor.

3. EXECUTION

3.1 Painting Repairs and Restoration

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

.3 Refer to finish schedule in appropriate section of the specification. In case of conflict between any pre-finishing item and the finishing schedule, the finishing schedule shall govern the choice.

3.2 Demonstration

.1 Contractor will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 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.

.3 Use OMM, As-Built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements shall be as specified in appropriate sections.

.5 Contractor will record these demonstrations on video tape for future reference.

3.3 Field Quality Control

.1 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 Proceed in accordance with Section 01 74 00 – Cleaning and Waste Processing.

.2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

3.5 Protection

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Supply and installation of portable fire extinguishers, extinguisher cabinets and fire safety blankets.

.2 Related Sections:

.1 This section shall be read in conjunction with all other mechanical specification sections (Division 21, 22, 23).

1.2 References

.1 American National Standards Institute (ANSI)

.1 ANSI/NFPA 10 [2013], Portable Fire Extinguishers.

.2 B.C. Building Code 2012.

1.3 Submittals

.1 Submit shop drawings and product data in accordance with Section 01 - Submittal Procedures and Section 21 – Fire Protection–General Requirements.

2. PRODUCTS

2.1 Manufacturers

.1 Acceptable Manufacturers: National Fire Equipment,

2.2 FE-1 Recessed Cabinet with Extinguisher (finished areas):

.1 N.F.E. Model CE-950-3-2-R-G-T extinguisher cabinet

.2 229 mm [9”] wide x 610 mm [24”] high x 152 mm [6”] deep cabinet

.3 Semi – recessed steel cabinet with turnback frame for 100 mm [4”] wall thickness

.4 Full length semi-concealed piano hinges for 180 degree swing

.5 Flush stainless steel door latch with no exposed fasteners

.6 22 gauge steel tub

.7 16 gauge steel door and trim with optional 5 mm clear tempered glass (-G-T)

.8 Grey prime coated finish ready for field painting

.9 NFE 4.5 kg [10 lb.] ABC dry chemical multipurpose fire extinguisher

2.3 FE-2 Surface Mounted Cabinet with Extinguisher (service areas):

.1 N.F.E. Classic Cabinet model ECS-999 extinguisher cabinet

.2 267 mm [10 ½”] wide x 610 mm [24”] high x 160 mm [6 ¼”] deep cabinet

.3 Surface mount steel cabinet

.4 Cylinder lock with key (provide same keying throughout the facility and turn keys over to the Owner’s representative at time of demonstration)

.5 18 gauge steel tub

.6 Plexus glass panel, break glass hammer and instruction decal

.7 White baked enamel finish

.8 NFE 4.5 kg [10 lb.] ABC dry chemical multipurpose fire extinguisher

2.4 Extinguisher Brackets

.1 Type recommended by extinguisher manufacturer.

2.5 Cabinets

.1 Type as indicated above, constructed of 1.6 mm thick steel, 180^{o} opening door of 2.5 mm thick steel with latching device.

.2 Cabinets to maintain fire resistive rating of construction in which they occur.

.3 Cabinet door: with 5 mm full glass panel.

3. EXECUTION

3.1 Installation

.1 Install fire extinguishers in cabinets at locations as indicated on the drawings.

.2 Coordinate locations of fire extinguisher cabinets with the framing trades in order to facilitate recessed and semi-recessed installations.

.3 Mount fire extinguishers and cabinets such that the top of the extinguisher is at 1220 mm [4 feet] above the floor.

.4 Install fire extinguisher cabinet doors, glazing panels and fire extinguishers in the cabinets prior to the project substantial completion review by the Departmental Representative.

3.2 Identification

.1 Identify fire extinguishers in accordance with the recommendations of NFPA 10.

.2 Attach a tag or label to all fire extinguishers, indicating the month and year of installation, with space for recording subsequent service dates.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational wet sprinkler systems to meet the requirements described herein and in complete accord with applicable codes and ordinances. Materials and installation for wet pipe fire protection and sprinkler systems for heated areas.

.2 Sustainable requirements for construction and verification.

1.2 Related Sections

.1 Section 01 78 10 – Closeout Submittals.

.2 Section 21 05 05 – Fire Protection–General Requirements.

1.3 References

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA) ANSI/NFPA 13, Installation of Sprinkler Systems.

.1 ANSI/NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances.

.2 ANSI/NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 Underwriters Laboratories of Canada (ULC)

.1 CAN4 S543- [M984], Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.4 Quality Assurance

.1 Provide quality assurance in accordance with Section 21 05 05 – Fire Protection-General Requirements, and as specified in this section.

.2 Qualifications

.1 Installer: company or person specializing in fire standpipe installations by the approved by manufacturer.

1.5 Submittals

.1 Provide submittals in accordance with Section 21 05 05 – Fire Protection-General Requirements, and as specified in this section.

.2 Submit samples of the following:

.1 Each type of sprinkler head.

.2 Signs.

.3 Product Data

.1 Submit manufacturer's printed product literature, specifications and datasheets.

.4 Shop Drawings shall indicate the following:

.1 Materials.

.2 Finishes.

.3 Method of anchorage

.4 Number of anchors.

.5 Supports.

.6 Reinforcement.

.7 Assembly details.

.8 Accessories.

.5 Quality assurance shall include the following:

.1 Test reports

.1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

.4 Special requirement from client’s underwriter insurer.

.2 Manufacturer's Field Reports: manufacturer's field reports specified.

.6 Closeout Submittals

.1 Manufacturer's Catalog Data, including specific model, type, and size for

.1 Pipe and fittings.

.2 Alarm valves.

.3 Valves, including gate, check, and globe.

.4 Water motor alarms.

.5 Sprinkler heads.

.6 Pipe hangers and supports.

.7 Pressure or flow switch.

.8 Fire department connections.

.9 Excess pressure pump.

.10 Mechanical couplings.

.2 Drawings

.1 Sprinkler heads and piping system layout.

.2 Show data essential for proper installation of each system.

.3 Show details, plan view, elevations, and sections of systems supply and piping.

.4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.

.5 Review all documents (Architectural, Mechanical, Electrical and Structural) and ensure sprinkler system is coordinated with other services within the building.

.6 Electrical wiring diagrams.

.3 Design Data

.1 Calculations of sprinkler system design.

.2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.

.4 Field Test Reports: Preliminary tests on piping system.

.5 Operation and Maintenance Manuals

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground piping and other documentation for incorporation into manual specified in Section 01 78 10 - Closeout Submittals in accordance with ANSI/NFPA 13.

1.6 Coordination of Work

.1 Cooperate and coordinate with other trades on the project, in accordance with Section 21 05 05 – Fire Protection-General Requirements.

1.7 Delivery, Storage, and Handling

.1 Provide delivery, storage and handling in accordance with Section 21 05 05 – Fire Protection-General Requirements, and as specified in this section.

1.8 Waste Management and Disposal

.1 Provide waste management and disposal in accordance with Section 21 05 05 – Fire Protection-General Requirements.

1.9 Equipment Protection & Cleanup

.1 Protect equipment and materials in accordance with Section 21 05 05 – Fire Protection-General Requirements, and as specified in this section.

1.10 Finishes

.1 All prime painted equipment and products shall be finish painted as per the finish schedule or elsewhere noted in the contract documents.

1.11 Engineering Design Requirements

.1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area. Refer to code report for additional requirements.

.2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings. Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.

.4 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.

.5 Design systems for earthquake protection for buildings in seismic zone.

.6 Design system in accordance with ANSI/NFPA 13, using the following parameters:

.1 Hazard

.1 To suit occupancy as indicated.

.2 Pipe size and layout

.1 Hydraulic design or pipe schedule sizing design.

.2 Sprinkler head layout: to ANSI/NFPA 13 or as directed by Authority Having Jurisdiction.

.3 Zoning

.1 System zoning as indicated.

.7 Location of Sprinkler Heads

.1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13 for light or ordinary hazard occupancy depending on the zone.

.2 Uniformly space sprinklers on branch.

.8 Water Distribution

.1 Make distribution uniform throughout the area in which sprinkler heads will open.

.2 Discharge from individual heads in hydraulically most remote area to be 100% of specified density.

.9 Density of Application of Water

.1 Size pipe to provide specified density when system is discharging specified total maximum required flow.

.2 Application to horizontal surfaces below sprinklers shall be 6.3 lpm per m^2 or as required for specific fire zone.

.10 Sprinkler Discharge Area

.1 Area: hydraulically most remote 186 m^2 area as defined in NFPA 13.

.11 Outside Hose Allowances

.1 Include allowance in hydraulic calculations of 250 USgpm for outside hose streams.

.12 Friction Losses

.1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.

.13 Water Supply

.1 Contractor shall base hydraulic calculations on a current water flow test to be obtained and paid for by the contractor.

.2 Sprinkler Engineer shall obtain up to date water pressure information and hydraulically size the system to maintain 15 psi pressure at the highest and furthest away sprinkler.

.3 Provide redundant water supplied as indicated on the drawings and as required within the code report.

1.12 Maintenance

.1 Extra Materials: Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.1 Provide spare sprinklers and tools as required by ANSI/NFPA 13.

.2 Heads to be mounted in case and located in the Mechanical Room.

2. PRODUCTS

2.1 Pipe, Fittings and Valves

.1 Pipe

.1 Ferrous: to ANSI/NFPA 13.

.2 Copper tube: to ANSI/NFPA 13.

.2 Fittings and joints to ANSI/NFPA 13

.1 Ferrous: screwed welded flanged or roll grooved.

.2 Copper tube: screwed soldered or brazed.

.3 Valves

.1 ULC listed for fire protection service.

.2 Up to NPS 2: bronze, screwed ends, OS & Y; gate.

.3 NPS 2 ½ and over: cast iron, flanged or roll-grooved ends, indicating butterfly valve.

.4 Swing check valves.

.5 Ball drip.

.4 Pipe hangers

.1 ULC listed for fire protection services.

.2 Epoxy coated hangers and supports in natatorium.

2.2 Sprinkler Heads

.1 Temperature rating on fusible links shall suit specific hazard area with minimum margin of safety 10°C.

.2 All sprinkler heads shall be of quick response type, having a response time between 30 to 90 seconds.

.3 For suspended ceilings, provide semi-recessed pendant type with chrome plated finish and escutcheon.

.4 For exposed areas, provide standard upright type with chrome plated finish. For sidewall application, provide sidewall type with chrome plated finish and escutcheon.

.5 Provide dry heads on wet system where serving areas subject to freezing.

.6 General: to ANSI/NFPA 13 and ULC listed for fire services.

.7 SPRINKLER HEAD – Mechanical Rooms

.1 Upright corrosion resistant type.

.8 SPRINKLER HEAD – All other Exposed Structure Areas

.1 Provide standard upright type with chrome plated finish

.9 SPRINKLER HEAD – Concealed with Finished Ceiling

.1 For suspended ceilings, provide recessed pendant type with concealed cover and escutcheon. Tyco – QR or equal

.10 SPRINKLER HEAD – As required by the Code Report

.1 Doors @ fire rating – Quick response pendant

.2 Close space Quick response heads designed for 3 GPM/ln ft. Tyco – FRB or equal.

2.3 Supervisory Switches

.1 General: to ANSI/NFPA 13 and ULC listed for fire service.

.2 Valves

.1 Mechanically attached to valve body, with normally-open and normally-closed contacts and supervisory capability.

.3 Flow switch type

.1 With normally-open and normally-closed contacts and supervisory capability.

.4 Pressure alarm switch

.1 With normally-open and normally-closed contacts and supervisory capability.

2.4 Fire Department Connection

.1 To ANSI/NFPA 13 and ULC listed, Siamese type, location as indicated on fire protection drawings. Thread specifications to be compatible with local fire department.

.2 Two-way flush mounted Siamese fire department connection with chrome-plated finish with identifying sign cast on plate and 20 mm ($^3/_4$ in.) automatic drip connected to drain marked "Sprinkler Fire Department Connection". Threaded metal caps and chains.

2.5 Pressure Gauges

.1 All pressure gauges to be ULC listed.

.2 Shall have maximum limit of not less than twice normal working pressure at point where installed.

2.6 Spare Parts Cabinet

.1 For storage of maintenance materials, spare sprinkler heads and special tools.

.2 Construct to sprinkler head manufacturers standard.

3. EXECUTION

3.1 Installation

.1 Refer to code report for special requirements.

.2 Install, inspect and test to acceptance in accordance with ANSI/NFPA 13.

.3 Protect sprinkler heads against mechanical injury with standard guards when necessary.

.4 Provide 25 mm diameter nipple and 25 mm x 15 mm reducing fitting for each upright head.

.5 Provide on sprinkler system take-off from water supply approved detector type double check valve assembly with approved listed OS & Y gate valves on both sides.

.6 All sprinkler system isolation valves shall have contacts so that they can be monitored on the building fire alarm systems.

.7 Centre heads in two directions in ceiling tile. Maintain code-required spacing.

.8 Arrange sprinkler piping and provide drain valves such that it is completely drainable. Extend drain lines to an accessible location above ceiling over housekeeping areas. Provide valved-hose connection and access panel.

.9 Provide sprinkler flow test connections as per NFPA 13.

.10 Allow for additional sprinkler heads in mechanical rooms to accommodate field conditions.

.11 Install approved monitored valves and flow switches for all zones. Monitored valves and flow switches shall be wired to central fire alarm system by Electrical. Identify each valve by indicating which portion of the system is controlled by each valve.

.12 All sprinkler head locations shall be coordinated with the lighting, audio equipment, and all other obstacles on the ceilings.

.13 Adjust sprinkler piping up or down if conflictions occur between structure, lighting, electrical, plumbing piping or ductwork.

.14 Do not install any sprinkler heads until all piping systems have been flushed of all contaminants such as cutting oil.

.15 All off site prefabrication of sprinkler piping shall be at the contractor’s own risk.

.16 Provide on wall near sprinkler valve, cabinet containing extra sprinkler heads of each type and a wrench suitable for each head type. Six (6) extra sprinkler heads for less than 300 sprinklers, 12 for 300 to 1000 sprinklers, and 24 for over 1000 sprinkler heads of each type.

.17 See Bulletin 93-1 Protection of Standpipes and Sprinkler Piping against Freezing in City of Vancouver design.

.18 Provide sprinkler heads in all elevator pits and at top of elevator shafts.

.19 Provide dry pendant or sidewall heads on all wet sprinkler systems with heads piped into cold areas.

.20 Provide close spaced heads where required to protect interconnected floor spaces. Coordinate head locations with heat baffles. See code report requirements.

3.2 Testing

.1 All tests required by this standard for the work shall be performed by this Contractor. When the authority having jurisdiction desires to be present during the conduct of tests, the Contractor shall give the Authority Having Jurisdiction advance notice of the time tests are to be performed.

.2 When the representative of Authority Having jurisdiction is not available and permission is granted by that authority, tests may be witnessed by the Owner or his representative and the Contractor's material and test certificate as per NFPA standards shall be completed and forwarded to the Authority Having Jurisdiction.

.3 The sprinkler system is subject to final inspection test, and approval by the Authority Having Jurisdiction, Fire Marshall and Departmental Representative.

.4 Before requesting approval and acceptance testing of the equipment by the Authority Having Jurisdiction, Fire Marshall, the installing company shall furnish a written statement to the effect that the work covered in this installation has been completed and tested in accordance with the approved plans and specifications, and shall provide a "Contractor's Material and Test Certificate" as required by the NFPA Standard No. 13, General Information.

.5 All systems and piping shall be tested hydrostatically at not less than 1380 kPa pressure for two (2) hours, or at 345 kPa in excess of the maximum static pressure when the maximum static pressure is in excess of 1034 kPa.

.6 The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested.

.7 Brine or other corrosive chemicals shall not be used for testing systems.

.8 No substance to stop leaks shall be introduced to any sprinkler system.

.9 Install fire department connection as indicated.

.10 Install spare parts cabinet as indicated.

.11 Pressure gauges

.1 Location

.1 On water entry.

.2 In each independent pipe from wet pipe header or valve.

.3 At accelerators.

.2 Install to permit removal.

.3 Locate so as not subjected to freezing.

.12 Valve identification

.1 Identify drain valve, by-pass valves and main shut-off valve and all auxiliary valves.

3.3 Final Approval

.1 Before asking final approval of the automatic dry and wet sprinkler system by the authority having jurisdiction, the installing company shall furnish a written statement to the effect that the work covered by its contract has been completed and tested in accordance with the approved specifications and plans.

.2 Contractor's Certificate - NFPA Testing Contractor's Certificate is to be completed and forwarded to the authority having jurisdiction and the Departmental Representative as evidence that the necessary tests and materials have been provided. It is stressed that all sections of the certificate are to be completed.

.3 There shall be maintained on the premises a supply of spare sprinklers (never less than six (6)). These sprinklers shall correspond as to types and temperature ratings with the sprinklers in the property. The sprinklers shall be kept in a cabinet. The cabinet shall be located in the mechanical room.

.4 A special sprinkler wrench shall also be provided and kept in the cabinet, to be used in the removal and installation of sprinklers.

.5 The stock of spare sprinklers shall be as follows for each type of sprinkler head used on the project:

.1 For systems not over 300 sprinklers, not less than six (6) sprinklers.

.2 For systems 300 to 1,000 sprinklers, not less than twelve (12) sprinklers.

.3 For systems above 1,000 sprinklers, not less than twenty-four (24) sprinklers.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Division 21 Section 21 05 05 “Fire Protection - General Requirements”.

.2 Division 21 Section 21 13 13 "Wet Pipe Sprinkler System”.

1.2 References

.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

.1 ANSI/NFPA13-2016 Select Edition, Standard for the Installation of Sprinkler Systems.

.2 ANSI/NFPA 25-2014 Select Edition, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 Submittals

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit two 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 and product data in accordance with Section 01 33 00 - Submittal Procedures and in accordance with ANSI/NFPA 13.

.1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Test reports:

.1 Test hydrostatically to meet requirements of fire protection system to which it will be connected.

.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.

.4 Manufacturer's Field Reports: manufacturer's field reports specified.

.4 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 Provide detailed hydraulic calculations including: summary sheet, Contractor's Material and Test Certificate for aboveground piping, as well as other deliverables for incorporation into manual specified in Section 01 78 10 - Closeout Submittals, in accordance with ANSI/NFPA 13.

1.4 Quality Assurance

.1 Qualifications:

.1 Installer: company or person specializing in dry pipe sprinkler system installations.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 23 - Health and Safety.

1.5 Engineering Design Criteria

.1 Design system in accordance with ANSI/NFPA 13, using following parameters:

.1 Hazard:

.1 To suit occupancy as indicated and as required by code.

.2 Pipe size and layout:

.1 Hydraulic design.

.2 Sprinkler head layout: to ANSI/NFPA 13 and as indicated on drawings for special applications.

.3 Water supply:

.1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with ANSI/NFPA 13.

.4 Zoning:

.1 System zoning as indicated and as required by code.

1.6 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - 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: in accordance with Section 01 74 19 - Construction Waste Management and Disposal.

1.7 Maintenance

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Provide spare sprinklers and tools as required by ANSI/NFPA 13.

2. PRODUCTS

2.1 Pipe, Fittings and Valves

.1 Pipe:

.1 Ferrous: to ANSI/NFPA 13.

.2 Copper tube: to ANSI/NFPA 13.

.2 Fittings and joints to ANSI/NFPA 13:

.1 Ferrous: screwed, welded, flanged or roll grooved.

.2 Copper tube: screwed, soldered, brazed.

.3 Auxiliary valves:

.1 ULC listed for fire protection service.

.2 Up to NPS 2: bronze, screwed ends, OS & Y gate.

.3 NPS 2 1/2 and over: cast iron, flanged or roll grooved ends, indicating butterfly valve.

.4 Swing check valves.

.5 Ball drip.

.6 Tamper devices wired back to fire alarm panel.

.4 Pipe hangers:

.1 ULC listed for fire protection services.

2.2 Sprinkler Heads

.1 General: to ANSI/NFPA 13 and ULC listed for fire services.

2.3 Auxiliary Supervisory Switches

.1 General: to ANSI/NFPA 13 and ULC listed for fire service.

.2 Valves:

.1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.

.3 Flow switch type:

.1 With normally open and normally closed contacts and supervisory capability.

.4 Pressure alarm switch:

.1 With normally open and normally closed contacts and supervisory capability.

2.4 Water Gong

.1 To ANSI/NFPA 13 and ULC listed for fire service. Location as indicated.

2.5 Fire Department Connection

.1 To ANSI/NFPA 13 and ULC listed, siamese type, location as indicated. Thread specifications to be compatible with local fire department.

.2 Polished bronze chrome plated recessed exposed with identifying sign cast on plate. Threaded metal caps and chains.

2.6 Dry Pipe Valve

.1 ULC listed.

.2 Cast iron, flanged type, sized to suit water main.

.3 Components:

.1 Accelerator.

.2 Air maintenance device with low pressure alarm.

.3 Alarm pressure switch with supervisory capability.

.4 Pressure gauges.

.5 Drain valve.

.6 Test valve with associated piping.

.7 Shut off valve - OS & Y with tamper-proof device wired back to fire alarm panel.

2.7 Compressed Air Supply

.1 Automatic Air Compressor.

.2 ULC listed.

.3 Capacity:

.1 To restore normal air pressure in system within 30 minutes.

.2 To provide air pressure in accordance with instruction sheet furnished with dry pipe valve.

.4 Piping: ferrous, NPS 3/4 screwed joints and fittings, to ANSI/NFPA 13.

2.8 Pressure Gauges

.1 ULC listed.

.2 Maximum limit of not less than twice normal working pressure at point where installed.

2.9 Relief Valve

.1 ULC listed.

2.10 Spare Parts Cabinet

.1 For storage of maintenance materials, spare sprinkler heads and special tools.

.2 Construct to sprinkler head manufacturers standard.

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, inspect and test to acceptance in accordance with ANSI/NFPA 13 and NFPA 25.

.2 Testing to be witnessed by Fire Commissioner of Canada Canadian Forces Fire Marshal authority having jurisdiction.

.3 Install water gong as indicated.

.4 Install fire department connections as indicated.

.5 Install spare parts cabinet as indicated.

.6 Pressure gauges:

.1 Location:

.1 On water side and air nitrogen side of dry pipe valve.

.2 At air receiver.

.3 In each independent pipe from air supply to dry pipe valve.

.4 At exhausters and accelerators.

.2 Install to permit removal.

.3 Locate so as not subjected to freezing.

.7 Valve identification:

.1 Identify drain valve, by-pass valves and main shut-off valve and all auxiliary valves.

3.3 Field Quality Control

.1 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 Proceed in accordance with Section 01 74 00 – Cleaning and Waste Processing.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical and plumbing systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Should inconsistencies exist such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the Departmental Representative in writing during the bidding period.

.4 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.5 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Departmental Representative at no extra cost.

.6 Install equipment to provide access and ease of maintenance.

.7 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start up and test.

.8 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.9 Provide seismic restraints for all required equipment, piping and ductwork.

.10 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of twelve (12) months from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.11 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.12 'Provide' shall mean; supply and install'.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings. Drawings shall take precedence over specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Permits

.1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the work.

.3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

.4 Contractor shall provide schedule B1/B2 letters of assurance for seismic engineering and for fire protection/sprinkler system engineer.

1.4 Tender Price Breakdown

.1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Departmental Representative.

.2 As a minimum, include the following in the tender price breakdown:

.1 Site Services: Materials, labour

.2 Mechanical: Equipment, materials, labour

.3 Plumbing: Equipment, materials, labour

.4 Sheet Metal: Equipment, materials, labour

.5 Fire protection: Equipment, materials, labour

1.5 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings to show:

.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 Manufacturer to certify current model production.

.3 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.

.5 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.

.3 Operation data to include:

.1 Operation instruction for systems and component.

.2 Description of actions to be taken in event of equipment failure.

.3 Valves schedule and flow diagram.

.4 Colour coding chart.

.4 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.

.5 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.

.6 Approvals:

.1 Submit 2 copies 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.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 1 set of mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.

.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.

.9 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.

.6 Cost of transfer as-builts onto reproducible media & auto-cad disks are this contractor's responsibility. Departmental Representative will release drawings to contractor after signing a copy right form.

.7 Shall the contractor choose to undertake this Departmental Representative, allow $400 / sheet. This will cover costs for drafting time & printing costs.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.6 Quality Assurance

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 23 - Health and Safety.

1.7 Maintenance

.1 Furnish spare parts in accordance with Section 01 78 10 - Closeout Submittals as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 10 - Closeout Submittals.

.3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.8 Delivery, Storage, and Handling

.1 Waste Management and Disposal:

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

1.9 Examination of Site

.1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender.

1.10 Quality of Work

.1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Departmental Representative.

.2 Work which does not conform to standards accepted by the Departmental Representative and the trade may be rejected by the Departmental Representative. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.11 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals (shop drawings etc.) use the same SI units as stated in the specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

EQUIVALENT NOMINAL DIAMETER OF PIPES					
mm	**Inches (NPS)**	**mm**	**Inches (NPS)**	**mm**	**Inches (NPS)**
3	1/8	65	2-1/2	375	15
6	1/4	75	3	450	18
10	3/8	100	4	500	20
15	1/2	125	5	600	24
20	3/4	150	6	750	30
25	1	200	8		
30	1-1/4	250	10		
40	1-1/2	300	12		
50	2				

.5 Metric Duct Sizes:

.1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.12 Alternate Materials and Equipment

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List. If no acceptable manufacturer has been listed, refer to approved equivalents below.

.2 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted to the Departmental Representative no later than ten (10) working days prior to the closing date of tender, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum.

.3 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Departmental Representative. In the event that the product has been approved as "Alternate Only", this shall be stated in the quotation, and the contractor shall bear any and all costs for design/system modifications to accommodate the “alternate” equipment.

.4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such work.

1.13 Drawings and Specifications

.1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Departmental Representative, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.14 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Structural Departmental Representative before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.15 Excavation and Backfill

.1 Refer to requirements of Division 31.

.2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

.3 Refer to details on drawings as well. Should a conflict occur, contact the Departmental Representative for clarification.

1.16 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.17 Connections to Existing Services

.1 Maintain liaison with the Owner and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.18 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

.4 Contracting authority received enquiries during tender period to be submitted prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.

.5 All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 2004.

1.19 Equipment Protection and Clean Up

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.20 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive (variance frequency drive) shall be inverter only rated.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.5 Motors less than 1-hp shall be 120 V, 60 Hz, 1 phase. Motors 1-hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless otherwise noted.

.7 Provide motors complete with equipment except where indicated.

.8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.9 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.10 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.12 Minimum certified motor efficiency shall be as outlined in ASHRAE 90.1 2013.

1.21 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves;

.2 Cleanouts and traps;

.3 Controls, coils and terminal units;

.4 Expansion joints.

.5 Filters

.6 Strainers

.2 Mark removable ceiling tiles used for access with colour coded dots.

.3 Provide ULC-listed fire rated access doors installed in rated wall and ceilings.

.4 Refer to Section 23 05 05 for additional requirements.

1.22 Miscellaneous Metals

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

.3 Access platforms and catwalks.

1.23 Pipe Sleeves

.1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes. Sleeves shall extend 25 mm on either side of the wall.

.2 Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand. Provide concrete curbs in mechanical spaces per UBC Standards.

.3 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.24 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.25 Substantial Performance

.1 Refer to requirements with Section 23 05 00.

1.26 Acceptable Manufacturers

.1 Refer to requirements within Section 23 05 00

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Departmental Representative two (2) months prior to final inspection.

.2 Provide four (4) 216 mm x 280 mm capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine.

.3 Index binder according to the following system:

.1 Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

.2 Tab-1.1 List of Mechanical Drawings:

.3 Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

.4 Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

.5 Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from shop drawings.

.6 Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

.7 Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

.8 Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.4 The divider tabs shall be laminated mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

3. EXECUTION

3.1 Painting Repairs and Restoration

.1 Do painting in accordance with Section 09 91 10 - Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore to new condition, finishes which have been damaged.

3.2 Record Drawings:

.1 Enter dimensions from building line to all buried services, including coordinates and depth elevations of manholes, tanks, outside shut-off valves, and other similar elements.

.2 At substantial completion, the Departmental Representative shall transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, on “As Built” CADD files. From these files plot a set of as-built prints. Drafting quality shall be same as original drawings.

.3 The CADD disks may be borrowed from the Departmental Representative. Each "as-built" print shall bear the Contractor's identification, the date of record and the notation "We hereby certify that these drawings represent the As-Built Record of Construction." The Contractor's signature and company seal shall be placed below that notation. Contractor to sign release agreement before Departmental Representative shall provide drawings.

.4 The cost per drawing sheet for transferring information to the record drawings by the Departmental Representative shall be as agreed in the contract documents. Should the Contractor undertake major re-routing of services where the original layout is appropriate or should major changes in the scope of work occur, additional charges may apply. Costs for printing are not included.

3.3 Cleaning

.1 Clean interior and exterior of all systems including strainers.

3.4 Demonstration

.1 Commissioning Agent will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 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.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Contractor will record these demonstrations on video tape for future reference.

3.5 Protection

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

3.6 Core Drilling

.1 Clearly identified all proposed piping penetrations through existing slabs, walls etc. and advise the Contractor. Obtain x-rays of the locations to ensure penetration will avoid any existing post tension cables or reinforced steel. Advise the structural Departmental Representative of any conflicts as a result of the x-rays.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

.2 Division 21 – Fire Suppression

.3 Division 22 – Plumbing

.4 Division 23 – Heating, Ventilation & Air Conditioning

1.2 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings to show:

.1 Material Specification including CSA or ULC reference numbers.

.2 Installation details for various types of piping materials.

.3 Operating and maintenance requirements.

.3 Shop drawings and product data accompanied by:

.1 Manufacturer to certify current model production.

.2 Certification of compliance to applicable codes.

.4 Material Safety Data Sheets (MSDS)

.1 Submit Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures for the following products. Indicate VOC emissions, prior to installation or use:

.1 Adhesives.

.2 Caulking compounds.

.3 Sealants.

.4 Insulating materials.

.5 Fireproofing or fire stopping materials.

.5 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 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.

1.3 References

.1 Test Requirements: ULC-S115-M or CAN4-S115-M, "Standard Method of Fire Tests of Through Penetration Fire Stops".

.2 CAN4-S115-M under their designation of ULC-S115-M and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.

.3 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their “Products Certified for Canada (cUL) Directory

.4 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

.5 Inspection Requirements: ASTM E 2174 – 01, “Standard Practice for On-site Inspection of Installed Fire Stops.

.6 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.

.7 All major building codes: NBC and BCBC.

.8 NFPA 101 - Life Safety Code

1.4 Definitions

.1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.5 Quality Assurance

.1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A manufacturer’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

.2 Retain and pay for the service of a Professional Engineer registered in the Province of British Columbia to inspect each and every mechanical fire stopping installation, and as required by the Authority having jurisdiction, and provide a report on all installations. The fire stopping engineer shall provide letters of assurance in accordance with the BC Building Code.

.3 A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

.4 Firestop System installation must meet requirements of CAN4-S115-M or ULC S-115-M tested assemblies that provide a fire rating.

.5 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

.6 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural Departmental Representative prior to penetrating any load bearing assembly.

.7 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

.8 Allow for destructive testing of 5% of fire stopping applications. Should installations not conform to manufacturer's listed assembly, an additional 25% of installations may be destructively tested and should there be more failures, the contractor will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the project.

1.6 Acceptable Manufacturers

.1 Subject to compliance with through penetration firestop systems listed in U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following manufacturers as identified below:

.1 Hilti (Canada) Corporation

.2 3M

.3 Other manufacturers listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Director.

.4 Or approved alternate

2. PRODUCTS

2.1 Firestopping, General

.1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

.2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

.3 Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 Materials

.1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

.2 Cast-in place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are acceptable:

.1 Hilti CP 680 Cast-In Place Firestop Device

.1 Add Aerator adaptor when used in conjunction with aerator ("sovent") system.

.2 Hilti CP 681 Tub Box Kit for use with tub installations.

.3 Hilti CP 682 Cast-In Place Firestop Device for non-combustible pipe

.4 Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.5 Or approved alternate

.3 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).

.1 Hilti FS-ONE Intumescent Firestop Sealant

.2 Hilti CP 604 Self Levelling Firestop Sealant

.3 Hilti CP 620 Fire Foam

.4 Hilti CP 606 Flexible Firestop Sealant

.5 Hilti CP 601s Elastomeric Firestop Sealant

.6 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.4 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.1 Hilti FS-ONE Intumescent Firestop Sealant

.2 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.5 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa. differential. Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.1 Hilti CP 643N Firestop Collar

.2 Hilti CP 644 Firestop Collar

.3 Hilti CP 645/648 Wrap Strips

.4 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.6 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

.1 Hilti CP 637 Firestop Mortar

.2 Hilti FS 657 Fire Block

.3 Hilti CP 620 Fire Foam

.4 Hilti CP 675-T Firestop Board

.5 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.7 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:

.1 Hilti FS 657 Fire Block (for walls and floors)

.2 Hilti CP 658T Firestop Plug (for walls and floors)

.3 Hilti CP 680 Cast-In Place Firestop Device (for floors only)

.4 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.8 For penetrations through a Fire Separation wall provide a firestop system with a "F" Rating as determined by ULC or cUL as indicated below:

Fire Resistance Rating of Separation	Required ULC or cUL "F" Rating of Firestopping Assembly
30 minutes	20 minutes
45 minutes	45 minutes
1 hour	45 minutes
1.5 hours	1 hour
2 hours	1.5 hours
3 hours	2 hours
4 hours	3 hours

For combustible pipe penetrations through a Fire Separation provide a firestop system with a "F" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

3. EXECUTION

3.1 Preparation

.1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

.1 Verify penetrations are properly sized and in suitable condition for application of materials.

.2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

.3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

.4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

.5 Do not proceed until unsatisfactory conditions have been corrected.

3.2 Coordination

.1 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

.2 Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.3 Installation

.1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory.

.2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.

.1 Seal all holes or voids made by penetrations to ensure an air and water resistant seal.

.2 Consult with mechanical Departmental Representative, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

.3 Protect materials from damage on surfaces subjected to traffic.

3.4 Field Quality Control

.1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

.2 Keep areas of work accessible until inspection by applicable code authorities.

.3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

.4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

.5 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:

.1 Warning that the opening has being fire stop protected

.2 Indicate the fire stop system used (ULC or cUL)

.3 F rating or FT rating

.4 Fire stop product(s) used

.5 Person to contact and phone number in case of modification or new penetration of fire stop system

3.5 Adjusting and Cleaning

.1 Remove equipment, materials and debris, leaving area in undamaged, clean condition.

.2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.6 Demonstration

.1 Departmental Representative and/or owners representative will use equipment and systems for test purposes.

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.

.2 Also refer to Section 23 07 19 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 and recirculation.

.3 Non-potable water.

.4 Storm drainage piping and underside of drain bodies.

.3 Provide domestic hot water temperature maintenance cables and controls on all domestic hot water systems and domestic tempered water systems greater than 5 meters in length that do not have recirculation.

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 This Section shall be read in conjunction with and as a supplement 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. This Section indicates additional scope for thermal insulation and jacketing for plumbing equipment.

1.2 General Requirements

.1 The Installation firm shall be a current member of the Thermal Insulation Association of Canada (TIAC).

.2 Only Journeyman insulation applicators, with 3 years minimum successful experience in this size and type of project, shall perform the work.

.3 Provide thermal insulation on plumbing equipment and the following:

.1 Domestic cold water meters

.2 Domestic hot water storage tanks.

1.3 Insulation Minimum Thickness Schedule

.1 Factory insulated equipment need not comply with the minimum thickness table below provided they are insulated to a thermal resistance not less than RSI 0.58 (R3.3).

.2 Thermally insulate equipment to the following:

Duty	Interior		Exterior	
	mm	inches	mm	inches
Low Temperature Range (15°C to -75°C)	50	2	50	2
Intermediate Temperature Range (15°C TO 315°C)	50	2	50	2
Non potable storage tanks subject to condensation	25	1	-	-
Water meter	25	1	-	-

1.4 Equipment Finishes Schedule

.1 On all externally insulated equipment provide the following finish material:

.1 Low temperature equipment in mechanical rooms: PVC jacket to TIAC standard CEF/2

.2 Intermediate temperature equipment in mechanical room's canvas jacket to TIAC standard CEF/2.

.3 Indoor equipment elsewhere canvas/PVC jacket to TIAC standard CEF/2.

.4 Outdoor equipment aluminum jacket to TIAC standard CEF/1.

.5 Water meter canvas jacket to TIAC standard CEF/2.

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 This Section shall be read in conjunction with and as a supplement 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. This Section indicates additional scope for thermal insulation and jacketing for plumbing piping and plumbing piping accessories.

1.2 General Requirements

.1 Provide thermal insulation on all plumbing piping, valves and fittings and as follows:

.1 Domestic cold water, domestic hot water and recirculation.

.2 Service hot water and recirculation 82°C (180°F).

.3 Domestic tempered water and recirculation.

.4 Non-potable water.

.5 Storm drainage piping for the full length of the systems located within the building and the underside of drain bodies.

.6 All piping provided with heat tracing cable for freeze protection.

.7 Offset waste piping, p-traps and supplies under all wheelchair accessible lavatories and sinks.

.8 Provide foil faced flexible insulation on components requiring adjustment or servicing including booster pumps, meter sets, pressure reducing valves, valve bodies, strainers etc.

.9 Sanitary vent stacks for the last 3m (10') prior to penetrating the roof or penetrating into a cold attic or similar space.

.10 Roof Drains and Vents: Adhere flexible blanket insulation with adhesive applied to all laps. Provide annealed tie wire at 400mm (16") centres for securing insulation. Butt insulation and seal joints and breaks with 50mm (2") wide foil adhered over joint.

.11 Do not insulate exposed run-outs to plumbing fixtures, chrome plated piping, valves, fittings. Do not insulate run-outs to individual units and equipment not exceeding 3600 mm long.

1.3 Application Design Operating Temperatures

.1	Continuous Cold Water Drainage	10°C (50°F)
.2	Drip Pan Drain – Freezer	10°C (50°F)
.3	Drip Pan Drain – Heat Traced	10°C (50°F)
.4	Drip Pan Drain – Evaporator 11°C & Above	Insulation Not Required
.5	Drip Pan Drain – Evaporator Below11°C	10°C (50°F)
.6	Domestic Cold Water	10°C (50°F)
.7	Domestic Hot & Tempered Water	60 - 80°C (140 - 180°F)
.8	Interior Storm Drainage	10°C (50°F)
.9	Exterior Storm Drainage	Insulation Not Required

.10 Non-Potable Water Insulation Not Required

1.4 Piping Insulation Minimum Thickness Schedule

Type Of System	Design Operating Temperature Range °C (°F)	Thermal Conductivity of		Nominal Pipe Diameter (NPS)				
		Conductivity Range W/m.°C	Mean Rating Temperature °C (°F)	Runouts ≤ 1	1 to 1.25	1.5 to 3	4 to 6	≥ 8
				Minimum Thickness of Piping Insulation (mm)				
Above Grade Exterior	All	0.046-0.049	121 (250)	40	65	65	75	90
Hot Water Systems	61-93 (142-200)	0.036-0.042	52 (126)	40	40	50	50	50
	41-60 (106-141)	0.035-0.040	38 (100)	25	25	40	40	40
Cold Water Systems	5-13 (41-55)	0.033-0.039	24 (75)	25	25	25	25	25
	<5 (41)	0.029-0.037	10 (50)	25	25	25	25	40

Note: Where the thermal conductivity of a proposed insulation is greater than the range specified above, the thickness will be increased by the ratio of U2/U1.

U2 = proposed insulation “k” value at the table mean rating temperature.

U1 = upper range limit “k” value from the table above.

1.5 Piping Finish Schedule

.1 Conform to the following:

Duty	Type	TIAC Code
Indoors, concealed	Factory	CPF/2
Indoors, exposed in mechanical room and elsewhere	Canvas Jacket	CPF/1
Indoors, exposed in utility areas, parkade, etc.	PVC Jacket	CPF/4
Outdoors	Metal Jacket	CPF/3

2. PRODUCTS

2.1 Undersink Piping Covers

.1 ADA compliant waste and supply piping covers

.2 Suitable for all $1^1/_4$ NPS or 1½ NPS cast brass or tubular P-trap assemblies and $^3/_8$ NPS or ½ NPS angle stop assemblies

.3 Rigid high-impact, stain-resistant PVC.

.4 Bacteria/Fungus Resistance of zero growth as per ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.5 UV stable, will not fade or discolor

.6 Color: White

3. EXECUTION

3.1 Undersink Piping Covers

.1 Install on all exposed p-traps, offset p-traps and angle stop assemblies serving accessible lavatories.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 23 05 00 - Common Work Results - Mechanical.

.2 Section 23 05 01 – Pipe Installation.

.3 Section 23 05 22 - Valves - Bronze.

.4 Section 23 05 23 Valves - Cast Iron.

.5 Section 23 05 93 – Balancing and Testing.

1.2 References

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).

.1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.

.2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM B88M, Standard Specification for Seamless Copper Water Tube (Metric).

.3 American Water Works Association (AWWA).

.1 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67, Butterfly Valves.

.2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Place materials defined as hazardous or toxic in designated containers.

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

2. PRODUCTS

2.1 Piping

.1 Domestic hot, cold and recirculation systems, within building. Refer to application schedule on drawings.

.1 Above ground: copper tube, hard drawn, type K to ASTM B88M.

2.2 Fittings

.1 Bronze pipe flanges and flanged fittings, Class 150 to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 NPS 2 and larger: roll grooved to CSA B242. Fittings shall be wrought copper to ANSI/ASME B16.22 or cast bronze to ANSI/ASME B16.18, with cooper-tube dimensioned grooved ends. (Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.) Basis of Design: Victaulic Copper-Connection.

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 : lead free.

.4 Teflon tape: for threaded joints.

.5 Grooved couplings: designed with angle bolt pads to provide rigid joint at cooper-tubing sizes, complete with EPDM-HP flush seal type gasket, suitable for water temperature to +120°C [+250°F]. Installation-Ready, for direct slab installation without field disassembly. Basis of Design: Victaulic Style 607H.

.6 Dielectric connections between dissimilar metals: dielectric fittings to ASTM F492 complete with thermoplastic liner. Basic of Design: Victaulic Style 47.

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 22 - 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 22 - Valves - Bronze

.3 NPS 2-1/2 and over, 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 - Valves - Cast Iron

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 22 - Valves - Bronze.

.2 Lockshield handles:

.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 22 - Valves - Bronze

.2 Lockshield handles:

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 22 - Valves - Bronze

.2 NPS 2-1/2 and over, flanged:

.1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23 - Valves - Cast

2.7 Ball Valves

.1 NPS 2 and under, soldered:

.1 To ANSI/ASME B16.18, Class 150.

.2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 22 - Valves - Bronze

2.8 Butterfly Valves

.1 NPS 2-1/2 and over, wafer:

.1 To MSS-SP-67, Class 200.

.2 Cast iron body, ductile iron chrome plated disc, stainless steel stem, EPT liner.

.3 Lever operated

.2 NPS 2-1/2 and over, grooved ends:

.1 Class 300, bubble tight shut-off, bronze body, with copper-tube dimensioned grooved ends.

.2 EPDM encapsulated ductile iron disc with integrally cast stem.

.3 Operator:

.1 NPS 4 and under: lever handle.

.2 NPS 6 and over: gear operated.

.4 Basic of Design: Victaulic Style 608.

3. EXECUTION

Pipe Material Application Schedule					
System Description	**Location**	**Pipe Material**	**Joints**	**Spec Section**	**Notes**
Domestic Water	Inside Building	Type L Hard Copper (Cold	Solder, Brazed,	22 13 18	Grooved Mechanical Only Allowed On

Pipe Material Application Schedule					
System Description	**Location**	**Pipe Material**	**Joints**	**Spec Section**	**Notes**
	Above Ground	Water), Type K Hard Copper (Hot & Recirc Water)	Grooved Mechanical		Domestic Cold Water In Exposed Areas
Domestic Water	Inside Building Below Grade	Type K Soft Copper	Not Permitted	22 13 18	No Buried Joints Permitted
Domestic Water	Outside Building	Type K Soft Copper	Not Permitted	22 13 18	No Buried Joints Permitted

3.1 Installation

.1 Install in accordance with Plumbing Code and local authority having jurisdiction.

.2 Assemble piping using fittings manufactured to ANSI standards.

.3 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.4 Grooved joint shall be installed in accordance with the manufacturer’s written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer’s factory trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor’s representative is not considered qualified to conduct the training.)

3.2 Valves

.1 Isolate equipment, fixtures and branches with ball valves.

.2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 Pressure Tests

.1 Conform to requirements of Section 23 05 00 - Common Work Results - Mechanical.

.2 Test pressure: greater of 1.5 times maximum system operating pressure or 860 kPa.

3.4 Flushing and Cleaning

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Let system flush for additional 2 h, then draw off another sample for testing.

3.5 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 air chambers, expansion compensators are installed properly.

3.6 Start-Up

.1 Timing: Start up after:

.1 Pressure tests have been completed.

.2 Flushing & cleaning procedures have been completed.

.3 Certificate of static completion has been issued.

.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 HWR 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.

.5 Commission water treatment systems. Obtain water samples for crop irrigation system sufficient to ensure compliance with the Municipal Sewage Regulation (as administered by the BC Ministry of Agriculture), FoodSafe, Ministry of Agriculture and Vancouver Coastal Health Requirements. Testing is to be set up for: pH weekly, BOD weekly, TSS daily, Coliform weekly. Provide testing services for the first 6 months of operations.

3.7 Performance Verification

.1 Timing:

.1 After pressure and leakage tests and disinfection 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 – Balancing and Testing.

.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.

.4 Sterilize HWR 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, verifying that no residuals remain as a result of flushing and/or cleaning.

.3 Reports:

.1 In accordance with Section 23 08 00 – General Commissioning:

.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 The installation of drainage waste and vent piping.

1.2 References

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM B32, Specification for Solder Metal.

.2 ASTM B306, Specification for Copper Drainage Tube (DWV).

.3 ASTM C564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.2 Canadian Standards Association (CSA International).

.1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.

.2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.

.3 CAN/CSA-B125, Plumbing Fittings.

2. PRODUCTS

2.1 Material

2.2 Copper Tube and Fittings

.1 Above ground sanitary, storm and vent piping: Type DWV - copper to: ASTM B306.

.1 Fittings:

.1 Cast brass: to CAN/CSA-B125.

.2 Wrought copper: to CAN/CSA-B125.

.2 Solder: lead free, tin- 95:5, to ASTM B32.

2.3 Cast Iron Piping and Fittings

.1 Buried sanitary, storm and vent piping minimum NPS 3, to: CAN/CSA-B70.

.1 Joints:

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.

.2 Stainless steel clamps.

.2 Above ground sanitary, storm and vent: to CAN/CSA-B70.

.1 Joints:

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

3. EXECUTION

PIPE MATERIAL APPLICATION SCHEDULE					
System Description	**Location**	**Pipe Material**	**Joints**	**Spec Section**	**Notes**
Sanitary Drainage Waste & Vent	Inside Building Above Ground	Copper DWV, Cast Iron	Solder, Gasket & Clamp	22 13 17	Soldered Or Brazed Fitting Only For Forced Main (Pressurized) Sections
Sanitary Drainage Waste & Vent	Inside Building Below Grade	Schedule 40 PVC DWV Solid Core, Schedule 40 ABS DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	
Sanitary Drainage Waste & Vent	Outside Building	Schedule 40 PVC DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	Minimum Depth Of Bury For Plastic In Traffic Areas Is 900mm
Perimeter Drainage	Outside Building	PVC SDR 35 Perforated	Socket Glued	22 13 18	
Storm Drainage	Inside Building Above Ground	Copper DWV, Cast Iron	Solder, Gasket & Clamp	22 13 17	Soldered Or Brazed Fitting Only For Forced Main (Pressurized) Sections
Storm Drainage	Inside Building Below Grade	Schedule 40 PVC DWV Solid Core, Schedule 40 ABS DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	
Storm Drainage	Outside Building	Schedule 40 PVC DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	Minimum Depth Of Bury For Plastic In Traffic Areas Is 900mm

3.1 Installation

.1 In accordance with Section 23 05 01 – Pipe Installation.

.2 Install in accordance with Provincial Plumbing Code.

.3 Grade horizontal drainage and storm piping @ 2% minimum, unless noted otherwise.

3.2 Testing

.1 Pressure test buried systems before backfilling to 10 feet of water column.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.3 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 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label storm, sanitary, vent, pump discharge etc. c/w directional arrows every floor or 4.5 m whichever is less where piping cannot be routed around room, provide drain pans (and pipe to drain) underneath all piping within electrical rooms, elevator machine rooms, communication rooms and server rooms..

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 The installation of drainage waste and venting piping - plastic.

.2 Related Sections:

.1 Section 01 74 19 - Construction Waste Management And Disposal.

.2 Section 01 35 23 - Health and Safety.

.3 Section 23 05 01 – Pipe Installation.

1.2 References

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM D2235, Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.2 ASTM D2564, Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International).

.1 CSA-Series B1800, Plastic Nonpressure Pipe Compendium.

.2 CSA-B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.

.3 CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

1.3 Delivery Storage and Disposal

.1 Waste Management and Disposal:

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

.2 Collect and separate for disposal all recyclables for recycling in accordance with Waste Management Plan.

2. PRODUCTS

2.1 Piping and Fittings

.1 For buried DWV piping to:

.1 CSA-B181.1.

.2 CSA-B181.2.

.3 CSA-B182.1.

2.2 Joints

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

3. EXECUTION

PIPE MATERIAL APPLICATION SCHEDULE					
System Description	**Location**	**Pipe Material**	**Joints**	**Spec Section**	**Notes**
Sanitary Drainage Waste & Vent	Inside Building Above Ground	Copper DWV, Cast Iron	Solder, Gasket & Clamp	22 13 17	Soldered Or Brazed Fitting Only For Forced Main (Pressurized) Sections
Sanitary Drainage Waste & Vent	Inside Building Below Grade	Schedule 40 PVC DWV Solid Core, Schedule 40 Abs DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	
Sanitary Drainage Waste & Vent	Outside Building	Schedule 40 PVC DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	Minimum Depth Of Bury For Plastic In Traffic Areas Is 900mm
Perimeter Drainage	Outside Building	PVC SDR 35 Perforated	Socket Glued	22 13 18	
Storm Drainage	Inside Building Above Ground	Copper DWV, Cast Iron	Solder, Gasket & Clamp	22 13 17	Soldered Or Brazed Fitting Only For Forced Main (Pressurized) Sections
Storm Drainage	Inside Building Below Grade	Schedule 40 PVC DWV Solid Core, Schedule 40 Abs DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	
Storm Drainage	Outside Building	Schedule 40 PVC DWV Solid Core, Cast Iron	Socket Glued, Hub/Spigot	22 13 18, 22 13 17	Minimum Depth Of Bury For Plastic In Traffic Areas Is 900mm

3.1 Installation

.1 In accordance with Section 23 05 01 – Pipe Installation.

.2 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.

3.2 Testing

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.3 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 cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.4 Verification

.1 Verification requirements include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Local/regional materials.

.6 Low-emitting materials.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 23 21 14 – Hydronic Specialties

.3 Refer to Section 23 57 00 – Heat Exchangers for HVAC

1.2 Summary

.1 This section includes storage water tanks for potable water and gas fired domestic hot water boilers and accessories.

1.3 References

.1 Canadian Standards Association (CSA International)

.1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 ASME Boiler and Pressure vessel code, section IV, Part HLW

.3 ASHRAE/IES 90.1-2013

.4 ISO 9001 Quality Management System

.5 NFPA 70- National Electric Code

.6 NSF/ANSI Standard 61- Drinking Water System Components

.7 ASTM G123 “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

.8 CSA-B149.1, Natural Gas and Propane Installation Code.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties and accessories for each model indicated.

.3 Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, components, and size of each field connection

.4 Maintenance Data: Include in the maintenance manuals specified in Division 1. Include maintenance guide and wiring diagrams

1.5 Warranty

.1 Storage Tank: 10-year coverage for manufacturing or material defects, leaks and /or the production of rusty water. Tank coverage shall include failure due to scale buildup with no provision or condition for maintenance or inspections and no limitations on water chemistry. Tank warranty does not require inspection and maintenance of anode rods.

.2 Storage Tank Stress Corrosion Cracking Warranty – 10-year, non-prorated coverage for failure of tank or heat exchanger due to chloride-induced stress corrosion cracking with no limit to the level of dissolved chlorides in the potable water supply and no exclusion for scale build up.

.3 Domestic Hot Water Boiler – 5 year non-prorated coverage for boiler, burner, heat exchanger and all realted controls and components.

1.6 Regulatory Requirements

.1 Units: ETL, UL or CSA Certified as a Complete Water Heater Assemblies.

.2 Conform to ASME Section IV. Part HLW for Water Heater construction.

2. PRODUCTS

2.1 Domestic Hot Water Tanks

.1 The storage section of the water heater shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.

.2 All tank connections/ fittings shall be nonferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a manway sized access to the tank interior.

.3 The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00 “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

.4 Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

.5 All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

.6 Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.

.7 Lined or plated storage tanks will not be acceptable.

.8 The water heater will not require anode rods and none will be used. Tanks that employ anodes will not be acceptable.

.9 The tanks shall be equipped with the following:

.1 Lifting lugs.

.2 Two operating thermostats.

.3 An ASME rated temperature and pressure relief valve.

.4 Rear access manhole.

.5 Inlet and outlet connections as required on drawings. All connections to be line size (no exceptions). Provide minimum two spare tapping's per tank.

.6 50mm drain valve.

.7 Dial tank temperature and pressure gauges on the tank.

.10 The tanks shall be provided with a threaded tapping to accept thermal well and sensor (by others) to be connected to the Building Management System to monitor temperature.

2.2 Domestic Hot Water Boiler

.1 The WATER HEATER shall have input and output rating per schedule on drawings and shall be operated on LP Gas. Turn-down shall be 5:1 minimum with full modulating control.

.2 The water containing section shall consist of a heat exchanger constructed of a "Fin Tube" design, with straight copper tubes having extruded integral fins spaced seven (7) fins per inch. These tubes shall be "rolled" securely into glass-lined, cast iron headers. There shall be no bolts, gaskets or "O" rings in the head configuration. Removable access plugs shall be provided on the heat exchanger headers for the purposes of inspection, cleaning or repair. Water Heater drains shall be provided, having external access. The heat exchanger shall be mounted in a stress free jacket assembly in order to provide a "free floating design" able to withstand the effects of thermal shock. The WATER HEATER shall bear the ASME "HLW" stamp for 160 psi working pressure and shall be National Board listed. The complete boiler shall carry a five (5) year warranty.

.3 The WATER HEATER'S combustion chamber shall be constructed of stainless steel and sealed for combustion. The burner surface shall be constructed of heavy-duty ceramic material and fire in a vertical plane within the combustion chamber. The burner shall employ a special perforated flame injection tube extending the entire length of the heat exchanger. The burner shall fire in a full 360-degree pattern resulting in uniform heat transfer upon every inch of heating surface. A viewing port shall be provided, permitting visual observation of burner operation.

.4 The WATER HEATER shall use a combustion air blower, utilizing pulse width modulation, to draw a precise mixture of fuel and air into the combustion chamber for maximum efficiency. The combustion air blower shall operate for a pre purge period before burner ignition and a post purge period after burner operation to clear the combustion chamber. The WATER HEATER shall be equipped with a replaceable combustion air filter to protect the blower and burner from contaminants and debris.

.5 The WATER HEATER shall incorporate a gas train consisting of a pre-mix gas valve to supply gas and combustion air in exact proportions to allow burner input to vary based on load. The pre-mix gas valve shall perform the functions of safety shutoff, constant pressure regulation and air/gas ratio control. Full closing of the valve seat shall occur in less than 0.8 seconds when the valve is de-energized.

.6 The WATER HEATER shall be constructed with an 18 gauge pre-painted steel jacket assembly. The interior of the combustion chamber and flue collector shall be stainless steel. All inner jacket panels shall be fully gasketed and sealed. The jacket assembly shall be primed and pre-painted on both sides. All models shall be certified for installation on combustible floors without additional safety provisions. The WATER HEATER shall be suitable for installation with zero clearance from combustible material.

.7 The WATER HEATER'S standard construction shall include an air pressure switch to prove combustion air flow, a flow switch to prove water flow, downstream test valve and a factory installed ASME temperature and pressure relief valve. Standard controls shall include manual reset high limit, pump control for dedicated water heater pump. Standard construction shall include terminal strips for supply voltage connection, pump control connections, contacts for any failure, contacts for air louvers and run time contacts. The manufacturer shall verify proper operation of the burners, all controls and the heat exchanger by connection to gas, water and venting for a full factory fire test.

.8 The WATER HEATER shall be equipped with an Electronic Integrated Control Module with a microprocessor-based platform incorporating software customized for operation. All internal safety, operating and ignition controls shall be included in the electronic integrated control module. The electronic integrated control module shall provide on/off control of the gas supply to the burner, operation of the combustion air blower, ignition of the gas-air mixture, flame proving, control of water temperature set points, and monitoring of all safety functions.

.9 The WATER HEATER shall feature the control with a 2-line, 16 character LCD display, password security, pump delay with freeze protection, pump exercise and PC port connection. The WATER HEATER shall allow 0-10 VDC input connection for BMS control and have built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight water heaters without utilization of an external controller. Supply voltage shall be 120 volt / 60 hertz / single phase.

.10 Local communication, programming and a display of operating and alarm status conditions shall be accessible through the control panel. The control panel shall contain an on/off main power switch, a digital display of a temperature functions, the operational status of the WATER HEATER, or an active alarm fault. Data points visible in the digital display include inlet water temperature, outlet water temperature, water temperature differential, percent firing rate, setpoint temperatures and setpoint differential. Operational status shall be displayed for Off, Standby, Pre-purge, Ignition, and Post-purge. Fault status shall be provided for high limit, gas pressure (optional), low water, blocked drain, louver proving, and air pressure switch status.

.11 The WATER HEATER shall be designed to allow installation of multiple venting options. All flue and air inlet pipe shall be provided by the installing contractor. The WATER HEATER shall be equipped with:

.1 Vertical Direct Vent Sealed Combustion Flue with a separate combustion air.

.2 Vertical DirectAire Category I Flue (flue and air inlet pipe that may terminate in different pressure zones on the building exterior) with a separate Sidewall Combustion Air Pipe (B - Prefix Controls Only) using a sidewall air inlet kit supplied by Lochinvar;

.3 Vertical DirectAire Category II Flue (flue and air inlet pipe that may terminate in different pressure zones on the building exterior) with a separate Sidewall Combustion Air Pipe (M - Prefix Controls Only) using a sidewall air inlet kit supplied by Lochinvar;

.4 Horizontal DirectAire Category IV Flue (flue and air inlet pipe that may terminate in different pressure zones on the building exterior) with a separate Rooftop Combustion Air Pipe (M - Prefix Controls Only) using contractor supplied air inlet components and a sidewall vent kit supplied by Lochinvar.

.12 The WATER HEATER shall be supplied with a circulating pump of sufficient capacity to ensure scale-free heater performance. The pump shall be all bronze and provided for operation on 120 volt. 60 hertz, 1 phase power supply (unless otherwise specified).

.13 The WATER HEATER shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The WATER HEATER shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The WATER HEATER shall operate at up to 87% thermal efficiency. The WATER HEATER shall be certified for Oxides of Nitrogen (NOx) of less than 30 ppm corrected to 3% O2 by an independent laboratory.

3. EXECUTION

3.1 Installation

.1 Install in accordance with manufacturer's recommendations.

.2 The contractor shall allow for the supply, installation, and full wiring of a remote wall mounted boiler kill switches (install switches at all boiler room exists). The switches shall be wired such that it interrupts all boiler burner controls, allowing the boiler safeties to shut down boiler operation. The switched are to be wall mounted adjacent to all exit doors of the boiler rooms. The switches are to be a mushroom type with manual key activated reset. The switches shall be labeled `Boiler Emergency Shutdown`. All wiring is to be by this contractor, following all applicable code requirements for wiring applications, sizing, and conduits.

.3 Install natural gas fired domestic water heaters in accordance with CSA-B149.1.

3.2 Field Quality Control

.1 Commissioning agent to start up and commission DHW system.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation for plumbing specialties and accessories.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 23 08 00 – General Commissioning.

.3 Scope Includes:

.1 Cleanouts.

.2 Air chambers or water hammer arresters.

.3 Roof and floor drains.

.4 Cooling equipment condensate drains.

.5 Sumps, catch basins and manholes.

.6 Storm and sanitary sewer service connections.

.7 Water service connections.

.8 Backflow preventers.

.9 Vacuum breakers.

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other sections of this specification and as supplied by the Owner.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 References

.1 American Society for Testing and Materials International (ASTM).

.1 ASTM A126-[95(2001)], Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62-[02], Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA).

.1 AWWA C700-[02], Cold Water Meters-Displacement Type, Bronze Main Case.

.2 AWWA C701-[02], Cold Water Meters-Turbine Type for Customer Service.

.3 AWWA C702-1-[01], Cold Water Meters-Compound Type.

.3 Canadian Standards Association (CSA International).

.1 CSA-B64 Series, Backflow Preventers and Vacuum Breakers.

.2 CSA-B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 Plumbing and Drainage Institute (PDI).

.1 PDI-WH201, Water Hammer Arresters Standard.

1.4 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 for fixtures and equipment.

.2 Indicate dimensions, construction details and materials for specified items.

.3 Shop Drawings:

.1 Submit shop drawings to indicate materials, finishes, method of anchorage, dimensions, construction and assembly details and accessories for following:

.1 Water Meters

.2 Back Flow Preventers

.3 Floor Drains

.4 Cleanouts

.5 Roof Drains

.6 Sumps, Catch Basins, Manholes

.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 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals, include:

.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.

1.5 Cross Connection

.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.

2. PRODUCTS

2.1 Approved Manufacturers:

.1 See Section 23 05 00.

2.2 Clean Outs and Clean Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean outs on vertical rainwater leaders only. Ensure ample clearance at clean out for rodding of drainage system.

.2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

.3 Supply and install cleanouts on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where drain leave the building; where shown on the drawings, 7.6 m apart in horizontal drainage lines of 50 mm and 65 mm nominal diameter, 15.2 m apart in horizontal lines of 75 mm or 100 mm nominal diameter and not more than 30 m apart for larger pipe sizes and as called for in the British Columbia Plumbing Code.

.4 All outside cleanouts shall be extended to grade in cast iron. They shall be sufficiently anchored in a 300 mm x 300 mm x 100 mm thick concrete block of concrete to prevent rotation of the pipe. Concrete work shall be provided and installed by the General Contractor.

.5 All cleanouts shall be full size for pipes up to 100 mm diameter and 100 mm size for larger pipes. Cleanouts shall be extended to a finished wall or floor. No cleanouts shall terminate at the ceiling of a room, sanitary and storm shall be extended to the floor above. Cleanouts shall not terminate in the floor of any sterile rooms.

.6 Cleanouts for copper pipe shall be cast brass, Crane 1816, 1817 or Emco 57-18190 with raised shoulder on plug and gasket.

.7 Cleanouts for cast iron pipe shall be steel plug type, Associated Foundry.

.8 Cover for cleanouts shall be as follows:

.1 Unfinished areas, such as concrete floors in equipment rooms and flush type C.O. in outside areas, Jay R. Smith 4220 with extra heavy duty adjustable cast iron cover suitable for heavy traffic.

.2 Finished floors Jay R. Smith 4100 heavy duty with adjustable N.B. frame and cover.

.3 Finished floors pedestrian duty only Jay R. Smith 4020 medium duty with adjustable N.B. frame and cover.

.4 Floors finished in lino or other such thin material Jay R. Smith 4140 round with adjustable N.B. frame and cover.

.5 Walls finished with ceramic tile, Acudor UF5000 stainless steel access door.

.6 All painted walls, provide prime coated covers as specified for access panels with minimum clear opening of 200 mm x 200 mm for cleanouts 50mm and smaller 300 mm x 300 mm for cleanouts larger than 50 mm. Avoid covers on feature walls; i.e.: wood panels. If unavoidable, the covers shall be for painted walls but with finish material secured to the cover to the satisfaction of the Departmental Representative and finished flush with wall. In all sterile areas provided stainless steel finish on all access panel. All cleanouts shall have locations clearly indicated.

.9 All barriers for cleanout plugs shall be securely anchored so that they do not rotate when plug is being removed.

2.3 Water Hammer Arrestors

.1 Copper construction, bellows type: to PDI-WH201 standards.

2.4 Pressure Regulators

.1 Capacity: 2 Valves size @ 25% and 75%.

.1 Inlet pressure: 703 kPa.

.2 Outlet pressure: 413 kPa.

.3 Total Capacity: 10 l/s (160 USGPM)

.2 Up to NPS1-1/2 bronze bodies, screwed: to ASTM B62.

.3 NPS2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class [B].

.4 Semi-steel spring chambers with bronze trim.

.5 Station shall be complete with 2 PRV's sized each @ 50% flow, globe valve by-pass, valves and pressure gauges.

2.5 Strainers

.1 860 kPa, Y type with 20 mesh, monel, stainless steel removable screen.

.2 NPS2 1/2 and over, cast iron body, flanged ends, with bolted cap.

2.6 Water Hammer Arresters

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm minimum, and minimum 450 mm long.

.2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves, flush valves and to fixture or group of fixtures complete with accessible isolation valve.

2.7 Roof Drains:

.1 Refer to drawings for schedule

.2 Flow Characteristics: Full open flow.

.3 Material: All major components including body, flashing clamping flange, under deck clamping ring and dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanized or prime painted steel.

.4 Body:

.1 Sump: minimum 180 mm internal diameter, minimum 75 mm deep.

.2 Discharge: nominal 100 non threaded MJ.

.3 Bosses: solid, integrally cast, for under deck clamping ring and flashing flange bolts.

.4 Deck flange: nominal 300 mm outside diameter, minimum 50 mm width.

.5 Flashing Clamping Flange: Outside diameter same as outside diameter of deck flange; Vnotched positive draining gravel stop lip, 15 mm high.

.6 Dome Strainer: Minimum 150 mm high; 8 mm to 15 mm slotted openings, sides and top.

2.8 Floor Drains:

.1 Refer to drawings for schedule

.2 Floor drains shall have lacquered cast iron body with double drainage flange, weep holes combined two piece body reversible clamping device and adjustable nickel/bronze strainer. Shower and washroom floor drains shall have a removable perforated sediment bucket.

.3 Floor drains in equipment rooms shall have polished bronze funnel type strainer, and extension for floating floor.

2.9 Area Drains:

.1 Refer to drawings for schedule

.2 Area drain shall have lacquered cast iron body with adjustable collar and galvanized ductile iron locking grate.

2.10 Equipment Drains

.1 Provide a sloped connection from packaged equipment drain pans to nearest sanitary sewer trapped connection. Slope at minimum of 0.5% grade. Drains size to be 25 mm complete with 100 mm deep trap at unit.

.2 Provide in each section of a built-up air handling unit which maintains water carry over a galvanized water proof drain pan with a minimum of 50 mm sides and a floor sloped to a 50 mm floor drain, to be full width of the plenum and a rim of 1/2 the plenum height in length. Drain is to be flashed into the water proof floor and is to slope to an open trapped sanitary connection at a rim of 0.5% grade. Floor drain trap is to be deep enough to ensure a water seal at a maximum pressure of the fan system with a rim depth of 100 mm.

2.11 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current AWWA requirements and CSA B64 standards.

.2 Provide complete reduced pressure principle type assembly, consisting of pressure differential relief valve, located between two (2) positive seating replaceable check valves with stainless steel or bronze seats Watts No. 909. Provide strainer between gate valve and first check valve on units 50 mm and smaller.

.3 Provide complete double check valve type assembly consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide check valve on units 50 mm and smaller. Watts No. 709.

.4 Provide complete atmospheric vent backflow preventer assembly, consisting of two (2) positive sealing replaceable check valves with bronze seats, integral stainer and threaded vent connection. Watts No. 9D.

2.12 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards. Watts No. 800.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts No. 388ASC.

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.13 Trap Seal Primers

.1 Bronze automatic trap primer complete with sediment strainer, union and access door for concealed installations with 15 mm 1/2 in. copper tubing connections between primer valve and floor drain.

2.14 Pressure Reducing Valves

.1 25 mm and smaller: Bronze body, SS integral stainer, renewable SS seat, high temperature rated diaphragm suitable for hot or cold water. Rated at maximum inlet pressure of 2100 kPa, maximum reduced pressure 175 kPa, maximum temperature 90°C.

.2 30 mm and larger: Pilot operated, cast iron body, modified globe design, threaded ends to 50 mm, flanged ends 65 m and larger. Maximum inlet pressure 2100 kPa. Maximum temperature 90°C. Bronze trim. Pilot control system: bronze with SS trim, hydraulically operated, diaphragm actuated.

.3 Size to suit flow capacities and service.

.4 Provide with gate valve and union on inlet and outlet, globe valve bypass, pressure gauge on inlet and outlet and pressure relief valve on reduced pressure side.

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 data sheet.

3.2 Installation

.1 Install in accordance with provincial codes, and local authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

.3 Bury outside water and drainage pipe minimum 1200 mm, unless noted otherwise.

.4 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.5 Where floor drains are located over occupied areas, provide waterproof installation.

.6 Drainage lines shall grade 2 mm per 100 mm unless otherwise indicated on drawings.

.7 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa.

.8 Locate plumbing vents minimum 5 m from air intakes.

.9 Provide a heat trap loop in domestic hot water supply piping at domestic hot water storage tank.

.10 Install cast iron connections from weeping tile to storm drainage system including backwater valve, and cleanout. Provide access for servicing of backwater valve.

.11 Provide and install valved connections on hot and cold water lines to each hot water tank complete with vacuum breakers on cold water make-up and temperature pressure relief valve.

.12 Install vacuum breakers or backflow preventers to AWWA standards on plumbing lines where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibbs and flush valves. All backflow preventers shall be installed at a maximum 1500 mm above the floor or ground level.

.13 Install trap primer on all drains which do not receive water daily. Primers shall be installed in an area accessible for easy maintenance.

.14 Provide seismic restraints for tanks and all high centre of gravity equipment.

.15 Provide seismic valve on all gas meter installations.

.16 All R.P. device backflow preventors shall be provided with daylight type drainage or full flow piping drain line or sump.

.17 Do not run any wet piping through electrical machine rooms or other similar rooms.

.18 Provide pump out drains in all elevator pits

.19 Provide dielectric fittings in all dissimilar metal connections.

.20 Provide mastic coated drainpans under all piping installed in electrical, elevator, transformer and communications rooms. Pipe drainpan to nearest floor drain via indirect waste.

.21 All sanitary system traps not intergrated into plumbing fixtures (such as water closets, urinals, lavatories, janitor’s sinks) shall be connected to a trap priming system unless specifically noted otherwise. This includes floor drains, floor sinks, traps serving combination waste and vent systems, and other traps serving un-primed fixtures. The trap priming system is to be designed and installed by the contractor. Trap primer piping is to be designed and installed by the contractor, and connected to the domestic water system at a point field determined by the contractor. The trap primer piping is not indicated on plans and is the responsibility of the contractor.

.22 The contractor shall coordinate access to all mechanical equipment as well as piping valves. Access panel requirements and locations shall be fully coordinated with all involved contractors prior to the installation of any mechanical system.

.23 The contractor also is required to review the mechanical, structural, and architectural documents for the identification of any seismic joints or seismic separations within the building structure that affects the installation of any mechanical systems. At each of these locations, the contractor shall allow for the design, supply, and installation of applicable mechanical system flexible connections along with support of these systems on each side of the seismic joint or separation. This applies to all piping systems as well as ductwork systems. Flexible connections are to be compatible with the corresponding system (material, pressure rating, size, etc.).

.24 Floor drains serving sprinkler backflow preventer test/relief drains shall be provided with a 30`` high, minimum 6`` diameter galvanized steel (minimum schedule 10) standpipe connection. The standpipe connection shall be connected to the exposed floor surface with pipe flange (welded to the standpipe) that is gasketed and bolted to the floor with concrete inserts or lag screws. The installation shall not allow floor surface water to be drained. The sprinkler test lines shall be piped with an air gap to the standpipe.

3.3 Cleanouts

.1 Supply and install cleanouts on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack, where drain leave the building and where shown on the drawings. On long continuous runs install cleanouts 7.6 m apart in horizontal drainage lines of 50 mm and 65 mm nominal diameter, 15.2 m apart in horizontal lines of 75 mm or 100 mm nominal diameter and not more than 30 m apart for larger pipe sizes and as called for in the British Columbia Plumbing Code.

.2 Bring cleanouts to wall unless impossible then to finished floor, unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS4.

.4 All outside cleanouts shall be extended to grade in cast iron. They shall be sufficiently anchored in a 300 mm x 300 mm x 100 mm thick concrete block of concrete to prevent rotation of the pipe. Concrete work shall be provided and installed by the General Contractor.

3.4 Services

.1 Provide new sanitary and storm sewer connections to site services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.2 Provide new water service complete with water meter with bypass valves. Provide necessary thrust blocks on underground water piping as required and detailed. Provide sleeve in wall for service main and adequately support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Securely anchor service main inside to concrete wall. Provide 1.2 mm galvanized sheet metal sleeve around service main to 150 mm above floor and 1800 mm above floor and 1800 mm minimum below grade. Size for minimum of 50 mm of loose fill insulation.

3.5 Excavation & Backfilling

.1 Provide any excavations necessary for the installation of the mechanical work. No cutting, boring or excavating necessary for this work in or about the building which may cause interference with the progress of the work or weaken the structure in any way, shall be undertaken without the approval of the Departmental Representative before commencing work. Trenches or tunnels for all underground piping shall be excavated to a depth slightly more than required and graded so as to secure all available fall. Support each length of pipe with concrete blocks and bricks, or backfill the trench with gravel to the required depth and grade. Sanitary and storm lines outside of the building shall be kept as deep as practical. See Section 02 41 19 for Backfilling in all trenches shall be with sand or pea gravel where approved, 150 mm below pipe and up to 150 mm over top of piping, then flushed with water so as to ensure the total length of each pipe is resting on solid footing. Remainder of all trenches shall be filled by the General Contractor. Where sewer, water or storm pipes pass under a grade beam or footing the trench around the piping up to and in contact with the footing, provide a 450 kg concrete grouting so as to seal the outside

trenching from normal storm runoff and backflow of rain water through the trenching and into the crawl space and/or under the basement floor.

.2 Backfilling in all trenches shall be with sand or pea gravel where approved, 150 mm below pipe and up to 150 mm over top of piping, then flushed with water so as to ensure the total length of each pipe is resting on solid footing. Remainder of all trenches shall be filled by the General Contractor. Where sewer, water or storm pipes pass under a grade beam or footing the trench around the piping up to and in contact with the footing, provide a 450 kg concrete grouting so as to seal the outside trenching from normal storm runoff and backflow of rain water through the trenching and into the crawl space and/or under the basement floor.

.3 Where sewer, water or storm pipes pass through exterior walls below grade, the General Contractor shall install corbels on the exterior walls and run bridging from corbel to undisturbed soil for the support of the pipes. One inch thick waterproof mastic shall be applied around the pipes which pass through the wall.

.4 Repair concrete walls, pavement, walks, louvres, etc., where these have been damaged by the mechanical contractor

3.6 Wall Hydrants

.1 Install wall hydrants 800 mm above finished grade unless otherwise indicated.

3.7 Water Hammer Arrestors

.1 Install on branch supplies connected to groups of fixtures, flush valves, and all quick-closing devices, at top of all risers and install complete with accessible isolation valve.

.2 Install on pool fill line upstream of solenoid valves.

.3 Water hammer arrestors are to be installed at the locations noted here in addition to locations recommended by the manufacturer of the water hammer arrestor. The contractor is to coordinate water hammer arrestor sizing with the manufacturer.

3.8 Back Flow Preventers

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.

.2 Pipe discharge to terminate over to nearest drain or daylight when possible.

3.9 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. All floor drains require trap seal primers EXCEPT aquatic and change area deck drains which are hosed down daily.

.3 Install plastic tubing to floor drain.

3.10 Strainers

.1 Install with sufficient room to remove basket. Strainer to be installed on incoming Fire & water services before all other devices except the service isolation valve.

3.11 Start-Up

.1 General:

.1 In accordance with Section 23 08 00 - General Commissioning.

.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.

3.12 Field Quality Control

.1 Verification requirements, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.13 Testing and Adjusting

.1 General:

.1 In accordance with Commissioning Section 23 08 00 : General Commissioning, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 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.

.4 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Clean out sumps.

.4 Verify provisions for movement of roof systems.

.5 Access doors:

.1 Verify size and location relative to items to be accessed.

.6 Cleanouts:

.1 Verify covers are gas-tight, secure, yet readily removable.

.7 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.8 Wall, Ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.9 Pressure regulators, PRV assemblies:

.1 Adjust settings to suit locations, flow rates, pressure conditions.

.10 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.11 Commissioning Reports:

.1 In accordance with Section 23 08 02: Commission Forms, Reports section, supplemented as specified.

.12 Training:

.1 In accordance with Section 23 08 03: Commissioning Training, supplemented as specified.

.2 Demonstrate full compliance with Design Criteria.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Use of mechanical systems during construction.

1.2 Use of Systems

.1 Use of new permanent heating and / or ventilating systems for supplying temporary heat or ventilation 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 90 % filters, inspected daily, changed every 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 project manager.

.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.

.3 Exhaust systems are not included in approvals for temporary heating ventilation.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Division 21 – Fire Suppression

.2 Division 22 – Plumbing

.3 Division 23 – Heating, Ventilation & Air Conditioning

1.2 Intent

.1 Provide complete, fully tested and operational mechanical and plumbing systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Should inconsistencies exist such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the Departmental Representative in writing during the bidding period.

.4 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.5 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Departmental Representative at no extra cost.

.6 Install equipment to provide access and ease of maintenance.

.7 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start up and test.

.8 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.9 Provide seismic restraints for all required equipment, piping and ductwork.

.10 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of twelve (12) months from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.11 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.12 'Provide' shall mean; supply and install'.

.13 The contractor shall design and install all seismic restraints as well as mechanical equipment and mechanical system supports. The restraints and supports shall be specifically designed to fasten to the structure indicated in the documents and installed in the field. The complete design for these systems shall be completed by a qualified professional engineer (by the contractor), and shall comply with all applicable code requirements including the BC Building Code and National Building Code. The more stringent code shall apply. General standards should follow the publications listed below:

.1 SMACNA (Sheet Metal and Air Conditioning Contractors National Association) Seismic Restraint Manual Guidelines for Mechanical Systems

.2 ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) HVAC Applications Handbook (Seismic Design Chapter 54)

.3 FEMA (Federal Emergency Management Agency) Installing Seismic Restraints for Mechanical Equipment

.4 VISCMA (Vibration Isolation and Seismic Control Manufacturers Association) Installing Seismic Restraints for Mechanical Equipment

.14 If the equipment is indicated on the schedules or within the motorlist (both included in the mechanical drawings) as a single point connection, the equipment shall be provided with all integral HOA type starters, internal wiring to all motors, starters, lighting, service outlets etc. Such that a single electrical connection can be utilized to power all components within the unit. The unit shall also incorporate the required step-down transformers and wiring to connect all of these internal components including controls wiring. Coordinate with the controls subcontractor for the supply, installation, and wiring of control components.

1.3 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings. Drawings shall take precedence over specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.4 Permits

.1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the work.

.3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

.4 Contractor shall provide schedule B1/B2 letters of assurance for seismic engineering and for fire protection/sprinker system engineer.

1.5 Tender Price Breakdown

.1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Departmental Representative.

.2 As a minimum, include the following in the tender price breakdown:

.1 Mechanical: Equipment, materials, labour

.2 Plumbing: Equipment, materials, labour

.3 Sheet Metal: Equipment, materials, labour

.4 Fire protection: Equipment, materials, labour

.5 Controls: Equipment, materials, labour

1.6 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

.1 Fastening details for Seismic restraints

.2 Mounting details for spring isolation of equipment.

.3 Sprinkler drawings including hydraulic calculations per NFPA-13.

.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 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative minimum 7-days before final inspection.

.3 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.

.4 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.

.5 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 – Balancing and Testing.

.6 Approvals:

.1 Submit 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.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.2 Chemical treatment reports

.3 Back-flow preventer reports

.4 Results of Owner’s Orientation (demonstrations)

.5 List of spare parts turned over to owner’s forces.

.8 Site records:

.1 Departmental Representative will provide 1 set of white prints @ contractors cost to mark changes as work progresses and as changes occur.

.2 Use different colour waterproof ink for each service.

.3 Make available for reference purposes and inspection.

.9 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.

.6 Cost of transfer as-builts onto reproducible media & auto-cad disks are this contractor's responsibility. Departmental Representative will release drawings to contractor after signing a copy right form.

.7 Shall the contractor choose to undertake this Departmental Representative, allow $400 / sheet. This will cover costs for drafting time & printing costs.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.7 Maintenance

.1 Furnish spare parts in accordance with Section 01 78 10 - Closeout Submittals and as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Additional spare parts shall also be included as outlined in their appropriate sections.

1.8 Examination of Site

.1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender.

1.9 Quality of Work

.1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Departmental Representative.

.2 Work which does not conform to standards accepted by the Departmental Representative and the trade may be rejected by the Departmental Representative. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.10 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals (shop drawings etc.) use the same SI units as stated in the specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

EQUIVALENT NOMINAL DIAMETER OF PIPES

mm	*Inches (NPS)*	*mm*	*Inches (NPS)*	*mm*	*Inches (NPS)*
3	*1/8*	*65*	*2-1/2*	*375*	*15*
6	*1/4*	*75*	*3*	*450*	*18*
10	*3/8*	*100*	*4*	*500*	*20*
15	*1/2*	*125*	*5*	*600*	*24*
20	*3/4*	*150*	*6*	*750*	*30*
25	*1*	*200*	*8*		
30	*1-1/4*	*250*	*10*		
40	*1-1/2*	*300*	*12*		
50	*2*				

.5 Metric Duct Sizes:

.1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.11 Alternate Materials and Equipment

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List. If no acceptable manufacturer has been listed, refer to approved equivalents below.

.2 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted to the Departmental Representative no later than ten (10) working days prior to the closing date of tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum.

.3 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Departmental Representative. In the event that the product has been approved as "Alternate Only", this shall be stated in the quotation, and the contractor shall bear any and all costs for design/system modifications to accommodate the “alternate” equipment.

.4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such work.

1.12 Drawings and Specifications

.1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Departmental Representative, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.13 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Structural Departmental Representative before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.14 Excavation and Backfill

.1 Refer to requirements of Division 31.

.2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

.3 Refer to details on drawings as well. Should a conflict occur, contact the Departmental Representative for clarification.

1.15 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.16 Connections to Existing Services

.1 Maintain liaison with the Owner and provide a schedule to interrupt, reroute or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.17 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

.4 Contracting authority received enquiries during tender period to be submitted prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.

.5 All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 2004.

1.18 Equipment Protection and Clean Up

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.19 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive (variance frequency drive) shall be inverter only rated.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.5 Motors less than 1-hp shall be 120 V, 60 Hz, 1 phase. Motors 1-hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless otherwise noted.

.7 Provide motors complete with equipment except where indicated.

.8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.9 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.10 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.12 Minimum certified motor efficiency shall be as outlined in ASHRAE 90.1 2004.

1.20 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves;

.2 Volume and splitter dampers;

.3 Fire dampers;

.4 Controls, coils and terminal units;

.5 Expansion joints.

.6 Filters

.7 Strainers

.2 Mark removable ceiling tiles used for access with colour coded dots.

.3 Provide ULC-listed fire rated access doors installed in rated wall and ceilings.

.4 Refer to Section 23 05 05 for additional requirements.

1.21 Miscellaneous Metals

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

.3 Access platforms and catwalks.

1.22 Pipe Sleeves

.1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes. Sleeves shall extend 25 mm on either side of the wall.

.2 Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand. Provide concrete curbs in mechanical spaces per UBC Standards.

.3 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.23 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.24 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Departmental Representative.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall not be used for temporary heating.

.6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.25 Temporary or Trial Usage

.1 Temporary or trial usage by the Owner or Departmental Representative of mechanical equipment supplied under contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.4 Avoid thermal shock to heating system by coordination with the Owner during planning, construction and operation of temporary heating system.

.5 Return condensate to the heating plant. Meter equipment is not required.

1.26 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Heating air conditioning, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the contractor to have a substantial completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Air and water systems have been balanced with draft report submitted to Departmental Representative.

.4 Valve tagging and equipment identification is complete.

.5 Warranty forms have been mailed to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.6 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.7 Draft Operating/Maintenance Manuals have been submitted.

.8 Operating and Maintenance demonstrations have been provided to the Owner.

.9 Written inspection report by manufacturer’s representative has been submitted for noise and vibration control devices and flexible connections.

.10 Record drawings have been submitted.

.11 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.12 All seismic restraint devices have been installed.

.13 All previously identified deficiencies have been corrected.

.3 The following shall be an outline checklist of the minimum requirements to be met by the contractor prior to the Departmental Representatives' Substantial Performance by the contractor.

.4 Inspection:

.1 Complete Commissioning Checklists

.2 Final Plumbing Inspection Certificate from local plumbing inspector

.3 Final Gas Inspection Certificate from local gas inspector

.4 Final Sprinkler Materials and Test Certificate

.5 Final Backflow Prevention test reports for all backflow devices

.6 Controls Commissioning, Checklist and 15 day trend logs for all major equipment (AHU's, Chiller/Boiler Plants, selected space corners)

.7 Fire alarm test certificate (via DIV.26)

.8 Fire stopping and Fire Damper test letter

.9 Seismic Engineers inspection of all Seismic restraints and schedule C letters of assurance

.10 Vibration isolation supplier's inspection report

.11 Sprinkler Contractors Engineer of record inspection and Schedule C letter of assurance

.12 Chemical Treatment supplies final inspection and test certificate

.13 Potable water main's flushing and chlorination test certificate

.14 Sound level tests reports (as required)

.15 Major equipment – suppliers start-up test sheets and letters certifying start up. (Boilers, chillers, packaged equipment)

.16 Final As-Built Drawings ready for review

.17 Maintenance and operation manuals, ready for review

.5 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:

.1 Submit find air and water balance reports.

.2 Submit final operating and maintenance manuals.

.3 Complete final calibration.

.6 The Departmental Representative shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required, shall be at the expense of the Contractor.

.7 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.27 Acceptable Manufacturers

.1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.

.2 It remains the responsibility of the contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 Submit within 14 days of contract award a copy of the list underlining the name of the manufacturer whose price was carried in the tender. If no manufacturer's names are submitted, it will be assumed that the price carried in the tender was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

.5 List of acceptable Manufacturers:

• Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
• Air Curtains	Biddle / Thermoscreens
• Air Flow Measuring Air Monitor, Air Stations	Cambridge, Sentinel, Ebtron
• Air Handling Units - Indoor or Outdoor Pre-manufactured	Engineered Air, Haakon, Scott Springfield, Ventrol, Hunt Air
• Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco, Wheatley, Spirotherm
• Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Nailor, Trox
• Air Valves - Mixing, Constant, Volume and VAV	E.H. Price, Titus, Trane, Nailor Industries
• Air Vents	Hoffman, Maid-O-Mist, Taco
• Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison, Ruskin
• Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
• Balancing Dampers	Maxam, Ruskin, Greenheck
• Balancing Agents	KD Engineering, MDT Systems, Western Mechanical Systems
• Bypass Filter (closed loop systems)	Sumco, GESL, Pace Chemicals

• Commissioning Authority	To be retained directly by Owner (Airmec)
• Condensing Units	Trane, Dunham Bush, York, Carrier
• Fluid Cooler - Blow Through	Baltimore Air Coil, Evapco, Marley/ Recold
• Dampers - Control, Backdraft	Ruskin, Tamco, Greenheck
• Dampers - Smoke-Fire Comination	Ruskin, Controlled Air, Prefco
• Domestic Water Heaters - Gas	Rudd, AO Smith, State, PVI
• Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
• Drinking Fountains	Western, Haws, Elkay, Sunroc
• Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Fans - Bathroom Exhaust	Broan, Penn Zephyr, Nutone, Broan, Greenheck, Cook
• Fans - In-Line Centrifugal	Greenheck, Jenn Air, Ammerman, ILG, Cook, Penn, Twin-City, Carnes
• Filters	Cambridge, AAF, Pacific, FARR, Viledon
• Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
• Fire Hose Cabinets, Valves and Extinguishers	NFE, Grigor, Wilson & Cousins, Flag, National Fire Equipment
• Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
• Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Flexible Duct	Thermaflex, Wiremold, GI Industries Type H.P.
• Gauges - Air	Dwyer, Magnehelic, Onicon
• Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
• Grooved Mechanical Pipe Joints	Victaulic, Mech Line (only where permitted)

• Hose Bibbs	Jenkins, Dahl, Toyo, Kitz, Mifab, Woodford, JR Smith, Acorn
• Insulation - Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
• Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, CS Louvre (Exhaust Use Only)
• Plumbing Brass	Chicgo Faucets, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
• Plumbing Fixtures	Crane, American Standard, Kohler, Toto
• Pumps - In-Line Circulators, Centrifugal, Vertical Inline	Armstrong, B & G, Taco, Grundfos
• Pumps - Sump	Monarch, Barnes, Hydromatic, Myers, Zoeller
• Pumps - Vertical In-Line and Base Mounted	Armstrong, B & G, Taco, Grundfos
• Sinks - Mop	Fiat, Crane, American Standard
• Sinks - Stainless Steel	KIL, American Standard, Elkay, Kindred
• Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
• Tank - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc., Armstrong
• Tanks - Water Storage	PVI, Clemmer, AO Smith
• Thermometers	Trerice, Marsh, Ashcroft, Winters
• Unit Heaters - Cabinet	Trane, Engineered Air, Rosemex, McQuay
• Unit Heaters - HW	Engineered Air, Trane, Rosemex, McQuay, Dunham Bush, Sigma
• Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
• Valves - Circuit Balancing	Armstrong, B & G, Wheatley, Tour & Anderson

• Valves - Drain, Radiator	Jenkins,Dahl, Crane, Toyo, Kitz
• Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
• Valves - Plumbing Flush	Crane, Sloan, Teck
• Valves - Pressure Reducing	Armstrong, Bell & Gossett, Taco
• Valves - Relief	Armstrong, Bell & Gossett, Taco, Wheatley
• Valves - Silent Check	Val-matic, APCO, StreamFlo
• Valves - Suction Diffusers Combination Check and Balance	Armstrong, B&G, Taco
• Variable frequency drives	ABB, Hitachi, Danfoss, Cutler Hammer, Yaskawa
• Valves - Water Pressure Reducing	Watts, Clayton, Singer, Zurn. Wilkins, BCA, Cash Acme, Braukman
• Vibration Isolation	Mason, Vibro Acoustic
• Water Closet Seats	Olsonite, Moldex, Beneke

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Departmental Representative two (2) months prior to final inspection.

.2 Provide four (4) 216 mm x 280 mm capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine.

.3 Index binder according to the following system:

Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

Tab-1.1 List of Mechanical Drawings:

Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from shop drawings.

Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.4 The divider tabs shall be laminated mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Existing Services

.1 Disconnect and cap all mechanical services in accordance with requirements of local authority having jurisdiction.

.2 Building Mechanical Services: Maintain all building services during demolition/removal of existing.

2.3 Core Drilling

.1 Clearly identified all proposed piping penetrations through existing slabs, walls etc and advise the Contractor. Obtain x-rays of the locations to ensure penetration will avoid any existing post tension cables or reinforced steel. Advise the structural Departmental Representative of any conflicts as a result of the x-rays.

3. EXECUTION

3.1 Repairs/ Restoration

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged extensively for priming and touch-up.

3.2 Cleaning

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 Field Quality Control

.1 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 Demonstration

.1 Departmental Representative and/or owners representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment and personnel to demonstrate and instruct the operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Where specified elsewhere in Division 21, 22 or 23 manufacturers to provide demonstrations and instructions.

.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 Contractor will record these demonstrations on video tape for future reference.

3.5 Protection

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 22 05 05 – Firestopping – Mechanical.

.2 Section 23 08 06 - Cleaning and Start-up of Mechanical Piping Systems.

2. EXECUTION

2.1 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.

2.2 Clearances

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated whichever is greater without interrupting operation of other system, equipment, and components.

2.3 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. 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.

.5 The contractor shall allow for piping cooling coil drainpans and all condensate collection points to the nearest floor drain for an indirect waste connection. If a gravity drained connection cannot be made because of invert elevations, the contractor shall provide a packaged condensate pump with integral float control to be wired by this contractor to the unit power connection. The condensate drain line shall be insulated with continuous minimum 1`` thick insulation from the point of connection to the indirect waste connection.

.6 Provide a piped drain connection for each low point in buried or encased ductwork. The duct drain (1/2`` dia. Type L copper tube with soldered fittings) shall be trapped and piped to an indirect waster fitting to the nearest floor drain. If the drain line can be terminated within a heated accessible space but not connected to a gravity drained system, a shutoff valve and downturned elbow shall be provided. If the low point drain cannot be piped to an indirect waste or a heated accessible space, the drain trap is to be 2`` dia cast iron primed, vented, and connected to the sanitary waste system.

2.4 Air Vents

.1 Install manual air vents at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping (copper tubing) for automatic air vents to approved location and terminate where discharge is visible.

2.5 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.

.5 Dielectric waterway fittings may be used in lieu of unions or flanged connections. Waterways shall be grooved and/or threaded end(s), with inert thermoplastic lining. Basis of Design: Victaulic Style 47.

2.6 Pipework Installation

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Grooved joint shall be installed in accordance with the manufacturer's written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half the 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 concealed pipework to minimize furring space, maximize headroom, and conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible.

.12 Ream pipes, remove scale and other foreign material before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Provide for thermal expansion as indicated.

.1 For water systems, Victaulic flexible couplings may be used on header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. The contractor is responsible for providing engineered design to demonstrate thermal expansion capability and requirements where loops are required, use flexible-type couplings on the loops.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless otherwise indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Use ball valves at branch take-offs for isolating purposes except where otherwise specified.

.7 The mechanical contractor shall coordinate with the balancing subcontractor regarding the appropriate sizing of all balancing valves and calibrated balancing valves. The balancing subcontractor shall provide direction to the mechanical contractor for the appropriate size for each balancing valve within each system that is to be balanced. The valves shall be selected to provide appropriate throttling range without imposing a pressure drop of more than 2.5 psi. The balancer is to determine each valves respective flow rate (even if heat transfer and temperature differential calculations are required to determine flowrates). If full line sized valving meets these requirements, then a full line installation of appropriate fittings to transition from the pipe size indicated on the drawings to the recommended valve size.

.16 Check Valves:

.1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.

.2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

.17 Avoid installation of service components (such as valves, air vents, strainers etc in secure areas.

.18 Provide expansion compensation for all closed piping systems including but not limited to: heating water, chilled water, closed condenser water systems, and all other closed piping systems that operate at varying temperatures. Expansion compensation as described in this section may be eliminated from open systems such as domestic cold, domestic hot, domestic hot recirculating systems.

.19 It is the contractor`s responsibility to retain the services of a qualified professional engineer to design the thermal pipe expansion system for the actual installed layout of all piping systems covered by this specifications section.

.20 The contractor also is required to review the mechanical, structural, and architectural documents for the identification of any seismic joints or seismic separations within the building structure that affects the installation of any mechanical systems. At each of these locations, the contractor shall allow for the design, supply, and installation of applicable mechanical system flexible connections along with support of these systems on each side of the seismic joint or separation. This applies to all piping systems as well as ductwork systems. Refer to this section for piping system products, and section 23 05 16 and 23 33 00 for ductwork products.

.21 The contractor is to install flexible piping connections to all equipment that contains rotating components including but not limited to the following: hydronic coils within fan powered terminal units, isolated boilers, entrance heaters that are externally isolated, air handling units that are externally isolated, isolated pumps, isolated pump packages, cooling towers, chillers, heat pumps, and all compressorized equipment. Refer to 23 05 48 as well.

.22 The contractor is to install temperature probe ports and pressure probe ports upstream and downstream of all heating systems components including but not limited to the following items: heat exchangers, all hydronic coils, finned tube elements, radiant heaters, in-floor heating zones, pumps. The contractor shall coordinate these items with the balancing contractor to ensure that all ports are installed as required by the balancer.

2.7 Sleeves

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.4 Sizes: 6 mm minimum clearance between sleeve and un-insulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, and 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: Provide space for firestopping. 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.

2.8 Escutcheons

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

2.9 Preparation for Firestopping

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to **Section 22 05 05 – Fire-stopping - Mechanical.**

.2 Un-insulated unheated pipes not subject to movement: No special preparation.

.3 Un-insulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging fire-stopping material or installation.

.4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

2.10 Flushing Out of Piping Systems

.1 In accordance with Section 23 08 06 - 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 00 – Cleaning and Waste Processing.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

2.11 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 Division 21, 22 & 23.

.3 Maintain specified test pressure without loss for 8 hours minimum unless specified for longer period of time in relevant sections of Division 21, 22 & 23.

.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 owner’s representative c/w signed form outlining piping being witnessed.

.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.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

.2 Division 21 – Fire Suppression

.3 Division 22 – Plumbing

.4 Division 23 – Heating, Ventilation & Air Conditioning

1.2 General Requirements

.1 Access for maintenance or adjustment of all parts of the mechanical system shall be provided. This shall apply but not be limited to valves, volume dampers including splitter dampers, fire dampers, cleanouts and controls.

.2 Where equipment is concealed by a removable tile ceiling, the location of equipment shall be indicated by coloured markings on the T bar system.

.3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.

.4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.

.5 Provide Drywall type access doors in all public drywall spaces requiring access to equipment.

.6 All fasteners on access panels shall be tamper proof, contractor shall provide three (3) sets of keys.

.7 Locate all access doors outside of secure areas where possible. Where not possible, review locations of panels with the Departmental Representative and owner prior to installation. All access panels within secure area are to be of penal quality, lockable, vandal-proof and ligature resistant.

1.3 Acceptable Manufacturers

.1 Acudor

.2 Maxam

.3 Milcor

.4 Bilco

.5 Baucoplus

.6 Or approved alternates

2. PRODUCTS

2.1 Access Door Types

.1 Drywall Surface:

.1 Baucoplus series fabricated with extruded aluminum frame with gypsum board inlay and structural corner elements. Hinge to be concealed 2-point hinge, non-corroding with screw driver cam latch.

.2 Masonry: Acudor UF-5000 universal flush door.

.3 Tile Surface: Acudor UF-5000 stainless steel universal flush door.

.4 Plaster Walls and Ceiling: Acudor PS-5030 with expansion casing bead and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster.

.5 Acoustic Plaster: Acudor AP-5010 with 12 mm recessed door lined with self-furring lath and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster.

.6 Acoustical Tile Ceilings: Acudor AT-5020 with 12 mm recessed door to receive acoustic tile.

.7 Fire Rated Walls: Acudor FB-5060 uninsulated doors where temperature rise is not a problem and Acudor FW-5050 insulated door for maximum 250°C rise after 30 minutes. Door and frame shall be 16 gauge with masonry anchor straps and carry a ULC - 2 hour 'B' label.

.8 Fire Rated Ceilings: Acudor FB-5050, 50 mm thick insulated door with one hour combustible and three hour non-combustible rating.

.9 Ductwork: Nailor Industries 800 series insulated duct access doors with gaskets and camlocks, stainless steel in stainless steel ducts.

2.2 Construction

.1 Flush to frame type steel door with rounded safety corners: 16 GA door, 18 GA frame under 400 mm x 400 mm, and 14 GA door, 16 GA frame over 400 mm x 400 mm. Concealed bar hinge and one piece trim flange.

.2 For ductwork provide access doors with lever locks, insulated for insulated ductwork.

.3 Allan key cam locking device on the side opposite the hinges.

.4 Prime coat grey baked enamel after 5 stage iron phosphate preparation, or stainless steel #4 satin finish where required.

.5 300 mm x 300 mm minimum for inspection and hand access.

.6 600 mm x 600 mm minimum, larger if indicated on drawings, where entry is required and access is difficult.

.7 Size to suit masonry modules when located in a masonry wall.

.8 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface material and pattern if this is available at the time the units are ordered.

3. EXECUTION

3.1 Installation

.1 Installation:

.1 Access doors are to be provided by the mechanical division. This contractor is responsible for coordinating locations, cutting opening and installing panels. Any secondary supports will be by the ceiling or wall contractor.

.2 Access doors in mechanical equipment to be provided and installed by the mechanical division.

.2 Access for maintenance or adjustment of all parts of the mechanical system shall be provided. This shall apply but not be limited to valves, volume dampers including splitter dampers, fire dampers, cleanouts and controls.

.3 Access panel requirements and locations shall be fully coordinated with all involved contractors prior to the installation of any mechanical systems or equipment. Where equipment is concealed by a removable tile ceiling, the location of equipment shall be indicated by coloured markings on the T-bar system.

.4 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.

.5 Provide stainless steel doors in walls of washrooms and janitor rooms.

.6 All fasteners on access panels shall be tamper proof, contractor shall provide three (3) sets of keys.

3.2 Location

.1 Location: Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Section 01 74 19 – Construction Waste Management And Disposal.

.2 Section 23 07 11 – Fire-stopping.

.3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.2 References

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.3 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction 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 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.

2. EXECUTION

2.1 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.

2.2 Clearances

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated whichever is greater without interrupting operation of other system, equipment, components.

2.3 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. 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.

2.4 Air Vents

.1 Install automatic air vents 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.

2.5 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.

2.6 Pipework Installation

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.9 Install, except where indicated, to permit separate thermal insulation of each pipe.

.10 Group piping wherever possible and as indicated.

.11 Ream pipes, remove scale and other foreign material before assembly.

.12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.13 Provide for thermal expansion as indicated.

.14 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless otherwise indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Use ball or gate valves at branch take-offs for isolating purposes except where otherwise 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 2400 mm above floor in Mechanical Rooms.

.15 Check Valves:

.1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.

.2 Install swing check valves in horizontal lines and elsewhere as indicated.

2.7 Sleeves

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.4 Sizes: 6 mm 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: Provide space for firestopping. 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.

2.8 Escutcheons

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

2.9 Preparation for Firestopping

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 23 07 11 - Firestopping.

.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 firestopping material or installation.

.4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

2.10 Flushing Out Of Piping Systems

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

2.11 Pressure Testing Of Equipment and Pipework

.1 Advise Departmental Representative or project manager 48 hours minimum prior to performance of pressure tests.

.2 Pipework: Test as specified in relevant sections of Division 21, 22 & 23.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Divisions.

.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 construction manager or project manager

.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 authorities.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for flexible connections, expansion joints, anchors and guides for building services piping.

1.2 Related Sections

.1 Section 23 08 06 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 References

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.4 Submittals

.1 Submit product data and indicate for item[s] as applicable:

.1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.5 Performance Requirements

.1 Provide expansion compensation for all closed piping systems including but not limited to: heating water, chilled water, closed condenser water systems, and all other closed piping systems that operate at varying temperatures. Expansion compensation as described in this section may be eliminated from open systems such as domestic cold, domestic hot, domestic hot recirculating systems.

.2 It is the contractor`s responsibility to retain the services of a qualified professional engineer to design the pipe expansion system for the actual installed layout of all piping systems covered by this specification section.

.3 The contractor also is required to review the mechanical, structural, and architectural documents for the identification of any seismic joints for seismic separations within the building structure that affects the installation of any mechanical systems. At each of these locations, the contractor shall allow for the design, supply, and installation of applicable mechanical system flexible connections along with support of these systems on each side of the seismic joint or separation. This applies to all piping systems as well as ductwork systems.

2. PRODUCTS

2.1 Flexible Connection

.1 Application: to suit motion per manufacturer’s recommendations

.2 Minimum length in accordance with manufacturer's recommendations to suit offset.

.3 Inner hose: stainless steel corrugated.

.4 Braided wire mesh stainless steel outer jacket.

.5 Operating conditions:

.1 Working pressure: 1034 kPa.

.2 To match system requirements.

2.2 Anchors and Guides

.1 Anchors:

.1 Provide as required.

.2 Alignment guides:

.1 Provide as required.

.2 To accommodate specified thickness of insulation.

.3 Vapour barriers, jackets to remain uninterrupted.

3. EXECUTION

3.1 Installation

.1 Install expansion joints with cold setting.

.2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.

.3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and components for metering hydronic water systems, including installation.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 American Society of Mechanical Engineers (ASME)

.1 ASME Fluid Meter's Handbook: Their Theory and Application.Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.2 Material Safety Data Sheets (MSDS).

1.3 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 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.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. Flow and temperature ranges.

.5 Signal processor calibration data.

.6 Minimum turndown ratio.

.4 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.

.5 Closeout Submittals:

.1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 70 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 - 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 60 00 – Materials and Equipment.

.2 Waste Management and Disposal:

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

1.6 Hydronic Water System Metering

.1 Type of metering:

.1 Energy consumption, supply and return temperature, compensated for specific gravity.

.2 Design data:

.1 Flow rates:

.1 100% Design:

.3 Design differential pressure at normal design flow rate: 25 kPa.

.4 Maximum accuracy of complete meter installation at normal design flow and design temperatures to be plus or minus 0.1%.

.5 Primary flow measuring elements:

.1 Averaging velocity pressure type pitot tube (Annubar).

.6 Flow transmitters may form an integral part of primary flow measuring element.

.7 Standard of design for venturi, primary flow measuring elements: ASME Fluid Meter Handbook.

.8 State in proposal minimum lengths of straight pipe required upstream and downstream of primary element to meet specified accuracy requirements.

.9 If meter to be smaller than main size, state in proposal size of pipe required.

.10 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.

.11 Acceptable types of transmitters, computing devices:

.12 Read-out instrument display:

.1 Thermal power: kW.

.2 Thermal energy consumption: MJ.

.3 Water flow rate: L/s.

.4 Temperature difference: degrees C.

.13 Signal transmission between primary measuring element and signal conditioners:

.1 Power: 24 VDC.

.2 Signal: 4-20 mA

.14 Connection to Building Automation System (BAS):

1.7 Pressure Guages:

.1 Gauges shall be 110 mm diameter 1% accuracy cast aluminum case, aluminum ring, phosphor bronze bourdon tube, brass movement, front re-calibrator and glass window.

.2 Dials shall read metric units kPa.

.3 For gauges on liquid service provide a bronze pulsation damper and needle valve.

1.8 Thermometers:

.1 Thermometers shall be 225 mm scale adjustable angle, cast aluminum case or ABS plastic case, red reading mercury, glass front and complete with 18 mm NPT brass separable well, Celsius scale.

1.9 Static Pressure Gauges

.1 Photohelic - 120/1/60 adjustable photohelic pressure gauge c/w 100 mm (4”) dial in case, external 4 - 20 Ma signal for connection to remote system. Manufactured by Dwyer.

2. EXECUTION

2.1 Manufacturer's Instructions

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

2.2 Installation of Primary Element

.1 Follow manufacturer's instructions.

2.3 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.

2.4 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.

2.5 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.

2.6 Locate meters and gauges in the following locations and as shown on the drawings.

.1	Energy Consumption / Flow Meter	– Condenser Water Systems
.2	Pressure Gauges	– Both sides of Press. Red. Valves
		– Pumps - Suction and Discharge
		– Expansion Tanks
		– Pressure Tanks
		– Sprinkler System
		– Domestic Water Supply Entry
.3	Pressure Gauge Taps	– Both Sides of Two Way Control Valves
		– All Lines to Three Way Control Valves
.4	Stem Type Thermometers	
		– Heat Exchangers - Inlets and Outlets
.5	Thermometer Wells	– All Lines to Three Way Control Valves
.6	Static Pressure Gauges	– Built-up Filter Banks
		– Unitary Filter Sections

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for thermometers and pressure gauges in piping systems.

1.2 References

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B40.100, Pressure Gauges and Gauge Attachments.

.2 ASME B40.200, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB).

.1 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.3 Submittals

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

.2 Submit shop drawings and product data.

.3 Submit manufacturer's product data for following items:

.1 Thermometers.

.2 Pressure gauges.

2. PRODUCTS

2.1 General

.1 Design point to be at midpoint of scale or range.

2.2 Direct Reading Thermometers

.1 Industrial, variable angle type, liquid filled, 125 mm scale length.

2.3 Thermometer Wells

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass.

2.4 Pressure Gauges

.1 112 mm, dial type: to ASME B40.100, Grade 1A, phosphor bronze, bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Snubber for pulsating operation.

.2 Gasketed pressure relief back with solid front.

.3 Bronze stop cock.

3. EXECUTION

3.1 General

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 Thermometers

.1 Install in wells on piping. Provide heat conductive material inside well.

.2 Install in locations as indicated on drawings and on inlet and outlet of:

.1 Heat exchangers (All 4 sides).

.2 Condensing units

.3 DHW tanks (Inlet & Outlet.

.3 Install wells for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

.1 Install in following locations:

.1 Suction (before & after strainer) and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 In other locations as indicated on drawings.

.2 Use extensions where pressure gauges are installed through insulation.

3.4 Coil Connections

.1 The contractor is to provide thermometers in supply and return piping of all AHU coils and at all BMS temperature sensors. The contractor is to also provide pressure gauges at the following locations: Across supply / return piping of AHU coils, chillers, and heat exchangers (both sides).

3.5 Temperature and Pressure Measurement Ports

.1 The contractor is to install temperature probe ports upstream and downstream of all heating system components including but not limited to the following items: heat exchangers, all hydronic coils, finned tube elements, radiant heaters, in-floor heating zones, pumps. The contractor shall coordinate these items with the balancing contractor to ensure that all ports are installed as required by the balancer.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Bronze - valves.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 22 42 01 – Plumbing Specialties and Accessories.

.4 Section 23 05 01 – Pipe Installation.

1.2 References

.1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).

.2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.2 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

.2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.

.3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 Submittals

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

.2 Closeout Submittals:

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

2. PRODUCTS

2.1 Materials

.1 Valves:

.1 Except for specialty valves, to be single manufacturer.

.2 All 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:

.1 Solder ends to ANSI/ASME B16.18.

.2 Grooved ends similar to CSA B242. (Copper-tube dimensioned.)

.3 Lockshield Keys:

.1 Where lockshield valves are specified, provide three 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.

.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.

.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.

.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: Lockshield.

.6 Butterfly Valves

.1 65 mm through 150 mm

.1 Copper tube dimensioned grooved ends.

.2 Cast bronze body.

.3 EPDM encapsulated ductile iron disc with integrally cast stem.

.4 Basis of Design: Victaulic Style 608.

.5 Balancing valves shall be sized to flow and selected for 2 ft. pressure drop across the valve in the fully open position in accordance with manufacturer’s recommendation.

.7 Balancing Valves:

.1 Up to 50 mm

.1 Return side of heating/cooling elements.

.2 Read out ports, drain valve and cap.

.3 Position readout and memory.

.4 Polyurethane packaging (R4-5) to be used as removable insulation.

.5 Coil-Hook-up Connections: Victaulic Koil-Kits Series 799 or 79V may be used at coil connections. The kit shall include a Series 786/787/78K circuit-balancing valve, Series 78Y Strainer-Ball, Series 78U Union-Port fitting, with Series 78T ball valve and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after commissioning.

.2 65 mm to 300 mm

.1 Return side of heating/cooling elements and distribution branches.

.2 Read out ports.

.3 Position readout and memory.

.4 Basis of Design: Victaulic / TA Hydronics.

.3 Provide flow meters with appropriate ranges to provide flow readout.

.1 For installations up to 20 valves, provide standard gauge meter.

.8 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, horizontal lift type, composition disc, Class 150:

.1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

.2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.4 NPS 2 and under, vertical lift type, bronze disc, Class 125:

.1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.9 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.

.10 Ball Valves:

.1 NPS 2 and under:

.1 Body and cap: Cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125

.3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders.

.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.

3. EXECUTION

3.1 Installation and Application

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide threaded lug type butterfly valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.3 Use eccentric plug valves in water systems for throttling/balancing service.

.4 Use memory radiator balancing valves in water and glycol systems terminal heat transfer unit balancing service. For radiant panels provide "circuit setter" valves on return line for each central zone; and a ball valve for shut off service.

.5 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.6 Size drain lines and drain valves equal to size of apparatus drain connection.

.7 For pipe sizes 20 mm and over, minimum drain size to be 20 mm.

.8 Provide hose thread connection with cap and chain for 20 mm drain valves located in ceiling and public areas.

.9 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm where not piped directly to floor drains.

.10 Provide valved drain and hose connections off the bottom of all strainers.

.11 Install gate or ball valves for shut off and isolating service, to isolate equipment, part of system, and vertical risers. Ball valves shall be used up to and including 50 mm.

.12 Install globe or angle valves for throttling service and control device or meter bypass.

.13 Use plug cocks for gas service.

.14 Use plug cocks in water system for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

.15 Use butterfly valves in (in condenser water systems), interchangeably in place of gate valves on all piping 65 mm and larger.

.16 Provide gate or ball valve in hot and cold water lines serving a male or female washroom group of fixtures at each hose bibb and at all equipment requiring isolation.

.17 Use bronze body ball valves for domestic water service.

.18 Provide valves upstream of all meters, gauges, automatic air vents, etc. for isolation purposes.

.19 Run line size pipe to floor drains from all drain cocks, drain valves, etc.

.20 Provide main piping system drain valves as a low point and pipe to drain. Drain valves shall be two pipe sizes smaller than largest mains and minimum 25 mm.

.21 Provide 50 mm globe by-pass valves around steam isolation valves 150 mm and larger.

.22 Provide isolation valves in all systems such that floor by floor for horizontal systems, all risers in a vertical system and zone areas on a large horizontal system can be isolated.

.23 Spring loaded water check valves shall be located eight pipe diameters downstream of pumps or elbows.

.24 Remove internal parts before soldering.

.25 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

.26 Triple duty valves are not allowed.

.27 Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)

3.2 Valve Connections

.1 Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.

.2 Thread pipe sizes 50 mm and smaller.

.3 Flange pipe sizes 65 mm and larger.

.4 Solder or screw to solder adapters for copper tubing.

.5 Use grooved body valves with mechanical grooved jointed piping.

.6 Provide butterfly valves with tapped lug body when used for isolating service.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1, Power Piping.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A125, Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563, Specification for Carbon and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 ANSI/MSS SP69, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.

.4 Underwriters Laboratories of Canada (ULC)

1.3 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.

1.4 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings and product data for following items:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 Quality Assurance

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 60 00 – Materials & Equipment.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 General

.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 Pipe Hangers

.1 Finishes:

.1 Pipe hangers and supports: galvanized.

.2 Provide 2 part epoxy marine grade paint on all supports located in aquatic area, aquatic storage rooms parking garage level mechanical rooms. Painting by qualified trade or factory supplied with cost incurred by this contract. Paint before installing hangers.

.3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

.2 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.

.3 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 to MSS SP69.

.4 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies.

.2 Steel brackets:

.5 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.

.6 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 for all HOT PIPING.

.7 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 riveting to insulation shields.

.8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.

.9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: galvanized with epoxy coated in areas described above.

.2 Finishes for copper: epoxy coated.

.10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 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.

2.4 Insulation Protection Shields

.1 Insulated cold piping:

.1 64 kg/m^3 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.

2.5 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.

2.6 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 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops.

.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.

2.7 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

2.8 Equipment Anchor Bolts and Templates

.1 Provide templates to ensure accurate location of anchor bolts.

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, cooling towers, and other equipment 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 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.5 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.

.6 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 Provincial 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, but not less than one hanger at joints.

.6 Within 300-mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 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.

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.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Heat tracing cables for pipes and tanks including controls and installation.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 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 Instructions: submit manufacturer'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 - 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 60 00 – Material & Equipment.

.2 Waste Management and Disposal:

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

1.6 Acceptable Manufacturers

.1 Raychem, Serge Baril

2. PRODUCTS

2.1 Pipe Tracing Heating Cables

.1 The heater shall consist of two (2) self-limiting 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core. The length of cable shall be confirmed on the job site.

2.2 Controls

.1 The system shall be controlled by an AMC-F5 line-sensing thermostat, complete with 3000 mm capillary tube, set to maintain pipe temperature.

2.3 Acceptable Manufacturers:

.1 Raychem

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 Apply heater cable linearly on pipe after the pipe has been successfully pressure tested.

.2 Install heat tracing on all heating / chilled pipes, p-traps, and domestic water lines in the parking garage and all other unheated spaces.

.3 Secure heater to pipe with cable ties or GT66 fibreglass tape at 600 mm centres and fasten longitudinally with heat transfer tape.

.4 Wrap all valves with a minimum of 1300 mm 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 away from valves, flanges, pumps, etc.

.6 Install ambient sensing thermostat away from sunlight.

.7 Apply "Electric Traced" signs to the outside of the thermal insulation, spaced approximately every 3 m.

.8 Make power and control connections.

.9 Power supply to be 115v

3.3 Testing

.1 After installation and before installation of insulation, subject heater to testing using a 2500 VDC megger. Minimum insulation resistance should be 20 to 1000 megohms.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Vibration isolation materials and components, and their installation.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 23 08 00 – General Commissioning.

1.2 References

.1 National Fire Protection Association (NFPA)

.1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

.2 National Building Code of Canada (NBC) – 2010

.3 British Columbia Building Code – 2012

.4 The most stringent code shall apply.

1.3 Submittals

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures

.1 Shop drawings: submit drawings stamped and signed by a Professional Engineer registered or licensed in Province of British Columbia, Canada.

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

1.4 Quality Assurance

.1 Provide signed and sealed letters of assurance, as required by the authority having jurisdiction, taking responsibility for the seismic restraints.

.2 Provide these letters of assurance sealed by a registered professional engineer for the seismic restraints, “Assurance of Professional Design and Commitment for Field Review” as well as “Assurance of Professional Field Review and Compliance”.

2. GENERAL

.1 Where imperial units have been indicated in brackets following the requirements in SI units, the conversion is approximate and provided for convenience. The SI units shall govern.

.2 Provide vibration isolation on all motor driven fans regardless of power rating and all other motor driven equipment over 0.35 kW (0.5 HP) (as indicated on the motor nameplate), and on piping and ductwork specified herein. For fans less than 0.35 kW (0.5 HP), provide isolation with neoprene grommets at the support points. Fire pumps and jockey pumps driven by electric motors are excluded.

.3 Select equipment isolators and other components as indicated to satisfy the following requirements of Table 1.

.4 Isolators and bases which are factory supplied with equipment shall meet the requirements of this section. Where internal isolation is provided, the isolation requirements specified in Table 1 apply to all separate vibration sources in the unit. Where internal vibration isolation is not provided, the unit frame shall be rigid enough such that the isolators can be attached directly without additional stiffening.

.5 Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the center of gravity of the equipment. Include height of center of gravity on shop drawings. Otherwise, provide suitable horizontal restraint isolators.

.6 Select isolators in accordance with equipment weight distribution to allow for an average deflection meeting or exceeding the specified deflection requirements and so that no isolator has a deflection less than 80% of the static deflection specified. A minimum of 4 isolators are required for each piece of equipment, unless specified otherwise. Number and colour code each isolator to show location. Mark code number and colour on shop drawings, on each isolator and on each base to ensure proper placement. Clearly tag all springs to show undeflected height and static deflection.

.7 Provide horizontal limit springs on all fans (except vertical discharge) having a static pressure in excess of 1.0 kPa static pressure, and on hanger supported, horizontally mounted axial fans with more than 330 N thrust due to static pressure. The springs shall limit the movement of flexible duct connections to 25% of the fabric width under steady state conditions and to 40% at start-up.

.8 Provide all concrete inertia bases where specified or required by equipment manufacturers. Bases to be located between the vibrating equipment and the vibration isolation elements. Provide concrete inertia bases for centrifugal fans with static pressure in excess of 0.875 kPa (3.5” SWG) and/or motors in excess of 30 kW (40 HP) and on base mounted pumps over 15 kW (20 HP), except slab on grade installations or unless otherwise specified. Provide concrete inertia bases on all plug fans that also require thrust restraints.

.9 Other than equipment requiring concrete inertia bases, provide structural steel bases for all vibration isolated equipment, unless the equipment manufacturer certifies direct attachment capabilities.

.10 Use ductile materials in all vibration isolation equipment.

.11 Install flexible duct connectors on all ductwork connected to isolated equipment. The flexible duct connectors shall meet the requirements of the mechanical equipment specifications.

.12 All electrical connections to vibration isolated equipment shall be made with flexible conduit or other flexible means acceptable to the acoustical Departmental Representative so as not to restrict the maximum anticipated movement of the equipment under the design seismic excitation. Co-ordinate with Division 16.

.13 Provide resilient hangers on all piping, etc., rigidly connected to vibration isolated equipment. Provide the hangers for a distance of 3.0m for a 25mm pipe and 13.5m for a 250mm pipe. Isolate other pipe sizes for a proportionate distance (both interpolation and extrapolation may be required). Select the three closest hangers to the vibration source for the lesser of 25mm static deflection or the static deflection of the isolated equipment. Select the remaining isolators for the lesser of 25mm (1”) static deflection or one-half the static deflection of the isolated equipment.

.14 Where resilient hangers cannot be provided for piping rigidly connected to vibration isolated equipment (such as a rigid fire-stop falling within the required isolation distance), provide flexible connectors. One end of each flexible connector shall be installed directly to a flange of the isolated equipment (between the equipment and isolation valves) unless otherwise indicated on the drawings.

.15 Provide an acceptable means of corrosion protection for all equipment, attachments and accessories supplied under this section, suitable for the conditions in which this equipment, etc. will be installed.

.16 Co-ordinate with Division 3 for the provision of housekeeping pads at least 100 mm high under all isolated equipment. Provide at least 175 mm clearance between drilled inserts and edge of housekeeping pads and follow structural Departmental Representative's instructions for drilled inserts.

.17 Bolt all equipment to the structure. Do not bridge isolation elements.

3. PRODUCTS

3.1 General

.1 Size and shape of bases type and performance of vibration isolation as indicated.

.2 Vibration isolation equipment and materials by one supplier.

.3 All elastomeric components in isolation pads, mounts, and seismic snubbers shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.

3.2 Isolators-General

.1 Supply all of the vibration isolation equipment by one approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Select isolators at the supplier's optimum recommended loading and do not load beyond the limit specified in the manufacturer's literature.

.3 All spring isolators shall be "open spring" unless otherwise stated. Seismically rated housed springs isolators such as Mason Type SSLFH may be used in place of the "open spring" isolators provided that they meet the requirements of the seismic restraint section.

.4 Select isolators for motor driven fans of less than 0.5 HP for a minimum static deflection of 3mm.

.5 Provide steel spring isolators for deflections of 12mm and over.

.6 Provide neoprene isolators for deflections 6mm and under.

.7 Provide either neoprene or steel spring isolators for deflections between 6mm and 12mm.

.8 Provide adjustable limit stops for spring isolation mounts on equipment with operating weights substantially different from the installed weights

3.3 Isolators – Steel Spring

.1 Springs shall have a working deflection between 0.3 and 0.6 of solid deflection and for base mounted equipment shall be "Iso-Stiff" (kx/ky = 1.0 to 1.5).

.2 Springs shall meet the requirements of the following standards:

.1 Cold Wound/Oil Tempered:

.1 Standard Spring Steel – SAE 1065/ASTM225

.2 Chromium Silicon Steel – ASTM A-401.

.2 Hot Wound:

.1 Various Spring Steel Alloys – SAE 1095, SAE 5160, SAE 4161.

.3 Spring mounts shall be complete with leveling devices and minimum 5mm (¼") thick neoprene acoustical spring cups located between the spring and the mount housing on at least one end of the spring.

.4 Acoustical spring cups shall be sized for a minimum deflection of 1mm (1/16") and shall meet the requirements for neoprene isolators.

.5 Use compression springs for all spring isolators.

.6 Springs shall be stable under operating conditions.

3.4 Neoprene Isolators

.1 Neoprene isolators shall have a manufacturer's warranty covering a minimum of ten (10) years from the date of acceptance of the work, or shall be manufactured from bridge bearing quality neoprene meeting CAN/CSA-S6-88 Section 11.5.8.

.2 Neoprene isolators shall not exceed 50 durometer.

.3 Provide steel inter-layers to distribute the load in a multi-layered isolator. Where a ribbed pad is supplied, the height of the rib shall not exceed 0.7 times the width of the rib.

.4 Neoprene pads or elements shall be selected at the supplier's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene manufacturer's literature.

.5 Use dynamic stiffness for sizing elastomers.

3.5 Hanger Mounts

.1 Satisfy requirements of this section for steel spring or neoprene isolators.

.2 Provide hangers capable of a 15° misalignment (+/- 15°) without binding.

3.6 Flexible Piping Connectors

.1 Provide flexible piping connectors meeting the following requirements:

.1 Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and polyester tire cord fractioning. Curing must take place in steel moulds closed within heated hydraulic presses. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.

.2 Connectors shall be rated at a pressure exceeding the design operating pressure of the equipment on which it will be used at the maximum operating temperature expected. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 300%.

.3 Sizes 20mm to 40mm shall have threaded one piece bolted flange assemblies with a single sphere. Sizes 50mm to 350mm shall have two spheres reinforced with a ductile iron external ring between the spheres. Sizes 400mm and higher shall be single sphere. Sizes 50mm and higher shall be complete with split ductile iron or steel flanges with hooked or similar interlocks.

.2 Submittals shall include test reports by independent Departmental Representatives on this or a similar flexible connector by the same manufacturer, demonstrating minimum reductions of 20dB in vibration accelerations and 10dB in sound pressure levels at typical blade passage frequencies for the equipment being isolated.

.3 Provide specification data and shop drawings for proposed alternate connectors for approval, if the requirements in 2.6.1 cannot be met due to the nature of the fluid conveyed.

.4 Protect flexible connectors from strain beyond their design limits. If control rods are required, they shall be cable type and shall include 6mm thick neoprene washer bushings sized to meet the design loading with a factor of safety of 3:1.

.5 In order to prevent heat build-up and to facilitate inspection, flexible piping connectors in hot lines shall not be insulated unless otherwise directed.

3.7 Steel Bases

.1 Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by the equipment manufacturer and to transmit design loads to the isolators and attachment points.

.2 Use height saving brackets in all mounting locations to maintain a nominal 50mm clearance below the base.

.3 Bases are to be furnished with built-in motor slide rails. Motor locations as specified /scheduled.

.4 Construct bases strictly in accordance with isolation supplier's drawings.

4. EXECUTION

4.1 Installation

.1 Execute the work in accordance with the specification and where applicable, in accordance with the manufacturer's instructions and only by workers experienced in this type of work.

.2 Install the isolators so that they provide the rated vibration isolation after equipment start-up. Do not attach isolators to equipment or to structure in a fashion which impairs their isolation capabilities.

.3 Provide a minimum clearance of 50mm to other structures, piping, equipment, etc., for all equipment mounted on vibration isolators.

.4 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing drilled inserts.

.5 When spring isolators are used for equipment with operating weights substantially different from installed weights, block the equipment with temporary shims to the final heights prior to making piping connections. When full load is applied, adjust the isolators to take up the load just enough to allow shim removal.

.6 After installation and adjustment of isolators, verify deflection under load to ensure loading is within specified range.

.7 Where hold-down bolts for isolators or attachments penetrate roofing membranes, co-ordinate with roofing section of specifications and with roofing contractor.

.8 For all pump installations, ensure that pumps are installed and aligned such that no piping loads are imposed on the pump. Pumps and piping should be independently supported and aligned prior to final connection.

.9 Where isolated piping connected to noise generating equipment is routed from the mechanical room through plumbing chases or other openings, position isolated piping to avoid contact with the structure, framing, gypsum wallboard and other elements which may radiate noise.

.10 Ensure that the installed seismic restraints do not adversely affect the proper functioning of any vibration isolation products required by this section.

.11 Install flexible duct connectors so that duct cross-section is not reduced by the deflection of the flexible connector.

4.2 Inspection and Report

.1 Arrange for a qualified representative of the isolation supplier to inspect the isolated equipment after installation and equipment start-up and to submit a concise report to the mechanical Departmental Representative stating any deficiencies in the installation.

.1 Isolation Schedule

Type	**Minimum Static Deflection in mm Equipment Supported By:**	
	Slab on Grade	**Elevated Slab**
Pumps:		
In-Line:		
Under 1.5kW (2HP)	1 (1/16)	3 (⅛)
1.5kW (2 HP) to 11.5kW (15 HP)	3 (⅛)	5 (¼)
Over 11.5kW (15 HP)	3 (⅛)	9 (⅜)
Base Mounted:		
Under 5.5kW (7.5 HP)	5 (¼)	19 (¾)
5.5kW (7.5 HP) and greater	19 (¾)	38 (1½)
Fans, Blowers & Packaged H & V Units:		
Under 0.5 HP	1 (1/16)	1 (1/16)
0.5 HP to 7.5 HP	25 (1)	25 (1)
7.5 HP to 40 HP - up to 400 rpm	38 (1½)	38 (1½)
7.5 HP to 40 HP - over 400 rpm	25 (1)	25 (1)
Over 40 HP – up to 400 rpm	38 (1½)	38 (1½)
Over 30 KW (40 Hp) – over 400 rpm	25 (1)	38 (1½)
NOTES:		

Type	**Minimum Static Deflection in mm** **Equipment Supported By:**	
	Slab on Grade	**Elevated Slab**
1. Table indicates required static deflection of isolators for all fans regardless of power rating and for all other motor driven equipment over 0.37kW (0.5 HP).		
2. Advise Departmental Representative of equipment not contained in this table and obtain clarification as to the isolation performance requirements.		
3. Steel spring isolators shall be used for all deflections 12mm (½") and over.		
4. Neoprene isolators shall be used for deflections 6mm (¼") and under.		
5. Use housed spring isolators for heat pump.		
6. Concrete inertia bases required for pumps over 20hp, fans over 40hp.		

4.3 Flexible Duct Connectors

.1 **Type D1:** Flexible duct connectors of Durodyne with Durolon fabric or approved equal.

.1 Provide 75 mm flexible duct connectors and a 40 mm metal to metal gap.

.2 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start up.

.3 Flexible duct connections shall be installed so that duct size is not reduced by the deflection of the flexible connector.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Seismic restraint systems (SRS) for statically supported and vibration isolated equipment and systems; described in Sections 21, 22 and 23.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 78 00 - Closeout Submittals.

.3 Section 21 13 13 - Wet Pipe Sprinkler Systems

.4 Section 23 05 48 - Vibration Isolation for Piping & Equipment.

1.2 References

.1 Canadian Standards Association (CSA International)

.1 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 National Building Code of Canada (NBC) – 2010

.3 British Columbia Building Code – 2012

.4 The most stringent code shall apply.

1.3 Definitions

.1 SRS: acronym for Seismic Restraint System.

.2 SCS: acronym for Slack Cable System.

1.4 System 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 B.C.

1.5 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 additional copy of shop drawings and product data to Structural Departmental Representative for review of connection points to building structure.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Provide signed and sealed letters of assurance, as required by the authority having jurisdiction, taking responsibility for the seismic restraints.

.2 Provide these letters of assurance sealed by a registered Professional Engineer for the seismic restraints, “Assurance of Professional Design and Commitment for Field Review” as well as “Assurance of Professional Field Review and Compliance”.

.5 Closeout Submittals:

.1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

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. No equipment, equipment supports or mounts to fail before failure of structure.

.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 Where hold down bolts for isolators or seismic restraint equipment penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene.

.8 Seismic control measures not to interfere with integrity of firestopping.

.9 Service and utilities entrance into building: Seismic valve for Gas system.

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 or directed by Seismic Engineer.

.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. Seismic restraints to provide gentle and steady cushioning action.

.3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS for 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 Provide flexible duct connectors on all air moving equipment with motors.

.4 Provide flexible pipe connectors on all floor-mounted pumps above grade.

.5 As indicated.

2.5 SRS for Piping Systems

.1 Sprinkler systems: To NFPA-13.

.2 Piping systems: for hangers longer than 300 mm; brace at each hanger.

.3 Compatible with requirements for anchoring and guiding of piping systems.

2.6 Slack Cable Restraint System (SCS)

.1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.

.2 Bracing methods:

.1 Structural angles or channels.

.2 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.

.3 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.

.4 Hanger rods to withstand compressive loading and buckling.

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 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.

.2 Install SRS at least 25 mm from equipment, systems, and services.

.3 Miscellaneous equipment not vibration-isolated:

.1 Bolt through housekeeping pad to structure.

.4 Co-ordinate connections with other disciplines.

.5 Vertical tanks:

.1 Anchor through housekeeping pad to structure.

.2 Provide steel bands above centre of gravity.

.6 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 or Seismic Engineer to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Inspection and Certification:

.1 SRS: inspected and certified by Seismic Engineer upon completion of installation.

.2 Provide written report to Departmental Representative with Letters of Assurance as required in the building code.

.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.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and requirements for the identification of piping systems, ductwork, valves and controllers, including the installation and location of identification systems.

.2 Sustainable requirements for construction and verification.

.2 Related Sections:

.1 Sections 21, 22 & 23.

1.2 References

.1 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

.4 Canadian Standards Association (CSA)

.1 CSA B128.1-06/B128.2.06 Design and Installation of non-potable water systems.

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
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.

2.3 Piping Systems Governed by Codes

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1

.2 Sprinklers: to NFPA 13.

.3 Chemical Treatment Piping – Ministry of Health Code

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
Blue	WHITE

.3 Background colour marking and legends for piping systems:

Contents	**Background colour marking**	**Legend**
Condenser Water Supply	Blue	CONDENSER SUPPLY
Condenser Water Return	Blue	CONDENSER RETURN
Make-up water	Yellow	MAKE-UP WTR
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CW SUPPLY
Storm water	Green	STORM
Sanitary	Green	SAN
Propane gas	to Codes	
Gas regulator vents	to Codes	
Fire protection water	Red	FIRE PROT. WTR
Condensate Drain	Green	COND

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.

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 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 located in upper boiler room. Provide one copy in each operating and maintenance manual.

.3 Number valves in each system consecutively.

.1 Plumbing to be numbers P-1, P-2, P-3…

.2 HVAC to be numbered H-1, H-2, H-3…

.3 Fire Protection to be numbered F-1, F-2, F-3…

3.7 Identification

.1 The contractor is to provide Avery coloured dots on the t-bar ceiling grid below valves and mechanical devices above. The colour of the dot shall identify the service above. i.e. red dot = heating valve above. The label shall indicate what the device is above – i.e. VAV box, below a VAV box above or Heating Valve etc.

3.8 Identification Requirements Specific for Non-potable Water Systems

.1 Distribution piping for non-potable water systems shall be clearly identified in accordance with the following:

.1 Pipe for non-potable systems shall be:

.1 Marked with the legend WARNING: NON-POTALE WATER – DO NOT DRINK

.2 Purple in color, or marked with a continuous purple stripe.

.2 Markings on pipe for non-potable water systems shall be:

.1 Permanent, distinct, and easily recognizable.

.2 In legible letters and numerals, at least 5 mm high, except where the size of the pipe makes 5 mm high letter and numbers impracticable.

.3 Of a color that contrasts with the color of the pipe.

.4 Repeated at intervals of not more than 1.5m.

.3 The presence of buried pipes shall be identified with a permanent warning tape installed at least 300 mm above the pipe, running lengthwise. In addition, a tracer wire shall be installed for non-metallic pipes.

.4 Outlet points shall be clearly and permanently marked with the legend WARNING: NON-POTABLE WATER – DO NOT DRINK or with a sign as depicted with the figure below. The sign shall be not less than 100 mm x 100 mm.

END OF SECTION

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.

.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.

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

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing

.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

.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.

.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 project.

.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 and 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 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 weather-stripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.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, airshafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

1.10 Application Tolerances

.1 Do TAB to following tolerances of design values:

.1 HVAC 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 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.2 Calibrate within 3months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 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.

1.14 Tab Report

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in D-ring binders, complete with index tabs.

1.15 Verification

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 20% 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.

1.16 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.

1.17 Completion of Tab

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

2. EXECUTION

2.1 Manufacturer's Instructions

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

2.2 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.

2.3 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%.

.2 Large low pressure duct systems up to 500 Pa: leakage 2 %.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

2.4 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.

2.5 Air System Procedure

.1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.

.2 The following procedure shall be adopted for central systems:

.1 Ensure dampers or volume control devices are in fully open position.

.2 Balance central apparatus to ±10% airflow.

.3 Balance branches, mains to ±10% airflow.

.4 Recheck central apparatus.

.5 Balance all terminal air outlets to ±10%.

.6 Rebalance central apparatus to ±5%.

.7 Recheck all air outlets.

.8 Perform acoustical measurements.

.9 Perform building pressurization tests and measurements at minimum and maximum outdoor air damper positions of the main air unit(s).

.3 When balancing air outlets:

.1 Rough balance furthest outlets and then balance sequentially back to source.

.2 Fine balance furthest outlet back to source.

.4 Take static pressure readings and air supply temperature readings at 10 points on each air system.

.5 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct *diameters *widths and re-do traverse.

.6 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.

.7 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.8 Where modulating dampers are provided, take measurements and balance at extreme conditions. (Balance variable volume systems at maximum airflow rate - full cooling, and at minimum airflow rate - full heating).

.9 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in the aquatic space throughout full range of fan delivery rates, under both clean & dirty filter conditions. Document abnormal building leakage conditions noted.

.10 Complete balancing to achieve positive building pressure with respect to lobby. A positive pressure relative to outside of *10 Pa* minimum and *20 Pa* maximum shall be achieved, measured with negligible outside wind velocity.

.11 Adjust building zones to achieve the following pressure differentials:

.1 Aquatic space to be negative to lobby.

.2 Aquatic to be neutral to change rooms.

2.6 Balancing and Adjusting of Domestic Water Systems

.1 Adjust PRV on main line to *570 kPa* maximum.

.2 Balance domestic hot water recirculating system piping to ensure flow from all points in the system. Ensure all hot and cold supply shut off valves are fully open.

2.7 Balancing Report

.1 Submit draft copies of reports prior to final acceptance of project.

.2 Include types, serial number and dates of calibration of instruments.

.3 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.

END OF SECTION

1. GENERAL

1.1 Related Sections

.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

.2 Division 21 – Fire Suppression

.3 Division 22 – Plumbing

.4 Division 23 – Heating, Ventilation & Air Conditioning

.5 Division 25 – Integrated Automation

1.2 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings to show:

.1 Material Specification including CSA or ULC reference numbers.

.2 Installation details for various types of piping materials.

.3 Operating and maintenance requirements.

.3 Shop drawings and product data accompanied by:

.1 Manufacturer to certify current model production.

.2 Certification of compliance to applicable codes.

.4 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 70 00 - Closeout Submittals.

.2 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.

1.3 References

.1 Test Requirements: ULC-S115-M or CAN4-S115-M, "Standard Method of Fire Tests of Through Penetration Fire Stops".

.2 CAN4-S115-M under their designation of ULC-S115-M and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.

.3 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their “Products Certified for Canada (cUL) Directory

.4 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

.5 Inspection Requirements: ASTM E 2174 – 01, “Standard Practice for On-site Inspection of Installed Fire Stops.

.6 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.

.7 All major building codes: NBC and BCBC.

.8 NFPA 101 - Life Safety Code

1.4 Definitions

.1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.5 Quality Assurance

.1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

.2 Retain and pay for the service of a Professional Engineer registered in the Province of British Columbia to inspect each and every mechanical fire stopping installation, and as required by the Authority having jurisdiction, and provide a report on all installations. The fire stopping engineer shall provide letters of assurance to the Mechanical Departmental Representative, in accordance with the BC Building Code.

.3 A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

.4 Firestop System installation must meet requirements of CAN4-S115-M or ULC S-115-M tested assemblies that provide a fire rating.

.5 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

.6 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural Departmental Representative prior to penetrating any load bearing assembly.

.7 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994)

.8 Allow for destructive testing of 5% of fire stopping applications. Should installations not conform to manufacturer's listed assembly, an additional 25% of installations may be destructively tested and should there be more failures, the contractor will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the project.

1.6 Acceptable Manufacturers

.1 Subject to compliance with through penetration firestop systems listed in U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following manufacturers as identified below:

.1 Hilti (Canada) Corporation

.2 3M

.3 Other manufacturers listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Director.

1.7 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 60 00 – Material and Equipment

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Storage and Protection:

.1 Store materials indoors in dry location.

.2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

.3 Waste Management and Disposal:

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

2. PRODUCTS

2.1 Firestopping, General

.1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

.2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

.3 Firestopping Materials are either “cast-in-place” (integral with concrete placement) or “post installed”. Provide cast-in-place firestop devices prior to concrete placement.

2.2 Materials

.1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

.2 Cast-in place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are acceptable:

.1 Hilti CP 680 Cast-In Place Firestop Device

.1 Add Aerator adaptor when used in conjunction with aerator (“solvent”) system.

.2 Hilti CP 682 Cast-In Place Firestop Device for non-combustible pipe

.3 Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.3 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).

.1 Hilti FS-ONE Intumescent Firestop Sealant

.2 Hilti CP 604 Self Leveling Firestop Sealant

.3 Hilti CP 620 Fire Foam

.4 Hilti CP 606 Flexible Firestop Sealant

.5 Hilti CP 601s Elastomeric Firestop Sealant

.6 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.4 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.1 Hilti FS-ONE Intumescent Firestop Sealant

.2 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.5 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa. differential. Products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.1 Hilti CP 643N Firestop Collar

.2 Hilti CP 644 Firestop Collar

.3 Hilti CP 645/648 Wrap Strips

.4 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.6 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

.1 Hilti CP 637 Firestop Mortar

.2 Hilti FS 657 Fire Block

.3 Hilti CP 620 Fire Foam

.4 Hilti CP 675-T Firestop Board

.5 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.7 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:

.1 Hilti FS 657 Fire Block (for walls and floors)

.2 Hilti CP 658T Firestop Plug (for walls and floors)

.3 Hilti CP 680 Cast-In Place Firestop Device (for floors only)

.4 Equivalent products listed in the U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory

.8 For penetrations through a Fire Separation wall provide a firestop system with a "F" Rating as determined by ULC or cUL as indicated below:

Fire Resistance Rating of Separation	Required ULC or cUL "F" Rating of Firestopping Assembly
30 minutes	20 minutes
45 minutes	45 minutes
1 hour	45 minutes
1.5 hours	1 hour
2 hours	1.5 hours
3 hours	2 hours
4 hours	3 hours

For combustible pipe penetrations through a Fire Separation provide a firestop system with a "F" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

3. EXECUTION

3.1 Preparation

.1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

.1 Verify penetrations are properly sized and in suitable condition for application of materials.

.2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

.3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

.4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

.5 Do not proceed until unsatisfactory conditions have been corrected.

3.2 Coordination

.1 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

.2 Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.3 Installation

.1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory.

.2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.

.1 Seal all holes or voids made by penetrations to ensure an air and water resistant seal.

.2 Consult with mechanical Departmental Representative, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

.3 Protect materials from damage on surfaces subjected to traffic.

3.4 Field Quality Control

.1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

.2 Keep areas of work accessible until inspection by applicable code authorities.

.3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

.4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

.5 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:

.1 Warning that the opening has being fire stop protected

.2 Indicate the fire stop system used (ULC or cUL)

.3 F rating or FT rating

.4 Fire stop product(s) used

.5 Person to contact and phone number in case of modification or new penetration of fire stop system

3.5 Adjusting and Cleaning

.1 Remove equipment, materials and debris, leaving area in undamaged, clean condition.

.2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.6 Demonstration

.1 Departmental Representative and/or owners representative will use equipment and systems for test purposes

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 Internal and external thermal duct insulation, accessories, sealers and finishes.

1.2 Related Requirements

.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 Section 21 05 01 – Common Work Results for Mechanical

1.3 References

.1 The latest revisions of the following standards shall apply unless noted otherwise.

.2 British Columbia Building Code or National Building Code, whichever is more stringent.

.3 ASHRAE 90.1-2013 – Energy Standard for Buildings Except Low Rise Residential Buildings

.4 Thermal Insulation Association of Canada (TIAC) – National Insulation Standards.

.5 CAN/ULC S102-M88 – Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

.6 CGSB 51-GP-52MA – Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.7 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.8 ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

.9 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining.

.10 ASTM C1290 – Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

1.4 Submittals

.1 Comply with Division 1 – Submission and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:

.1 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Manufacturer's installation instructions.

1.5 General Requirements

.1 The Installation firm shall be a current member of the Thermal Insulation Association of Canada (TIAC).

.2 Only Journeyman insulation applicators, with 3 years minimum successful experience in this size and type of project, shall perform the work.

.3 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.

.3 “K” value means Thermal Conductivity

.4 UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and World Health Organization (WHO).

.5 ASJ: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper

.6 SSL: Self-Sealing Lap.

.7 FSK: Foil Scrim Kraft; jacketing.

.8 PSK: Poly Scrim Kraft; jacketing.

.9 PVC: PolyVinyl Chloride.

.4 Provide thermal insulation on all HVAC ductwork and as follows:

.1 Hot duct and plenum: 20°C to 65°C (-4°F to149°F)

.2 Cold or dual temp duct and plenum - 65°C (149°F) and below

.3 Outside air duct and plenum: -40°C (-40°F) to 21°C (70°F)

.4 All exhaust air ductwork from outside wall or roof to damper but a minimum of 1.5 m (5 ft.) inside building.

.5 Combustion intake / relief air

.6 Insulation may be omitted on return air and exhaust air ducts and plenums located within the conditioned space.

.7 Insulation may be omitted on exposed ductwork in the area served by that duct.

.8 Insulation may be omitted on ductwork in return air plenums provided the ductwork serves that area.

.5 Provide acoustic internal insulation on ductwork and as follows:

.1 All ductwork indicated on drawings.

.2 All exposed supply and return ductwork in mechanical rooms from fan discharge to duct shaft or mechanical room perimeter wall.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.

.2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 List of acceptable Manufacturers:

.1 Knauf Insulation

.2 Manson Insulation Inc.

.3 Owens Corning Canada Inc.

.4 Roxul Inc.

.5 Johns Manville

.6 Armstrong World Industries

.7 Halstead Corp.

.8 Industrial Insulation Group IIG-LLC

2.2 General

.1 Products shall not contain asbestos, lead, mercury, mercury compounds or Polybrominated diphenyl ethers (PBDE).

.2 Mineral fibre specified includes glass wool and rock wool.

.3 The RSI value shall not be reduced from the specified values when tested in accordance with ASTM C1290.

.4 Insulation and jacketing materials shall not exceed 25 flame spread, 50 smoke developed rating when tested in accordance with CAN/ULC S102-M88.

.5 Elastomeric insulation shall comply with NFPA 90A, 90B and ASTM C1534

.6 Foam insulation products shall not use CFC or HCFC blowing agents in the manufacturing process and be formaldehyde free.

.7 Glass mineral wool products shall have a recycled content of a minimum of 50 percent recycled glass content.

.8 Low Emitting Materials: For all thermal and acoustical applications of glass mineral wool insulation, insulation shall be UL GREENGUARD Certified.

.9 Products shall be either Declare LBC Red List free or LBC compliant.

2.3 Intermediate Temperature Range Insulation (15°C TO 315°C)

.1 External rigid Insulation (TIAC C-1):

.1 Service temperature 5°C to 232°C (41°F to 450°F)

.2 Glass mineral wool board for low and medium temperature applications.

.3 Complying with ASTM C1071 and CGSB 51-GP-52MA

.4 All service aluminum foil-scrim kraft (FSK) jacket with glass fibre reinforcement, factory applied.

.5 Density 36kg/m3 (2.25 PCF)

.6 Minimum RSI 0.76/25mm (R 4.3/in)

.2 External flexible duct wrap insulation (TIAC C-2):

.1 Service temperature 5°C to 121°C (41°F to 250°F)

.2 For service temperatures above 121°C refer to 2.4 High Temperature Insulation

.3 Glass mineral wool flexible blanket for low and medium temperature applications.

.4 Complying with CGSB 51-GP-52MA, ASTM C1071 and ASTM C553.

.5 All service aluminum foil-scrim kraft (FSK) jacket with glass fibre reinforcement, factory applied.

.6 Density 12kg/m3 (0.75PCF),

.7 Minimum RSI 0.49/25mm (R 2.8/in) (installed)

.3 Internal rigid duct liner:

.1 Rigid glass mineral wool board, for low and medium temperature acoustical applications.

.2 Complying with ASTM C1071 and CGSB 51-GP-52MA

.3 Airstream surface faced with a black mat bonded to the glass mineral wool substrate.

.4 Air velocity rating 25.4 m/s (5,000 ft/min)

.5 Density 48kg/m3 (3 PCF),

.6 Minimum RSI 0.76/25mm (R 4.3/in)

.7 Insertion loss:

Thickness		**Frequency (Hz.)**						
mm	inches	125	250	500	1000	2000	4000	NRC
25	1	0.13	0.24	0.56	0.83	0.92	0.98	0.65
40	1.5	0.19	0.41	0.89	1.02	1.03	1.04	0.85
50	2	0.33	0.67	1.07	1.07	1.03	1.06	0.95

.4 Internal flexible duct liner:

.1 Flexible glass mineral wool blanket, for low and medium temperature acoustical applications.

.2 Complying with CGSB 51-GP-52MA, ASTM C1071 and ASTM C553

.3 Airstream surface faced with a black mat bonded to the glass mineral wool substrate.

.4 Air velocity rating 25.4 m/s (5,000 ft/min)

.5 Density 24kg/m3 (1.5 PCF)

.6 Minimum RSI 0.74/25mm (R 4.2/in)

.7 Insertion loss:

Thickness		**Frequency (Hz.)**						
mm	inches	125	250	500	1000	2000	4000	NRC
25	1	0.18	0.36	0.59	0.86	0.95	0.9	0.7
40	1.5	0.35	0.51	0.83	0.93	0.97	0.96	0.8
50	2	0.34	0.64	0.96	1.03	1	1.03	0.9

.5 Internal fibre free elastomeric duct liner:

.1 Service temperature -40°C to 93°C (-40°F to 200°F)

.2 Flexible, closed-cell elastomeric insulation in sheet form, for low and medium temperature acoustical applications.

.3 Complying with ASTM C534, NFPA 90A and 90B.

.4 Insulation materials shall be manufactured without the use of CFC's, HFC's, HCFC's PBDE or formaldehyde.

.5 Insulation materials shall be low VOCs, fibre free, dust free and resist mold and mildew, be ultra violet and weather resistant.

.6 Factory applied pressure sensitive adhesive or field applied adhesive.

.7 Air velocity rating 20.3 m/s (4,000 ft/min)

.8 Density 48kg/m3 (3 PCF)

.9 Minimum RSI 0.74/25mm (R 4.2/in)

.10 Insertion loss:

Thickness		**Frequency (Hz.)**						
mm	inches	125	250	500	1000	2000	4000	NRC
25	1	0.06	0.17	1.06	0.32	0.67	0.54	0.55
40	1.5	0.15	0.51	0.69	0.46	0.53	0.43	0.55
50	2	0.23	0.84	0.32	0.6	0.39	0.31	0.55

2.4 Fastenings, Adhesives and Coatings

.1 Insulation Fastenings:

.1 1.6 mm (16 ga) galvanized wire or 1.6 mm thick copper wire.

.2 Mechanical fasteners, welded fasteners or adhesive fasteners to meet SMACNA HVAC Duct Construction Standard for mechanical fasteners.

.2 Corner Beads: Galvanized steel or aluminum 38 mm x 38 mm x 0.37 mm thick.

.3 Jacket Fastenings:

.1 Thermocanvas and All Service Jacket: Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.

.2 Metal Jackets: Sheet metal screws, pop rivets.

.4 Adhesives:

.1 Fabric adhesive to insulation covering, water based, ultra white, washable, anti-microbial.

.2 Internal elastomeric insulation adhesive shall be as per manufacturer's recommendations.

.5 Coatings: Vapour barrier coating on reinforcing membrane.

2.5 Finish Jackets

.1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.

.2 Aluminum Jacket: 51 mil (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.

.3 Bitumen Membrane: 55 mil composite membrane consisting of a multiply embossed UV-resistant aluminum foil/polymer laminate over a layer of rubberized asphalt specially formulated for use on insulated duct and piping applications.

3. EXECUTION

3.1 General

.1 Supply and return ductwork exposed in the space being served does not require insulation.

.2 Installation shall be to Thermal Insulation Association of Canada (TIAC): National Insulation Standards and the following:

3.2 Rigid Insulation External Application

.1 Hot Duct and Plenum 20° to 65°C (CER/1)

.1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers, each direction.

.2 Provide insulation without integral vapor retarder with horizontal surfaces overlapping vertical surfaces and edges tightly butted together. Secure insulation by impaling on mechanical fasteners.

.3 In areas of limited space wire fastenings, insulation adhesive or other suitable methods of attachment may be substituted.

.2 Cold or Dual Temp Duct and Plenum, 65°C and below (CER/2)

.1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers, each direction.

.2 Install vapor retarder toward the ambient atmosphere with horizontal surfaces overlapping vertical surfaces tightly butted together. Secure insulation by impaling on mechanical fasteners.

.3 Where mechanical fasteners penetrate vapor retarder, and at all corners and joints, apply self adhesive vapor retarder tape or vapor retarder strips adhered with vapor retarder adhesive. Where raised seams are encountered, add a strip of insulation above seam termination on each side of the seam, secure to the seams an overlapping strip of insulating material of equal thickness to the one required to provide a continuous vapor retarder. Seal all joints and edges with self adhesive vapor retarder tape.

.4 In areas of limited space wire fastenings, insulation adhesive or other suitable methods of attachment may be substituted.

.3 Outside Air Duct and Plenum - -40°C to Ambient (CER/3)

.1 As per CER/2 application but firstly apply a layer of rigid insulation without vapor retarder before applying layer of rigid insulation with vapor retarder. All joints shall be staggered.

3.3 Flexible Insulation External Application

.1 Hot Duct and Plenum - 20°C to 65°C (CEF/1)

.1 On rectangular ducts ≥ 600mm in width, apply mechanical fasteners to the bottom surface at approximately 300 mm centres.

.2 Apply insulation without integral vapour retarder with 50 mm overlap at each joint. Secure insulation with wire fastening on approximately 300 mm centres, or by stapling laps.

.2 Cold or Dual Temp Duct and Plenum – sub-ambient to 65°C (CEF/2)

.1 On rectangular ducts ≥ 600 mm in width, apply to bottom surface mechanical fasteners at approximately 300 mm centers.

.2 Apply insulation with vapor retarder to the outside.

.3 Where mechanical fasteners or staples penetrate the vapor retarder and at all joints apply vapor retarder tape or vapor retarder strips adhered with vapor retarder adhesive.

.4 All joints shall be overlapped a minimum of 50 mm and stapled on approximately 100 mm centers.

.5 Secure insulation with wire fastening on approximately 300 mm centers.

3.4 Liner Internal Application

.1 General

.1 Where an interior duct liner is used, external insulation shall not be applied unless noted otherwise.

.2 Where an interior duct liner is used the thickness shall be selected to match the RSI value specified for external insulation. Where no external insulation is required internal acoustic duct liner shall be a minimum 25mm (1”).

.2 Rigid Duct Liner (CIR/1)

.1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers each direction.

.2 Apply insulation with surfaces overlapping vertical surfaces and with edges tightly butted together.

.3 Insulation shall be applied to the ductwork with a minimum 90% coverage of adhesive and mechanical fasteners.

.4 Where mechanical fasteners penetrate factory finish and at all joints, apply a heavy layer of seal coating.

.5 On high velocity duct systems 20 m/s to 30 m/s (4000 fpm -6000 fpm) apply reinforcing membrane over the entire insulation joint surface.

.6 Seal off leading edge of insulation to duct surface on low velocity ductwork with reinforced seal coating or metal nosing. On high velocity duct systems (over 20 m/s (4000 fpm) use metal nosing.

.3 Flexible Duct Liner (CIF/1)

.1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers each direction.

.2 Apply insulation with edges tightly butted together.

.3 Insulation shall be applied to the ductwork with a minimum 90% coverage of adhesive and mechanical fasteners.

.4 Where mechanical fasteners penetrate factory finish and at all joints, apply a heavy layer of seal coating.

.5 On high velocity duct systems 20 m/s to 30 m/s (4000 fpm -6000 fpm) apply reinforcing membrane over the entire insulation joint surface.

.6 Seal off leading edge of insulation to duct surface on low velocity ductwork with reinforced seal coating or metal nosing. On high velocity duct systems (over 20 m/s (4000 fpm) use metal nosing.

.4 Elastomeric Duct Liner

.1 Install in accordance with TIAC National Standards and / or British Columbia Insulation Contractors Association (BCICA) Quality Standards Manual for Mechanical Insulation.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Work shall be performed at the temperatures recommended by the product manufacturer.

.4 The skin side (smooth side) shall be exposed to the airstream.

.5 Butt-edge seams using manufacturer's adhesive by compression fit method to allow for expansion/contraction. Leave a ½" wide uncoated border at the butt-edge seams on the duct surface and the insulation surface. Overlap the insulation ¼" at the butt-edges and compress the edges into place. Apply adhesive.

.6 Allow minimum 48 hours for full adhesive cure before operating air system.

.7 Maintain uninterrupted continuity and integrity of insulation.

3.5 Finishes

.1 General

.1 Insulation on concealed ductwork shall be left with factory finish. No further finish is required.

.2 The following finishes apply to exposed ductwork and plenums only.

.2 Canvas Jacket – Indoor (CRF/1) (CRD/1)

.1 Use over rigid insulation for rectangular ductwork and flexible insulation for round ductwork, all with an integral vapor retarder. Apply continuous metal corner bead to all corners. Adhere vapor retarder tape over all joints and breaks in vapor retarder, and at all corners.

.2 Secure canvas jacket over insulation using fire resistive lagging coating and adhesive, and finish with one (1) coat of dire resistive lagging coating adhesive.

.3 Utility Finish – Indoor (CRF/2) (CRD/2)

.1 Use over rigid insulation for rectangular ductwork and flexible insulation for round ductwork, all with an integral vapor retarder. Apply continuous metal corner bead to all corners. Adhere vapor retarder tape over all joints and breaks in vapor retarder, and at all corners.

.4 Aluminum Jacket – Outdoor (CRF/3) (CRD/3)

.1 Adhere vapour retarder tape over all joints and breaks in vapor retarder and at all corners on cold or dual temp ductwork.

.2 Apply over the insulation surface a stucco embossed aluminum jacket secured with pop rivets or stainless s steel self tapping screws. All joints sealed or flashed to prevent water infiltration.

.5 Bitumen Membrane – Outdoor (CRF/5) (CRD/4)

.1 Install a modified bitumen membrane on rectangular ductwork and an aluminized modified bitumen membrane on round ductwork.

.2 Install in accordance to manufacturer's instructions.

3.6 Duct Insulation Minimum Thickness Table (ASHRAE 90.1 Zone 5, 6, 7)

Duty	Plenum(4)	Duct Location		
		Interior		Exterior
		Conditioned Space	Unconditioned Space	
	Insulation R-Value RSI (R)			
Cooling Air Supply	0.7 (4.2)	0.7 (4.2)	0.7 (4.2)	1.5 (8.5)
Heating Air Supply	1 (5.6)	1 (5.6)	1 (5.6)	1.5 (8.5)
Combined H/C Supply	1 (5.6)	1 (5.6)	1 (5.6)	1.5 (8.5)
Outdoor Air Supply	1 (5.6)	1 (5.6)	1 (5.6)	0
Return Air	0.7 (4.2)	0	0.7 (4.2)	1.5 (8.5)
Exhaust Air (1)(2)	0.7 (4.2)	0	0.7 (4.2)	0.7 (4.2)
Tempered Air	0.7 (4.2)	0.7 (4.2)	0.7 (4.2)	1.5 (8.5)
See note (3) for internal duct liner				
See note (6) for factory installed duct and plenums				

Note 1: Air temperatures 15°C to 49°C (60°F to 120°F)

Note 2: Provide RSI 0.58 (R3.3) insulation on all exhaust air ductwork from outside wall or roof to damper but a minimum of 1.5 m (5 ft.) inside building.

Note 3: Where an interior duct liner is used the thickness shall be selected to match the RSI value specified for external insulation. Internal acoustic duct liner shall be a minimum 25mm (1") where external insulation is not required.

Note 4: Plenums located outside the building shall be insulated to the values listed in the exterior column.

Note (6): Factory installed ductwork and plenums provided with equipment need not comply with this table provided they meet the minimum energy efficiency requirements listed in ASHRAE 90.1 tables 6.8.1A through 6.8.1K.

3.7 Duct Finishes Table

.1 Conform to the following:

Duty	Rectangular Duct		Round Duct	
	Type	TIAC Code	Type	TIAC Code
Indoor Concealed	None	None	None	None
Indoor Exposed in Mechanical Room & Elsewhere Except Utility Areas	Canvas Jacket	CRF/1	Canvas Jacket	CRD/1
Indoor Exposed in Utility Areas, Parkade, Etc.	Utility Finish	CRF/2	Utility Finish	CRD/2
Outdoor Exposed to Precipitation	Aluminum Jacket	CRF/3	Aluminum Jacket	CRD/3
Outdoor Elsewhere	Bitumen Membrane	CRF/5	Bitumen Membrane	CRD/4

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 Thermal insulation and jacketing for HVAC piping and HVAC piping accessories.

1.2 Related Requirements

.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 Section 21 05 01 – Common Work Results for Mechanical

1.3 References

.1 The latest revisions of the following standards shall apply unless noted otherwise.

.2 British Columbia Building Code or National Building Code, whichever is more stringent.

.3 ASHRAE 90.1 – 2010 Energy Standard for Buildings Except Low Rise Residential Buildings.

.4 Thermal Insulation Association of Canada (TIAC) – National Insulation Standards

.5 CAN/ULC S102-M88 – Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

.6 ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.7 ASTM C547 – Standard Specification for Mineral Fibre Pipe Insulation.

.8 Declare – Living Building Challenge (LBC), Red List

1.4 Submittals

.1 Comply with Division 1 – Submission and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:

.1 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Manufacturer's installation instructions.

.3 Manufacturer’s declaration that products are either Declare – Living Building Challenge (LBC), Red List free or LBC compliant.

1.5 General Requirements

.1 The Installation firm shall be a current member of the Thermal Insulation Association of Canada (TIAC).

.2 Only Journeyman insulation applicators, with 3 years minimum successful experience in this size and type of project, shall perform the work.

.3 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.

.3 “K” value means Thermal Conductivity

.4 UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and World Health Organization (WHO).

.5 ASJ: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper

.6 SSL: Self-Sealing Lap.

.7 FSK: Foil Scrim Kraft; jacketing.

.8 PSK: Poly Scrim Kraft; jacketing.

.9 PVC: PolyVinyl Chloride.

.4 Provide thermal insulation on all HVAC piping, valves and fittings and as follows:

.1 Condensate piping.

.2 Condenser water piping, outside building.

.1 Cooling tower sump, spray water, drain, overflow and chemical feed piping, outside 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 2½ NPS

.3 Flanges.

.4 Strainers.

.5 DO NOT insulate the following, unless noted otherwise:

.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 150mm (6") below floor slab up to heating element.

.5 Flexible interconnections between ceiling radiant heating panels.

.6 Condenser water piping inside building.

.6 Where insulation is not specified, coat exposed hot pumps, pipe and fittings, operating at or above 60°C (140°F) with a Therma-Lite liquid insulation product to prevent skin burns. This includes:

.1 Valves, 2½ NPS and smaller.

.2 Valve bonnets.

.3 Unions.

.4 Drip legs.

.5 Flexible connections.

.6 Expansion joints.

.7 Check valve covers.

.7 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.

.8 DO NOT insulate the following, unless otherwise noted:

.1 Drain lines for sumps 15°C (60°F) and over.

.9 If the Contractor, during renovations, should discover asbestos (or material suspected to be asbestos) on piping, ductwork, etc., he shall immediately cease all work in that area and contact Owner's representative.

.10 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.

.2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 List of acceptable Manufacturers:

.1 Knauf Insulation

.2 Manson Insulation Inc.

.3 Owens Corning Canada Inc.

.4 Roxul Inc.

.5 Johns Manville

.6 Armstrong World Industries

.7 Halstead Corp.

.8 Industrial Insulation Group IIG-LLC

2.2 General

.1 Products shall not contain asbestos, lead, mercury, mercury compounds or Polybrominated diphenyl ethers (PBDE).

.1 Mineral fibre specified includes glass fibre and rock wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values when tested in accordance with ASTM C547

.3 Insulation and jacketing materials shall not exceed 25 flame spread, 50 smoke developed rating when tested in accordance with CAN/ULC S102-M88 and NFPA 90A

.4 Foam insulation products shall not use CFC or HCFC blowing agents in the manufacturing process and be formaldehyde free.

.5 Glass mineral wool products shall have a recycled content of a minimum of 50 percent recycled glass content.

.6 Low Emitting Materials: For all thermal and acoustical applications of glass mineral wool insulation, insulation shall be UL GREENGUARD Certified.

.7 Products shall be either Declare LBC Red List free or LBC compliant.

2.3 Preformed Pipe Covering

.1 Low Temperature Thermal Insulation

.1 Piping service temperature -40°C to 5°C (-40°F to 41°F)

.2 Complying with ASTM C534

.3 Preformed and pre-slit flexible foamed elastomeric insulation with self-adhesive self seal or lap seal joints:

.1 Maximum “K” value at 24°C (75°F) = 0.039 W/m.°C (0.27 Btu.in/hr.ft^2.°F)

.4 Preformed flexible closed cell insulation:

.1 Maximum “K” value at 24°C (75°F) = 0.036 W/m.°C (0.24 Btu.in/hr.ft^2.°F)

.5 Phenolic closed cell preformed rigid insulation with all service jacket vapour retarder (ASJ). ASJ shall be re-enforced with glass fibre, factory applied with pressure sensitive lap closure.

.1 Maximum “K” value at 24°C (75°F) = 0.019 W/m.°C (0.13 Btu.in/hr.ft^2.°F)

.2 Low to Intermediate Temperature Thermal Insulation

.1 Piping service temperature 5°C to 315°C (41°F to 599°F)

.2 Preformed insulation, mineral glass wool pipe insulation with all service jacket vapour retarder (ASJ). ASJ shall be re-enforced with glass fibre, factory applied with pressure sensitive lap closure.

.3 Complying with ASTM C547.

.4 ASJ vapour transmission rate 0.02 perms maximum

.5 Maximum “K” value at 38°C (100°F) = 0.035 W/m.°C (0.24 Btu.in/hr.ft^2.°F)

2.4 Fastenings, Adhesives and Coatings

.1 Insulation Fastenings: 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 Jacket:

.1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.

.2 Metal Jackets:

.1 Sheet metal screws, pop rivets, stainless steel bands.

.3 PVC Jacket and Fitting Covers:

.1 PVC self-adhesive tape, plastic pop rivets, bonding cement.

.3 Adhesives:

.1 Fabric adhesive to insulation pipe covering, water based, ultra white, washable, anti-microbial

.4 Coatings:

.1 Vapour barrier coating on reinforcing membrane or on insulating cement:

2.5 Finish Jackets

.1 Jackets:

.1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.

.2 PVC Finishing Jacket: white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50 mm (0.02”) thick.

.3 Aluminum Jacket: 0.51 mm (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.

.2 Preformed Fitting Covers:

.1 PVC Fitting Covers pre-moulded one piece covers, white, UV resistant, for indoor or outdoor applications, 25/50 fire class, minimum 0.50 mm (0.02”) thick.

.2 Aluminum Fitting Covers: Die shaped components with factory applied protective liner on interior surface, 0.51 mm (22 ga.) thick,

3. EXECUTION

3.1 General

.1 Install in accordance with Thermal Insulation Association of Canada (TIAC) National Standards.

.2 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

.3 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified prior to insulation installation.

.4 Use two layers of preformed insulation with staggered joints when the required nominal wall thickness exceeds 75 mm.

.5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.6 Install hangers, supports outside vapour retarder jacket.

.7 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

.8 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.9 Insulate piping, fittings and valves. Do not insulate unions, flanges (except on flanged valves), “victaulic” couplings, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.10 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.11 Terminate insulation 75 mm (3") back from all uninsulated fittings to provide working clearance. Terminate insulation at 90°, finish with reinforced scrim cloth and vapour barrier mastic system or use vapour barrier mastic and pre-formed fitting cover over.

.12 On vertical pipes over 3 NPS provide insulation supports welded or bolted to pipe, directly above the lowest pipe fitting. Provide supports on 4.5 m (15’) centres.

.13 Do not insulate exposed run-outs to heating fixtures, valves, fittings etc. Runouts to individual terminal units shall not exceed 3700mm (12’) in length.

.14 All piping forming part of the HVAC system 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 (121psig) and greater.

.15 Where insulation is not specified:

.1 Hot Piping: Coat exposed hot pumps, pipe and fittings with Therma-Lite liquid insulation product to prevent skin burns

.2 Cold Piping: Coat exposed cold pumps, pipes, and fittings, connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc. with a No Sweat paint product to prevent condensation.

3.2 Installation Cold Water Application - (5°C to 15°C) TIAC 1501-C

.1 Piping: Apply pipe insulation with integral vapor retarder jacket to piping and hold in place by securing the jacket flap. Seal all flaps and butt strips with vapor retarder adhesive. Pipe insulation with integral self-sealing vapor retarder jacket will not require additional fastening.

.2 Screwed or welded fittings: Insulate fittings with section of the pipe insulation mitered to fit tightly. All seams shall be sealed using vapor retarder tape.

.3 Valves, Strainers: Insulate valve bodies, bonnets and strainers with fitted pipe insulation or mitered blocks all to thickness of adjacent pipe insulation, then seal all seams of vapor retarder with vapor retarder tape.

.4 Flanged and grooved fittings: Insulate with oversized pipe insulation or mitered blocks to the thickness of the adjacent pipe insulation, then seal all seams of vapor retarder jacket with vapor retarder tape.

3.3 Installation Hot Application - Intermediate Temperature (15°C - 315°C) TIAC 1501-H

.1 Piping: Pipe covering without integral jacket shall be held in place with insulation fastening at not less than 300 mm centres. Pipe insulation with integral jacket shall be held in place by stapling the flap on 75 mm centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.

.2 Screwed or welded fittings: Insulate fittings with sections of the pipe insulation mitered to fit tightly, or with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Alternately, insulate fittings with tightly placed flexible insulation and apply PVC fitting covers.

.3 Valves, Strainers: Insulate valve bodies and strainers with fitted pipe insulation segments, or mitered blocks all to thickness of the adjacent pipe insulation. Drains, blow off plugs and caps shall be left uncovered. Alternately, insulate with tightly placed flexible insulation and apply PVC fitting covers.

.4 Flanged and grooved fittings: Insulate with oversized pipe covering or mitered blocks to the thickness of the adjacent pipe covering. Alternately, insulate with tightly placed flexible insulation and apply PVC fitting covers.

.5 Insulation Termination Points: Terminate insulation 75mm from fittings to provide working clearance and bevel insulation at 45° angle.

3.4 Finishes

.1 Concealed piping shall be left as factory finished, TIAC standard CPF/2.

.1 Exposed Piping Indoor (Canvas) CPF/1:

.2 The factory applied integral all service jacket shall be neatly applied to receive the fabric jacket. Apply a jacket with a fire resistive lagging coating. Apply a finishing coat of fire resistive lagging coating

.2 Exposed Piping Indoor (PVC Jacket) CPF/4:

.1 Apply PVC jacketing using necessary fastenings on approximately 300mm centers, or bond using an adhesive recommended by the manufacturer to provide continuous seal. Overlap each section a minimum 75mm (3”). Cover longitudinal and circumferential joints with finishing tape neatly applied. On hot piping tacks may be used to secure jacket laps. Tacks are to be applied on 100mm (4”) centres.

.2 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply PVC jacket or preformed PVC fitting covers to provide a complete jacket system. Secure with appropriate fastenings and jacket finishing tape.

.3 Exposed Piping Outdoor (Metal Jacket) CPF/3

.1 Apply a coat (minimum 1 litre per 1.5 m) of weather coating over the insulated surfaces. While still wet, embed a layer of reinforcing membrane and finish with a final coat (minimum 1 liter per 1.5 m) of weather coating.

.2 Apply metal jacketing with a 60mm overlap at 3 o’clock using necessary fastenings on approximately 150mm centers.

.3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fitting covers to provide a complete jacket system. Secure with necessary fastenings.

3.5 Application Design Operating Temperatures

.1	Condenser Water (Interior)	Insulation Not Required
.2	Condenser Water (Exterior) Condenser Water (Exterior)	32°C Use 41°C (106°F)
.3	Cooling Tower Sump Spray Piping, Drain and Overflow	32°C Use 41°C (106°F)
.4	Chemical Feed (Exterior)	32°C Use 41°C (106°F)

3.6 Piping Insulation Minimum Thickness Schedule

Type Of System	Design Operating Temperature Range °C (°F)	Thermal Conductivity of Insulation		Nominal Pipe Diameter NPS				
		Conductivity Range W/m.°C	Mean Rating Temperature °C (°F)	Runouts ≤ 1	1 to 1.25	1.5 to 3	4 to 6	≥ 8
				Minimum Thickness of Piping Insulation (mm)				
Heating Systems (Steam, Condensate, and Hot Water)	>177 (350)	0.046-0.049	121 (250)	115	125	125	125	125
	122-177 (251-350)	0.042-0.046	93 (199)	75	100	115	115	115
	94-121 (201-250)	0.039-0.043	65 (149)	65	65	75	75	75
	61-93 (142-200)	0.036-0.042	52 (126)	40	40	50	50	50
	41-60 (106-141)	0.032-0.040	38 (100)	25	25	40	40	40
Cooling Systems (Chilled Water, Refrigeration)	5-13 (41-55)	0.033-0.039	24 (75)	25	25	25	25	25
	<5 (41)	0.029-0.037	10 (50)	25	25	25	25	40

Note: Where the thermal conductivity of a proposed insulation is greater than the range specified above, the thickness will be increased by the ratio of *U2/U1*.

U2 = proposed insulation “k” value at the table mean rating temperature.

U1 = upper range limit “k” value from the table above.

3.7 Piping Finish Schedule

.1 Conform to the following:

Duty	Type	TIAC Code
Indoors, Concealed	Factory	CPF/2
Indoors, Exposed in Mechanical Room and Elsewhere	Canvas Jacket	CPF/1
Indoors, Exposed in Utility Areas, Parkade, etc.	PVC Jacket	CPF/4
Outdoors	Metal Jacket	CPF/3

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.

.2 Related Sections:

.1 Section 21 – Fire Suppression.

.2 Section 22 – Plumbing.

.3 Section 23 – Heating Ventilation & Air Conditioning.

.4 Division 1 Commissioning requirements

.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 (also referred to as the Direct Digital Control, or DDC system).

.5 O&M - Operation and Maintenance.

.6 PI - Product Information.

.7 PV - Performance Verification.

.8 TAB - Testing, Adjusting and Balancing.

.4 A Commissioning Authority will be retained directly by the Owner to oversee commissioning, schedule, and work. This section is included for reference. The contractor will assist and participate in the Commissioning process fully to ensure all systems function according to the plans and specifications. The contractor shall provide demonstration of the mechanical systems.

.5 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.

.6 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

.7 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.2 Commissioning Overview

.1 Cx to be a line item of the mechanical Contractor's cost breakdown.

.2 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.3 Cx is conducted in concert with activities performed 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 include transfer of critical knowledge to facility operational personnel.

.4 The Commissioning Authority 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.

.5 Commission the following mechanical systems:

.1 Rooftop units

.2 Air Curtains

.3 Fans

.4 DX air conditioning units

1.3 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 the 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 Contractor. Above costs to be in form of progress payment reductions or holdback assessments.

1.4 PRE-CX Review

.1 During Construction:

.1 Co-ordinate provision, location and installation of provisions for Cx.

.2 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 Verify completion of TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.

.10 Ensure "As-Built" system schematics are available.

.3 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.5 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.

1.6 Submittals

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit at least 8 weeks prior to start of Cx.:

.1 Name of Contractor's Cx agent.

.2 Draft Cx documentation.

.3 Preliminary Cx schedule.

1.7 Commissioning Documentation

.1 Provide completed and approved Cx documentation to Commissioning Authority including Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI): Performance Verification (PV) Forms for requirements and instructions for use. The Commissioning Authority will provide initial standard forms for the contractor to use as a guide. Coordinate all forms with CFMS.

1.8 Commissioning Schedule

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 00 - Construction Progress Documentation

.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.

1.9 Commissioning Meetings

.1 Convene Cx meetings following project meetings: Section 01 31 19 – Project Meetings

.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. Cx 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 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 Cx 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.

1.10 Starting and Testing

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

1.11 Witnessing of Starting and Testing

.1 Provide 14 days notice prior to commencement.

.2 Departmental Representative or owners representative to witness of start-up and testing.

.3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.12 Manufacturer's Involvement

.1 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.

.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.

.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.2 Integrity of warranties:

.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.

.2 Verify with manufacturer that testing as specified will not void warranties.

.3 Qualifications of manufacturer's personnel:

.1 Experienced 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.

1.13 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 or owner's representative 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 Departmental Representative or owner's representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.

.3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.

.1 Rejected equipment to be removed from site and replaced with new.

.2 Subject new equipment/systems to specified start-up procedures.

1.14 Start-Up Documentation

.1 Assemble start-up documentation and submit to Departmental Representative or owner's representative for approval before commencement of commissioning.

.2 Start-up documentation to include:

.1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.

.3 Signed installation/start-up check lists.

.4 Start-up reports,

.5 Step-by-step description of complete start-up procedures, to permit owner's maintenance staff to repeat start-up at any time.

1.15 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 Departmental Representative or owner's 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 interim acceptance.

1.16 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.

1.17 Start of Commissioning

.1 Notify Departmental Representative or owner's representative at least 14 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.18 Instruments / Equipment

.1 Submit to Departmental Representative or owner's representative for review and approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Ladders.

.3 Equipment as required to complete work.

1.19 Commissioning Performance Verification

.1 Carry out Cx:

.1 Under accepted simulated operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

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

1.20 Witnessing Commissioning

.1 Departmental Representative or owner's representative to witness activities and verify results.

1.21 Authorities Having Jurisdiction

.1 Where specified 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.

1.22 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.

1.23 Extent of Verification

.1 Review and repeat commissioning of systems if inconsistencies found in more than 10% of reported results.

.2 Perform additional commissioning until results are acceptable to Departmental Representative.

1.24 Repeat Verifications

.1 Assume costs incurred by owner for third and subsequent verifications where:

.1 Verification of reported results fail to receive Departmental Representative's approval.

.2 Repetition of second verification again fails to receive approval.

1.25 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.

1.26 Deficiencies, Faults, Defects

.1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative or owner's representative.

.2 Report problems, faults or defects affecting Cx to Departmental Representative or owner's representative in writing. Stop Cx until problems are rectified.

1.27 Completion of Commissioning

.1 Upon completion of Cx leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Certificate of Completion.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative or owner's representative.

1.28 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.

1.29 Maintenance Materials, Spare Parts, Special Tools

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

1.30 Occupancy

.1 Cooperate fully with Departmental Representative or owner's representative during stages of acceptance and occupancy of facility.

1.31 Performance Verification Tolerances

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- [2] % of recorded values.

1.32 Owner's Performance Testing

.1 Performance testing of equipment or system by Departmental Representative or owner's representative will not relieve Contractor from compliance with specified start-up and testing procedures.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202, 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 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.

1.4 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 60 00 – Material and Equipment.

.2 Waste Management and Disposal:

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

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.

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 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.

.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 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 hours 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 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 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation for piping, valves and fittings for gas fired equipment.

.2 Utility service connection with new gas meter, seismic shutoff valve, and regulators.

.2 Related Sections:

.1 Section 23 05 01 – Pipe Installation.

.2 Section 23 08 05 - Performance Verification of Mechanical Piping Systems.

.3 Section 23 08 06 - Cleaning and Start-Up of Mechanical Piping Systems.

1.2 References

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5, Pipe Flanges and Flanged Fittings.

.2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM B75M, Standard Specification for Seamless Copper Tube Metric.

.4 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

.3 Canadian Standards Association (CSA International)

.1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

.1 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.

.2 CAN/CSA B149.2, Propane Storage and Handling Code.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 Submittals

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

.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.

2. PRODUCTS

2.1 Pipe

.1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

.1 NPS 1/2 to 2, screwed.

.2 NPS2 1/2 and over, plain end.

.2 Copper tube: to ASTM B837.

2.2 Jointing Material

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: non-metallic flat.

.4 Brazing: to ASTM B837.

2.3 Fittings

.1 Steel pipe fittings, screwed, flanged or welded:

.1 Malleable iron: screwed, banded, Class 150.

.2 Steel pipe flanges and flanged fittings: to ASME B16.5.

.3 Welding: butt-welding fittings.

.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.

.5 Bolts and nuts: to ASME B18.2.1.

.6 Nipples: schedule 40, to ASTM A53/A53M.

.2 Copper pipe fittings, screwed, flanged or soldered:

.1 Cast copper fittings: to ASME B16.18.

.2 Wrought copper fittings: to ASME B16.22.

2.4 Valves

.1 Provincial Code approved, lubricated plug or ball type.

.2 Seismic Gas Shut Off Valve:

.1 Up to 50 mm: Koso series 310 high pressure screwed body.

.2 65 mm and larger: Koso series 314 high pressure flanged body.

.3 138 kPa maximum gas pressure.

.4 Visual open-close indicator with manual reset.

.3 Polyethylene coated steel piping manufactured to CSA Z245.1M. High density polyethylene coating shall be to following schedule:

.4 Jointing Methods:

.1 Threaded Fittings to ANSI Standard B16.3:

.1 For above ground use, Schedule 80 pipe.

.2 Threaded joints not allowed underground.

.2 Forged Steel Socket Weld ANSI Standard B16.11.

.3 Wrought Steel Butt Welding fitting CSA Z245.10.

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 Piping

.1 Install in accordance with Section 23 05 01 – Pipe Installation, applicable Provincial/Territorial Codes, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

.2 Install drip points:

.1 At low points in piping system.

.2 At connections to equipment.

3.3 Pipe Installation

.1 Lay pipe to specified alignment, to within tolerance of 200 mm. Survey all routes and show measurements on as-built drawings complete with benchmarked dimensions.

.2 Lay copper pipe on 50 mm cushion of compacted clay fill or on flat, undisturbed trench bottom. Backfill around sides and to top of pipe with clay fill thoroughly tamped in place.

.3 Lower steel pipe carefully into trench to prevent damage to coating.

.4 Provide recesses on trench bottom for couplings, fittings and valves to ensure bearing will occur along barrel of pipe.

.5 Prevent dirt from entering exposed ends of pipe.

.6 In roads, streets, driveways, and parking areas, provide pipe sleeve of diameter 50 mm greater than gas pipe diameter.

.7 Lay service line pipe on proper grade to drain from building to gas main.

.8 Lay gas pipe on properly graded trench bottom to prevent sags and low points in piping.

.9 For steel pipe, wrap couplings and fittings with polyethylene tape and heat shrink over pipe.

.10 Whenever pipe is to be deflected vertically or horizontally, do not exceed amount of deflection recommended by manufacturer in order to maintain satisfactory piping.

.11 Ensure minimum clearance of 1000 mm between gas pipe and any underground structure that runs parallel to gas pipe.

.12 Ensure minimum clearance of 100 mm between gas pipe and any underground structure that crosses gas pipe.

.13 The contractor shall also install all required system and appliance gas regulators. Gas regulators shall be installed per code requirements on all appliances, and all regulators shall be vented (via closed piping systems) to exterior atmosphere when required at approved locations. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. This vent piping is to be designed and installed by the contractor as required by code. Vent piping is to be field routed as it is not specifically indicated on plans.

3.4 Valves

.1 Install valves with stems upright or horizontal.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.5 Field Quality Control

.1 Site Tests/Inspection: Test system in accordance with CAN/CSA B149.1 & CAN/CSA B149.2 and requirements of authorities having jurisdiction.

.2 Performance Verification: Refer to Section 23 08 05 - Performance Verification of Mechanical Piping Systems.

3.6 Adjusting

.1 Purging: purge after pressure test in accordance with CAN/CSA B149.1 or CAN/CSA B149.2.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.7 Cleaning

.1 Cleaning: in accordance with Section 23 08 06 - Cleaning and Start-Up of Mechanical Piping Systems.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.8 Seismic Gas Shut Off

.1 Install seismic gas shut off in lockable enclosure on outside of building. Enclosure to be expanded steel, labeled.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

.2 Sustainable requirements for construction and verification.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 29 - Health and Safety Requirements].

.3 Section 01 74 19 - Construction Waste Management and Disposal.

.4 Section 07 84 00 - Firestopping.

.5 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.6 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

1.2 References

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA), c. 33.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).

.1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.

.2 SMACNA HVAC Air Duct Leakage Test Manual.

.3 IAQ Guideline for Occupied Buildings Under Construction.

.7 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA).

1.3 Quality Assurance

.1 Certification of Ratings:

.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.4 Delivery, Storage and Handling

.1 Protect on site stored or installed absorptive material from moisture damage.

.2 Store and manage hazardous materials in accordance with Section 01 60 00 – Material and Equipment.

.3 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 47 19 - Construction 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 Separate for reuse and recycling and place in designated containers Metal and 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 Regional and Municipal regulations.

.7 Fold up metal and plastic banding, flatten and place in designated area for recycling

2. PRODUCTS

2.1 Seal Classification

.1 Seal classification:

.1 Class C: transverse joints and connections made air tight with gaskets or sealant or combination thereof.

2.2 Sealant

.1 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 fiber-glass tape, 50 mm wide.

2.4 Fittings

.1 Fabrication: to SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition and Addendum No. 1.

.2 Radius elbows.

.1 Rectangular: standard radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.

.2 Round: smooth radius 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 radius on branch 1.5 times width of duct and 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 Dampers to be minimum 1.5m from diffuser locations

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Short radius elbows.

.7 Obstruction deflectors: maintain full cross-section area.

2.5 Fire Stopping

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 23 33 16 – Dampers: Fire & Smoke.

.2 Fire stopping material and installation must not distort duct.

2.6 Galvanized Steel

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA construction.

1.1 Aluminum (Aluminum To Be Used On R/A Ductwork For AHU-1 And AHU-2)

.1 To SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to SMACNA as indicated.

.3 Joints: to SMACNA.

2.7 Hangers and Supports

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.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 mm.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA per the 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	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp.

.3 For steel beams: manufactured beam clamps:

3. EXECUTION

3.1 General

.1 Do work SMACNA HVAC Duct Construction Standards.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct.

.3 Support risers SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 All Aquatic area duct hangers & supports shall be non-metallic or 2-part epoxy coated to protect from corrosion. DO NOT DRILL supports in q-deck without protecting the deck. Refer to details for installation.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 Hangers

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with ASHRAE as follows:

Duct Size (mm)	**Spacing (mm)**
to 1500	3000
1501 and over	2500

3.3 Watertight Duct

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Seal other joints with duct sealer.

3.4 Sealing and Taping

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.5 Leakage Tests

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two - 90 degrees elbows.

.6 Complete test before performance insulation or concealment Work.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

.2 Sustainable requirements for construction and verification.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 29 - Health and Safety Requirements.

.3 Section 01 45 00 - Quality Control.

.4 Section 01 74 19 - Construction Waste Management and Disposal.

.5 Section 01 70 00 - Closeout Submittals.

1.2 References

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, [95].

1.3 Submittals

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.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: manufacturer's field reports specified.

.7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 70 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 - Health and Safety Requirements.

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 19 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for reuse and recycling and place in designated containers Metal and Plastic waste in accordance with Waste Management Plan (WMP).

.5 Divert unused materials from landfill to recycling facility.

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 150 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/m^2.

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 Hold open devices.

2.4 Turning Vanes

.1 Factory or shop fabricated double thickness with 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.

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 data sheet.

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: 150 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.

.2 Access Doors and Viewing Panels:

.1 Size:

.1 300 x 300 mm for inspection & hand access.

.2 450 x 450 mm for servicing entry.

.3 As indicated.

.2 Locations:

.1 Fire and smoke dampers.

.2 Control dampers.

.3 Devices requiring maintenance.

.4 Required by code.

.5 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 Perform cleaning operations in accordance with manufacturer's recommendations.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 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.

1.4 Quality Assurance

.1 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - 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 60 00 – Material and Equipment.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 Approved Manufactures

.1 Tamco, Ruskin

2.2 General

.1 Manufacture to SMACNA standards.

2.3 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.

2.4 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, to a maximum height 100 mm.

.3 Inside and outside nylon end bearings.

.4 Channel frame of same material as adjacent duct, complete with angle stop.

2.5 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: 100 mm.

.4 Bearings: self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

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 where indicated and as outlined below.

.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.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 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 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 - Closeout Submittals.

1.4 Quality Assurance

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Certificates:

.1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

1.5 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 60 00 – Material and Equipment.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 Approved Manufactures

.1 Tamco, Ruskin

2.2 Multi-Leaf Dampers

.1 Opposed blade type as indicated.

.2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Performance:

.1 Leakage: in closed position less than 2% of rated air flow at 250 Pa differential across damper.

.2 Pressure drop: at full open position less than 5 Pa differential across damper at 2.5 m/s.

.6 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.3 Back Draft Dampers

.1 Automatic gravity operated, multi leaf, steel construction with nylon bearings, counterweighted.

2.4 Relief Dampers

.1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 5 Pa static pressure.

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 where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation of flexible ductwork, joints and accessories.

.2 Related Sections:

.1 Section 23 31 14 – Metal Ducts

1.2 Submittals

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

.2 Co-ordinate submittal requirements and provide submittals.

.3 Submit Indoor Air Quality (IAR) Management Plan.

.4 Product Data: submit WHMIS MSDS for the following:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

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 Non-Metallic - Insulated

.1 Type 4: non-collapsible, coated mineral base fabric 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.

3. EXECUTION

3.1 Duct Installation

.1 Install flexible ductwork where indicated on the drawings and as specified.

.2 Provide intermediate supports for flexible ducts so that sagging does not occur. Very sharp turns and reduction in the area of the duct will not be permitted.

.3 Connect to ductwork, diffusers, and terminal units with stainless steel worm drive clamps, adjustable clamps or duct straps applied over two wraps of duct tape.

.4 Provide separate cable support to all diffusers in suspended ceilings, secured back to structure.

.5 Do not use flexible ductwork in secure areas.

END OF SECTION

1. GENERAL

1.1 Section Includes

.1 Materials and installation for acoustic duct lining.

1.2 Related Sections

.1 Section 23 07 13 – Duct Insulation

1.3 References

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

.1 SMACNA IAQ Guideline for Occupied Buildings.

2. PRODUCTS

2.1 Duct Liner

.1 General:

.1 Mineral Fibre duct liner: air surface coated with 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.

.3 Fungi resistance: to ASTM C1338.

.2 Flexible:

.1 Use on surfaces indicated on drawings and as outlined below.

.2 25 mm thick, to ASTM C1071, Type 1, fibrous glass blanket duct liner.

.3 Density: 24 kg/m^3 minimum.

.4 Thermal resistance to be minimum 0.37 (m^2.degrees C)/W for 12 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on coated airside: 30.5 m/sec.

.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 °C to plus 93 °C.

.3 Water-based fire retardant type.

2.3 Fasteners

.1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Polymer for aquatic return duct and Metal retaining clips for all others, 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 90A and NFPA 90B.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 °C to plus 93 °C.

3. EXECUTION

3.1 General

.1 Line inside of ducts where indicated.

.2 Duct dimensions, as indicated, are clear inside duct lining.

.3 Provide a minimum of 3m acoustic downstream of exhaust fans.

3.2 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, impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.

3.3 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 two coats of sealer over tape.

.2 Replace damaged areas of liner.

.3 Protect leading edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Fans, motors, accessories and hardware for commercial use.

.2 Sustainable requirements for construction and verification.

1.2 References

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA Publication 99, Standards Handbook.

.2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 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 in force.

.2 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.4 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 Shop Drawings:

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

.3 Provide:

.1 Fan performance curves showing point of operation, BHP and efficiency.

.2 Sound rating data at point of operation.

.4 Indicate:

.1 Motors, sheaves, bearings, shaft details.

.2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.

.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.

.6 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 Quality Assurance

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety.

1.6 Maintenance

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.1 Spare parts to include:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

1.7 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

2. PRODUCTS

2.1 Fans General

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for Mechanical Equipment supplemented as specified herein.

.2 Sizes as indicated.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for Mechanical Equipment

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for Piping and Equipment.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 Cabinet Fans - General Purpose

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, V-belt drive and guard outside casing.

.3 Fabricate casing of aluminum reinforced and braced for rigidity. Provide removable panels for access to interior. Integral duct connection flanges, adjustable motor pulley, corrosion resistant fasteners, stainless steel shaft, aluminum rub ring, housing and motor cover for corrosive environments.

.4 Acceptable Manufacturer:

.1 Dehli

.2 Greenheck

.3 Nutone

.4 Broan

.5 Penn

2.3 Cabinet Fans - General Purpose

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators, motor, V-belt drive and guard outside casing.

.3 Fabricate casing of zinc coated or phosphate treated steel reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to CAN/CGSB 1.181. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation.

2.4 Ceiling Fans

.1 Manufacturer shall be Big Ass Fans, or approved equal.

.2 Fan assembly shall be ETA or CSA listed, and meet UL 507 and CSA 22.2.

.3 Sound level shall not exceed 55 dBA at full speed.

.4 The fan shall be equipped with extruded aluminum alloy airfoils. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.

.5 Fan shall be controlled by integral variable speed drive.

.6 Motor shall be AC induction type, inverter rated, totally enclosed, fan cooled (TEFC) with an IP42 NEMA classification. The motor shall be capable of continuous operation in -34C to 50C ambient conditions.

.7 The gearbox shall be hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, cast iron housing, double lip seals, precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit.

.8 The fan mounting system shall be designed for secure installation to the structural supports. The mounting yoke shall be 3/16” A36 steel, powder coated.

.9 Safety cables shall be provided to ensure fan stability.

.10 Digital wall controller shall be provided to control fan direction, operation, speed, and programming. Cable between controller and fan shall be provided.

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 Fan Installation

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration Isolation for Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

3.3 Anchor Bolts and Templates

.1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and use.

.2 Sustainable requirements for construction and verification.

1.2 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.

1.3 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.4 Project Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

.3 Review exterior wall details and structural requirements/drawings. Ensure exterior louvre installation is fully coordinated with all other building elements.

1.5 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 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1.6 Quality Assurance

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 23 - Health and Safety.

1.7 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

1.8 Maintenance

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

2. PRODUCTS

2.1 Approved Manufactures

.1 Refer to Section 23 05 00.

2.2 General

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide supply outlets with sponge rubber seal around the edge.

.3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.4 Provide plaster frame for diffusers located in plaster surfaces.

.5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

.6 Provide 30 mm margin frame with concealed fastening.

.7 Fabricate of heavy aluminum extrusions.

.8 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face.

.9 Finish in factory baked enamel finish color by Departmental Representative if indicated on schedule.

.10 Refer to Air Outlet Schedule on drawings for specifications of air outlets.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size outside air louvres as indicated on drawings.

.2 Size air outlets as indicated on drawings.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

.2 Exterior louvres mounted in exterior walls for ducted and non-ducted applications.

.2 Related Sections:

.1 Section 23 37 13 Diffusers, Registers and Grilles.

1.2 References

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

.1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.3 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.

1.4 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 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

1.5 Quality Assurance

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 23 - Health and Safety.

1.6 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - 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 and recycling in accordance with Section 01 74 19 - Construction Waste Management and Disposal.

2. PRODUCTS

2.1 Gravity Roof Outside Air Intakes and Relief Vents

.1 Factory manufactured galvanized steel.

.1 Complete with integral birdscreen of 2.7 mm diameter ss wire.

.2 Vertical backdraft dampers on four two faces.

2.2 Gooseneck Hoods

.1 Thickness: to SMACNA.

.1 Kitchen: to ANSI/NFPA 96.

.2 Elsewhere: to SMACNA.

.2 Fabrication: to SMACNA.

.1 Kitchen: to ANSI/NFPA 96.

.2 Elsewhere: to SMACNA.

.3 Joints: to SMACNA and or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint considered class A seal.

.4 Supports: as required.

.5 Complete with integral birdscreen of 2.7 mm diameter ss wire. Use 12 mm mesh on exhaust, 19 mm mesh on intake.

2.3 Fixed Louvres - Aluminum

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1500 mm maximum centres.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish: anodized. Colour: to Departmental Representative’s approval during submittal process.

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 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

.1 Low-emitting materials.

3.3 Cleaning

.1 Proceed in accordance with Section 01 74 00 – Cleaning and Waste Processing.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Related Documents

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

.1 This Section includes variable air-volume, modular air-handling units with coils for indoor installations.

.2 Related Sections include the following:

.1 23 05 48 Vibration Isolation for Piping and Equipment.

1.3 References

.1 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1-2013, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

1.4 Delivery, Storage and Handling

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.5 Submittals

.1 Product Data: For each type of modular indoor air-handling unit indicated. Include the following:

.1 Certified fan-performance curves with system operating conditions indicated.

.2 Certified fan-sound power ratings.

.3 Certified coil-performance ratings with system operating conditions indicated.

.4 Motor ratings, electrical characteristics, and motor and fan accessories.

.5 Material gages and finishes.

.2 Filters with performance characteristics.

.3 Dampers, including housings, linkages, and operators.

1.6 Quality Assurance

.1 Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

.2 Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated.

.3 Comply with NFPA 70.

1.7 Coordination

.1 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 Extra Materials

.1 Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

.1 Filters: One set for each modular indoor air-handling unit.

.2 Fan Belts: One set for each modular indoor air-handling unit fan.

.3 Gaskets: One set for each access door.

2. PRODUCTS

2.1 General

.1 Factory assembled components to form units supplying air at designed conditions, as indicated.

.2 Horizontal and Vertical type, as indicated, having air tight modular components, as indicated on drawings.

2.2 Acceptable Manufacturers:

.1 Refer to section 23 05 00 as well

.2 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

.1 Daikin

.2 Trane

.3 York International Corporation.

.4 Temtrol.

2.3 Manufactured Units

.1 Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and accessories. Provide starters, and point power wiring as indicated on drawings. Provide single point power connection where indicated.

2.4 Cabinet

.1 Materials: Formed and reinforced single-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

.1 Outside Casing: Galvanized steel, 0.0516 inch thick.

.2 Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.

.1 Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.

.2 Thickness: 1 inch.

.3 Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

.4 Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.

.5 Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.

.6 Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

.7 Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.

.8 Location and Application: Encased between outside and inside casing.

.3 Access Panels and Doors: Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations:

.1 Fan Section: Inspection and access panels.

.2 Access Section: Doors.

.3 Coil Section: Inspection panel.

.4 Damper Section: access panel.

.5 Filter Section: Inspection and access panels to allow periodic removal and installation of filters.

.4 Condensate Drain Pans: Formed sections of stainless-steel sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.

.1 Drain Connections: Both ends of pan.

.2 Pan-Top Surface Coating: Elastomeric compound.

.3 Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

2.5 Fan Section

.1 Fan-Section Construction: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with vibration isolation. Refer to section 23 05 48.

.2 Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cut-off, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

.3 Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

.4 Forward-Curved Fan Wheels: Black-enamel or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

.5 Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.

.1 Ball-Bearing Rating Life: ABMA 9, L10 of 50,000 hours.

.6 Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.

.1 Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

.2 Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

.3 Belts: Oil resistant, non-sparking, and non-static; matched for multiple belt drives.

.4 Belt Guards: Fabricate to OSHA/SMACNA requirements; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent; prime coated. Provide belt guards for motors mounted on outside of cabinet.

.5 Motor Mount: Adjustable for belt tensioning.

.7 Vibration Control: Install fans on open-spring vibration isolators having a minimum of 1-inch static deflection and side snubbers. Refer to section 23 05 48 as well.

.8 Fan-Section Source Quality Control:

.1 Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data". Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans". Fans shall bear AMCA-certified sound ratings seal.

.2 Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.6 Coils

.1 Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils

.2 Water Coils: Cleanable coil fabricated according to ARI 410.

.1 Piping Connections: Threaded, [on same end] [on opposite ends].

.2 Tubes: Copper.

.3 Fins: Aluminum with fin spacing to meet performance requirements.

.4 Fin and Tube Joint: Mechanical bond.

.5 Headers: Seamless copper tube with brazed joints, prime coated.

.6 Frames: Galvanized-steel channel frame, 0.052 inch.

.7 Frames: Stainless steel, 0.0625 inch.

.8 Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.

.1 Working-Pressure Ratings: 200 psig, 325 deg F.

.9 Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.7 Dampers

.1 General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating", shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

.2 Damper Operators: Electric specified in Section 23 09 23 "Controls – General Provisions".

.3 Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

.4 Combination Filter and Mixing Box: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

2.8 Filter Section

.1 Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

.2 Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.

.1 Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid. MERV 8 per filter, MERV 13 final filter.

.2 Media and Media-Grid Frame: Non-flammable cardboard.

.3 Provide two additional filter sets for LEED building flush and spaces for hand-over.

2.9 Controls

.1 Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device. Provide with microprocessor controls to provide for all 24V control functions. Resident control algorithms shall make all heating, cooling and ventilating decisions in response from sensor measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, and minimizes drift from the setpoint. The microprocessor shall provide anti-short cycle timing and time delay between compressor operation.

.2 Provide programmable thermostat, located in the conditioned space. Provide cabling as required between the thermostat and the air handling unit.

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 Provide appropriate protection apparatus.

.2 Install units in accordance with manufacturer's instructions and as indicated.

.3 Ensure adequate clearance for servicing and maintenance.

3.3 Fans

.1 Install fan sheaves required for final air balance.

.2 Install flexible connections at fan inlet and fan outlets.

.3 Install vibration isolators.

3.4 Drip Pans

.1 Install deep seal P-traps on drip lines.

.1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 Examination

.1 Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

.2 Examine roughing-in of hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.6 Installation

.1 Install modular indoor air-handling units with the following vibration and seismic-control devices. Vibration and seismic-control devices are specified in Section 23 05 48.

.1 Units with Internally Isolated Fans: Secure units to anchor bolts installed in concrete bases.

.2 Floor-Mounted Units: Support on concrete bases using neoprene pads. Secure units to anchor bolts installed in concrete bases.

.3 Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.

.2 Arrange installation of units to provide access space around modular indoor air-handling units for service and maintenance.

3.7 Cleaning

.1 Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

.2 After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.8 Demonstration

.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units. Refer to Division 1 Section "Closeout Procedures.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Ductless split systems.

.2 Related Sections:

.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 Qualifications:

.1 Installer: Company specializing in performing the work of this section with minimum five years documented experience.

.2 Regulatory Requirements:

.1 Conform to ASME B31.9 and Provincial Boiler and Pressure Vessel Act for installation of piping system.

.2 Products Requiring Electrical Connection: Listed and classified by ULC and CSA, as suitable for the purpose indicated.

1.3 Submittals

.1 Shop Drawings and Product Datasheets: submit complete shop drawings and product data sheets indicating configuration, capacity, features, connections, and mounting requirements.

.2 Closeout: Submit installation and operating instructions for inclusion in the operations and maintenance manuals.

2. PRODUCTS

2.1 Manufacturers

.1 Basis of Design: as noted in equipment schedules.

.2 Acceptable Manufacturers: Daikin, Mitsubishi

2.2 General

.1 Indoor Unit: Packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, evaporator fans and motors, refrigerant coils, discharge grilles, permanent removable filters, controls and refrigerant.

.2 Outdoor Unit: Packaged, self contained, factory assembled pre-wired and pre-piped unit consisting of cabinet, compressor, outdoor refrigerant coil and fan, service valves, check valves, reversing valves, filter strainer, gauge ports, relays, contactors, circuit breakers, and starters.

.3 Indoor unit and outdoor unit shall be of same manufacturer and shall be matched for performance.

2.3 Refrigeration Compressors:

.1 Compressor shall be high performance rotary type.

.2 Units must be equipped with high-pressure cut-off with manual reset.

.3 Mounted enclosed panel shall include:

.1 Suction and discharge refrigerant pressure gauge tappings.

.2 High and low pressure cut out.

.3 Low ambient kit for operation to –17.8°C (0°F).

.4 Time delays to prevent repeated cycling of compressor on low loads, crank case heater.

2.4 Outdoor Condensing Units:

.1 Weatherproof outdoor unit with compressors for horizontal air flow, factory prewired and pre-piped, baked enamel finish.

.2 Single circuited coils with mechanical expanded copper tubing into aluminum fin. Clean, dehydrate and test coils. Seal and ship with holding charge of refrigerant.

.3 Fan section with direct drive propeller fan. drip-proof motors, resiliently mounted, pre-lubricated with built-in overload protection. Fan and coil guards.

2.5 Indoor Evaporator Units:

.1 Provide indoor unit for recirculating air flow with evaporator fan, 30% pleated, filters, duct connections, evaporator coils, condensate drain, factory pre-wired and pre-piped.

.2 Coils shall be ARI certified, single circuited, constructed of seamless copper tubing force fitted to aluminum continuous flat plate.

.3 Clean and dehydrate coils, charge with inert gas and seal for shipment.

.4 Electric reheat coils.

2.6 Refrigerant Piping and Accessories

.1 Refrigerant grade angle, globe and ball shut-off valves.

.2 Pressure gauge taps at compressor inlet and outlet and at all other locations required.

.3 Staged oil traps where evaporator is below compressor.

.4 Reversing valves and control circuitry.

2.7 Controls

.1 Provide programmable, solid state electronic, microprocessor controls as specified and required, including relays and control devices.

.2 Provide control devices to maintain proper compressor head pressures. Interlock condenser operation to refrigeration cycle and to switch reversing valves, etc.

.3 Provide 7-day programmable time schedules with night setback scheduling and automatic/on fan control. Provide auto restart backup for program protection on power failure.

.4 Provide programmable thermostat to be wall mounted and wired to the indoor unit controller.

3. EXECUTION

3.1 Installation

.1 Install in accordance with manufacturer’s recommendations.

.2 Provide and install all necessary refrigerant piping and electrical connection between "split" units.

3.2 Equipment Preparation and Start-Up

.1 Provide services of manufacturer's field Departmental Representative to set and adjust equipment for operation as specified.

END OF SECTION

1. GENERAL

1.1 General

.1 This Section specifies general conditions for Divisions 25 and is to be read, interpreted and coordinated with all other sections of Division 25 and Section 21 05 01 – Common Work Results for Mechanical.

1.2 Related Requirements

.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 Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification Sections apply to work specified in this section.

.3 Section 23 05 53 - Identification for HVAC Piping and Equipment.

.4 Section 23 08 00 – Commissioning of HVAC.

.5 Division 26 – Electrical.

1.3 References

.1 Work, materials, and equipment shall comply with the most restrictive of local, provincial and National authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

.2 British Columbia Codes:

.1 British Columbia Electrical Code

.2 British Columbia Safety Authority

1.4 General Scope

.1 'Provide' shall mean 'supply and install'.

.2 Provide complete, fully tested and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.3 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality but are not detailed installation instructions.

.4 Follow manufacturers' recommended installation instructions, details and procedures for equipment, supplemented by requirements of the Contract Documents.

.5 Install equipment to provide: service access, maintain service clearances and for ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner.

1.5 Coordination of Work

.1 Products furnished but not installed under this division

.1 Division 22 – Plumbing

.1 Temperature Sensor Wells and Sockets

.2 Domestic water sub metering

.2 Division 23 – Heating, Ventilation and Air Conditioning

.1 Pressure and Temperature Sensor Wells and Sockets

.2 Energy meters

.3 Automatic Damper Actuators

.4 Airflow Stations

.5 Terminal Unit Controls

.2 Products installed but not furnished under this division

.1 Division 22 – Plumbing

.1 Low-voltage wiring between 120VAC transformer and hands-free plumbing fixtures.

.2 Division 23 – Heating, Ventilation and Air Conditioning

.1 Refrigerant Leak Detection System

.3 Division 26 – Electrical

.1 Duct smoke detectors

.3 Products not furnished or installed under but integrated with the work of this division

.1 Division 23 – Heating, Ventilation and Air Conditioning

.1 Boiler controls

.2 Chiller controls

.3 Rooftop air-handling equipment discharge air temperature control

.4 Rooftop air-handling equipment economizer control

.5 VAV terminal unit cross-flow velocity sensor

.6 Variable frequency drives

.2 Division 26 – Electrical

.1 Fire alarm panel

1.6 Submittals

.1 Comply with Division 1 – Submission and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:

.2 Provide submittals on all hardware, software, and installation. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. Provide drawings as files on optical disk (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data and the following:

.1 BAS Hardware:

.1 Manufacturer's description and technical data, performance curves, product specification sheets, and installation/maintenance instructions for:

.1 Control Panels

.2 Transducers/Transmitters

.3 Sensors (including accuracy data)

.4 Actuators

.5 Valves

.6 Relays/Switches

.7 Operator Interface Equipment

.8 Wiring

.9 Other relevant items

.2 Wiring diagrams and layouts for each control panel. Show all termination numbers.

.3 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.

.2 Central System Hardware and Software:

.1 Manufacturer's description and technical data, product specification sheets and installation/maintenance instructions for:

.1 Central Processing Unit

.2 Monitors, Printers

.3 Interface Equipment Between CPU and Control Panels

.4 Operating System Software and/or Operator Interface Software

.5 Color Graphic Software and/or Third-Party Software

.6 Other relevant items

.2 Provide a schematic drawing of the central system. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.

.3 Riser diagrams of wiring between central control unit and all control panels.

.4 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.

.3 Controlled Systems

.1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.

.2 A schematic wiring diagram for each BAS. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the BAS schematic, it shall be labeled with the same name. All terminals shall be labeled.

.3 An instrumentation list for each controlled system. Each element of the BAS shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

.4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.

.5 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.

.4 Quantities of items submitted shall be reviewed but are the responsibility of the Division 25 Contractor.

.5 A description of the proposed process along with all report formats and checklists to be used in Section 25 08 00 “Commissioning of Integrated Automation “BAS Demonstration” and “BAS Acceptance.”

.6 Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the owner’s representative prior to hardware and software installation and programming.

.1 Point name

.2 Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location

.3 Expected range (upper and lower limit)

.4 Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification

.5 Type

.1 AI: analog input

.2 BI: binary input

.3 NAI: network analog input

.4 NBI: network binary input

.5 CP: Configuration Property

.6 P: Programmed (e.g., soft or virtual point in control sequence such as a PID input or output)

.7 C: Calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also indicate if it is a running average.

.6 Input resolution

.7 Graphic display resolution

.8 Data trend interval

.3 Schedules:

.1 Within one month of contract award, provide a schedule of the work indicating the following:

.1 Intended sequence of work items.

.2 Start dates of individual work items.

.3 Duration of individual work items.

.4 Planned delivery dates for major material and equipment and expected lead times.

.5 Milestones indicating possible restraints on work by other trades or situations.

.2 Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.

.4 Provide Record drawings and maintenance data in compliance with Division 01 - Closeout Submittals and the following:

.1 Submit project record documents upon completion of installation. Co-ordinate quantity to suit number of O&M manuals required. The documents shall be submitted for approval prior to final completion and shall include:

.2 Project Record Drawings. As-built versions of the submittal shop drawings provided as files on optical media and as 11” x 17” prints.

.3 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 25 08 00 Commissioning of Integrated Automation “BAS Demonstration” and “BAS Acceptance”.

.4 Certification of pressure test required for: Control Air Tubing.

.5 Operation and Maintenance (O & M) Manual.

.6 As-built versions of submittal product data.

.7 Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.

.8 Operator’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.

.9 Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.

.10 Graphic files, programs, and database on magnetic or optical media.

.11 List of recommended spare parts with part numbers and suppliers.

.12 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

.13 Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.

.14 Licenses, guarantees, and warranty documents for equipment and systems.

.15 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

.5 Training Materials. Provide course outline and manual for each class at least six weeks before first class. The BAS designer will modify course outlines and manuals if necessary to meet Owner’s needs. The BAS designer will review and approve course outlines and manuals at least three weeks before first class.

1.7 Acceptable Control System Primary Manufacturers

.1 Johnson Controls is the existing site controls provider. The new control system for the new building shall be capable of communicating with the existing site BMS. All control providers other than the existing provider (Johnson Controls) shall provide a single, complete control system for the entire site (i.e. carry the cost for retrofitting the entire existing site to the new proposed control system). The existing site controls shop drawings will be provided if the contractor would like to propose retrofitting the entire site control system.

Quality Assurance

.2 Installer and Manufacturer Qualifications

.1 Installer shall have an established working relationship with BAS Manufacturer of not less than three years.

.2 Installer shall have successfully completed BAS control system training. Upon request, Installer shall present certification of completed training including hours of instruction and course outlines.

1.8 Identification

.1 All components of the Building Management System shall be identification tagged. Comply with Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.9 Warranty

.1 Warrant work as follows:

.1 Warrant labor and materials for specified BAS free from defects for a period of 12 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

.2 Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

.3 Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

.4 Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of BAS designer's acceptance.

.2 Special warranty on instrumentation:

.1 All instrumentation shall be covered by manufacturer's transferable [one-year] "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.10 Substantial & Total Performance

.1 Comply with Section 21 05 01 Common Work Results for Mechanical – Substantial and Total Performance.

.2 A certificate of Substantial Performance will not be granted unless the controls systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

1.11 Ownership of Proprietary Material

.1 Project-specific software and documentation shall become Owner's property. This includes, but is not limited to graphics, record drawings, database, application programming code and documentation.

2. PRODUCTS

2.1 Not used

3. EXECUTION

3.1 Examination

.1 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Departmental Representative for resolution before rough-in work is started.

3.2 Co-ordination

.1 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

.2 Coordinate final graphics floor plans, room names and numbering with Architectural drawings including any changes made during construction. These graphics should be provided to the Engineers and the Owner for sign off before the graphics are completed.

.3 The contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

.4 Duct smoke detectors required for air handler shutdown are supplied under Division 26. The contractor shall interlock smoke detectors to air handlers for shutdown.

.5 Smoke dampers required for duct smoke isolation are provided under Division 23 and actuators under Division 25. Division 25 shall interlock these dampers to the air handlers as described in the Sequences of Operation."

.6 Fire/smoke dampers and actuators required for fire rated walls are provided under Division 23. Fire/smoke dampers powered by Div 26. Wiring for end-switch by Div 25. .

.7 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the BAS specified in this section. These controls shall be integrated into the system and coordinated by this Contractor as follows:

.1 Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.

.2 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

.3 The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.

.4 The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.3 General Workmanship

.1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

.2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

.4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

.5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

.6 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial, and federal codes and ordinances as identified in Part 1 of this specification.

3.4 Training

.1 Provide training sessions period for personnel designated by the Owner. The number of training sessions required should be agreed with the Engineers and Owner prior to commencement of training

.2 Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be one day in length and must be coordinated with the building owner.

.3 Train the designated staff of the owner to enable them to do the following:

.1 Day-to-day Operators:

.1 Proficiently to operate the system

.2 Understand BAS architecture and configuration

.3 Understand BAS system components

.4 Understand system operation, including BAS control and optimizing routines (algorithms)

.5 Operate the workstation and peripherals

.6 Log on and off the system

.7 Access graphics, point reports, and logs

.8 Adjust and change system set points, time schedules, and holiday schedules

.9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals

.10 Understand system drawings and Operation and Maintenance manual

.11 Understand the job layout and location of control components

.12 Access data from BAS controllers and ASCs

.13 Operate portable operator's terminals

.2 Advanced Operators:

.1 Make and change graphics on the workstation

.2 Create, delete, and modify alarms, including annunciation and routing of these

.3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals

.4 Create, delete, and modify reports

.5 Add, remove, and modify system's physical points

.6 Perform BAS field checkout procedures

.7 Perform BAS unit operation and maintenance procedures

.8 Perform workstation and peripheral operation and maintenance procedures

.9 Perform BAS diagnostic procedures

.10 Maintain, calibrate, troubleshoot hardware

.11 Adjust, calibrate, and replace system components

.3 System Managers/Administrators:

.1 Maintain software and prepare backups

.2 Interface with job-specific, third-party operator software

.3 Add new users and understand password security procedures

.4 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.

.5 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.

.6 The instructor(s) shall be factory-trained instructors experienced in presenting this material.

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 Section includes commissioning process requirements for control systems, assemblies, and equipment.

1.2 Related Requirements

.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 Division 01 – Measurement and Verification Plan General Requirements

.3 Section 21 05 01 – Common Work Results for Mechanical

.4 Section 23 08 00 – Commissioning of HVAC

.5 Section 23 08 10 – Measurement & Verification Requirements

.6 Section 25 09 01 - Controls Systems

.7 Section 25 90 00 – Integrated Automation Control Sequences

1.3 References

.1 Commissioning Agency (CxA)

.2 Commissioning Authority (CxAu) if applicable shall be engaged by the Client directly and act independent to this specification section.

.3 The latest revisions of the following standards shall apply unless noted otherwise.

.1 Applicable Building Code - Refer to Section 21 05 01

1.4 Submittals

.1 Comply with Division 1 – Submission and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:

.1 Certificates of readiness.

.2 Certificates of completion of installation, prestart, and start-up activities.

1.5 Contractor's Responsibilities

.1 Provide Project-specific construction checklists and commissioning process test procedures for actual control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

.2 Perform commissioning tests

.3 Hold construction phase controls coordination meeting.

.4 Attend testing, adjusting, and balancing review and coordination meeting.

.5 Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection.

.6 Provide information requested by the CxA for the final commissioning documentation.

.7 Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA's Responsibilities

.1 Attend construction phase controls coordination meeting.

.2 Verify and participate in commissioning testing.

.3 Verify testing, adjusting, and balancing of work are complete.

.4 Provide copies of documentation to the CxAu to facilitate the pursuit of LEED registration.

1.7 Commissioning Documentation

.1 Provide the following information to the CxA for the inclusion in the commissioning plan:

.1 Plan for delivery and review of submittals, systems manuals, and other documents and reports.

.2 Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

.3 Process and schedule for completing construction checklists for controls systems, assemblies, equipment, and components to be verified and tested.

.4 Certificate of completion certifying that installation, start-up checks, and start-up procedures have been completed.

.5 Certificate of readiness, certifying that controls systems, subsystems and equipment are ready for testing.

.6 Test and inspection reports, and certificates.

.7 Corrective action documents.

.8 Documented verification of testing, adjusting, and balancing reports.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 BAS Start-up Testing

.1 All testing listed in this article shall be performed by the Division 25 contractor and shall make up part of the necessary verification of an operating BAS. This testing shall be completed before the owner's representative is notified of the system demonstration.

.1 The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

.2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

.3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.

.4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

.5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.

.6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines. DO NOT call for system demonstration prior to these detailed tests being completed and systems properly functioning as per the sequence of operations and design intent.

.7 Verify that all graphics are complete and meet the Owner's Representative's requirements. Add or adjust graphics to suit the specific project requirements and Owner's requests.

.8 Alarms and Interlocks:

.1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

.2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

.3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.2 BAS Demonstration

.1 Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

.2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in "Start-up Testing" of this specification. The CxA will be present to observe and review these tests. The CxA shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in Article 1.10, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.

.4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

.6 Demonstrate compliance with Section 25 09 01 Control Systems - Part 1, "BAS Performance."

.7 Demonstrate compliance with Section 25 90 00 Integrated Automation Control Sequences through all modes of operation.

.8 Demonstrate complete operation of operator interface.

.9 Additionally, the following items shall be demonstrated:

.1 DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.

.2 Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of shed equipment outputs.

.3 Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

.4 Interface to the building fire alarm system.

.5 Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Departmental Representative/BAS designer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

.10 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

3.3 BAS Acceptance

.1 All tests described in this specification shall have been performed to the satisfaction of both the Departmental Representative and CxA prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the BAS designer. Such tests shall then be performed as part of the warranty.

.2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Section 25 09 01 Control Systems, "Submittals."

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 This is a performance specification for the provision of all labour and materials necessary to install complete and ready for operation, integrated building automation systems for this project. The scope of work includes the field installation and wiring, (both low and line voltage wiring), of sensors, devices, and control panels that are supplied with other mechanical equipment specified in other sections of Divisions 21, 22 and 23. It is the responsibility of the Controls Contractor to read the other sections and to include any controls related scope. This work shall include, but is not limited to:

.1 Controllers and Control Panels

.2 Transformers and power supply units, including UPS

.3 Routers

.4 Gateways (for integration of other equipment than mechanical)

.5 Third party controller(s) integration

.6 Network switches

.7 Servers

.8 PC or Laptop (Operating working station)

.9 Temperature and pressure sensors

.10 Other various sensors (as called on drawings)

.11 Relay panels,

.12 Damper operators,

.13 Control valves and valve operators

.14 Meters (various meters as called on drawings)

.15 Web browser interface (including remote access capabilities)

.16 BACnet communication interfaces (BACnet MS/TP and BACnet IP only) for all mechanically controlled equipment

.17 Remote control panels

.18 Lighting control panel interfaces

.19 Security system interfaces

.20 Fire alarm system interfaces

.21 Other control work not listed here but called for in construction documents

1.2 Related Requirements

.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 Section 21 05 01 – Common Work Results for Mechanical

.3 Section 23 05 53 - Identification for HVAC Piping and Equipment

.4 Division 25 - Integrated Automation

.5 Division 26 - Electrical

1.3 References

.1 The latest revisions of the following standards shall apply unless noted otherwise.

.2 ANSI/ASHRAE Standard 135 BACnet A Data Communication Protocol for Building Automation and Control Networks

1.4 System Description

.1 General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and an operator workstation. The operator workstation shall provide for overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.

.2 Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.

.3 Event Response: The BAS will provide the specified operational changes based on event response from the energy service provider.

.4 System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a web browser over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).

.5 The intent of the thin-client architecture is to provide operators complete access to the control system via a web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming.

.6 The system shall support web browser access to the building data. A remote user using a standard web browser shall be able to access the control system graphics and change adjustable set points with the proper password.

1.5 BAS Performance Standards

.1 The BAS system shall conform to the following minimum standards over network connections:

.1 Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 seconds.

.2 Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 seconds.

.3 Object Command: Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.

.4 Object Scan: Data used or displayed at a controller or workstation shall have been current within the previous 6 seconds.

.5 Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 45 seconds.

.6 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.

.7 Performance: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.

.8 Multiple Alarm Annunciation: Each workstation on the network shall receive alarms within 5 seconds of other workstations.

.9 Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.

.10 Control Stability and Accuracy: Control loops shall maintain measured variable at set point within tolerances listed in Table 1 under “Accuracy Required for Control.”

1.6 Sensors, Meters, Calculated Values, and Required Accuracies

Table 1

#	Object Description and Location if Applicable	Sensor or Value Type	Sensor Type or Calculation Method	Expected Range	Required End-to-End Accuracy	Display Resolution	Refresh Interval min	Trend Interval min	Accuracy Required for Control
S1	Ambient Dry-Bulb Temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	–29°C to 40°C (–20°F to 120°F)	±0.5°C (±0.1°F)	±0.25°C (±0.5°F)	1	10	±1.0°C (±2°F)
S2	Ambient Wet-Bulb Temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	–29°C to 40°C (–20°F to 120°F)	±1.5°C (±3.0°F)	±0.25°C (±0.5°F)	1	10	±1.5°C (±3°F)
S6	Building Main Meter Power	AI/BI (pulse)	True RMS		±1.0% of reading	1.0 kW	1	1	1.0 kW
S8	Zone (Space) Temperatures	AI	10000 ohm thermistor or 1000 ohm RTD	–1°C to 38°C (30°F to 100°F)	±0.5°C (±0.1°F)	±0.25°C (±0.1°F)	1	1	±0.5°C (±1°F)
S9	Carbon Dioxide	AI	Nondispersive infrared sensor technology	0 to 2000 ppm	±50 ppm	50 ppm	1	1	50 ppm
S10	Carbon Monoxide	AI	Electrochemical sensor	0 to 100 ppm	±5ppm	50 ppm	1	1	50 ppm
S11	Air Pressure (Ducts)	AI	Variable capacitance	0 to 2 kPa (0 to 8 in. w.g.)	±25 Pa (±0.1 in. w.g.)	125 Pa (±0.5 in. w.g.)	1	1	25 Pa (0.1 in. w.g.)
S12	Air Pressure (Space)	AI	Variable capacitance	-25 to 25 Pa (-0.1 to 0.1 in wg)'	3Pa (±0.01 in. w.g.)	3Pa (±0.01 in. w.g.)	1	1	1.3 Pa (0.005in. w.g.)

AI = analog input; BI = binary input; calculated = value calculated by the BAS hardware or BAS software

Table 1

#	Object Description and Location if Applicable	Sensor or Value Type	Sensor Type or Calculation Method	Expected Range	Required End-to-End Accuracy	Display Resolution	Refresh Interval min	Trend Interval min	Accuracy Required for Control
S13	Water Pressure	AI		0 to 1034 kPa (0 to 150 psi)	±2% of full scale	7kPa (1 psi)	1	1	3.5 kPa (0.5 psi)
S14	Water Temperature	AI		(0°C to 107°C) (32°F to 225°F)	±0.5°C (±1°F)	±0.5°C (±1°F)	1	1	±0.5°C (±1°F)
S15	Delta-T	AI	10000 ohm thermistor or 1000 ohm RTD matched pair		±0.15°C (±0.25°F)	±0.25°C (±0.5°F)	1	1	±0.15°C (±0.25°F)
S16	Relative Humidity	AI		0% to 100%	±5% RH	5%	1	1	±5% RH
S17	Water Flow	AI			±2% of reading	1000 L/s	1	1	
S18	Ducted Air Temperature	AI	10000 ohm thermistor or 1000 ohm RTD	7°C to 60°C (45°F to 140°F)	±0.5°C (±1°F)	±0.5°C (±1°F)	1	1	±0.5°C (±1°F)
S19	Electrical (amps, volts, watts, PF not specified elsewhere)	AI/BI (pulse)	pulse output		±1% of full scale	0.1	1	1	1/100 s or less
S28	Airflow Rate (measuring stations)	AI	Electronic or differential pressure		±5% of reading down to 0.75 m/s (150 fpm)	0.05 L/s (0.1 cfm)	1	1	±5% of reading down to 0.75 m/s (150 fpm)

AI = analog input; BI = binary input; calculated = value calculated by the BAS hardware or BAS software

2. PRODUCTS

2.1 Materials

.1 Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communications

.1 Control products, communication media, connectors, repeaters, hubs, and routers shall comprise an open protocol BAS. Controller and operator interface communication shall conform to open-protocol body certification requirements.

.2 Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BAS. Controller and operator interface communication shall conform to open protocol body certification requirements.

.3 Each controller shall have a communication port for connection to an operator interface.

.4 Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.

.5 Internetwork operator interface and value passing shall be transparent to internetwork architecture.

.1 An operator interface connected to the BAS shall allow the operator to interface with each internetwork controller as if directly connected. BAS information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.

.2 Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified BAS operation. An authorized operator shall be able to manage, maintain and access the BAS network of controllers.

.6 System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

.7 Workstations, Building Control Panels and Controllers with real-time clocks shall use the open-protocol time synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

2.3 Operator Interface

.1 PC-based workstations shall reside on a high-speed network with building controllers as shown on the drawings. Each workstation or each standard browser connected to server shall be able to access all BAS information.

.2 Workstation and controllers shall communicate using [open] protocol. Workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol [and open protocol] addressing as specified [in open protocol body].

.3 Hardware. Each operator workstation or web server shall consist of the following:

.1 Computer: Hardware shall meet or exceed BAS manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:

.2 The hard disk shall have sufficient memory to store:

.1 All required operator workstation software

.2 A B database at least twice the size of the delivered system database

.3 One year of trend data based on the points specified to be trended at their specified trend intervals.

.2 Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.

.4 Provide a notebook style PC as a Portable Operator's Terminal. This device may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting and full access to the BAS. Include all software and hardware required.

.5 System Software

.1 Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications. Examples include Microsoft Excel, Microsoft Access or other SQL database software. Acceptable operating systems are Windows or the latest Windows Server release.

.2 System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic such as analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.

.6 System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications:

.1 Automatic system database save and restore (include a enable/disable feature)

.2 Manual Database Save and Restore.

.3 System Configuration.

.4 On-Line Help.

.5 Security: Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. All system security data shall be stored in an encrypted format.

.6 System Diagnostics.

.7 Alarm Processing.

.8 Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm without relying upon acronyms or other mnemonics.

.9 Alarm Reactions.

.10 Trend Logs.

.11 Alarm and Event Log.

.12 Trend Plots:

.1 User-selectable X and Y trend inputs.

.2 User-editable titles, point names, and X and Y axis titles.

.3 User-selectable time period options: 24-hour period, 7-day period, 1-month.

.13 Object and Property Status and Control..

.14 Reports and Logs: Provide a reporting package that allows the operator to select, modify, or create reports. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.

.15 Standard Reports. The following standard BAS system reports shall be provided for this project. Provide ability for the owner to readily customize these reports for this project.

.1 All Objects/Points/Variables: All system (or subsystem) objects and their current values.

.2 Alarm Summary: All current alarms (except those in alarm lockout).

.3 Disabled Objects/points: All objects that are disabled.

.4 Alarm Lockout Objects/points: All objects in alarm lockout (whether manual or automatic).

.5 Alarm Lockout Objects/points in Alarm: All objects in alarm lockout that are currently in alarm.

.6 Logs:

.1 Alarm History

.2 System Messages

.3 System Events

.4 Trends

.7 Workstation Applications Editors: Provide full screen editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels. The editors shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers and schedules.

2.4 Controller Software

.1 Provide applications software for building and energy management. All software applications shall reside and operate in the system controllers.

.2 Editing of applications shall occur at the operator workstation.

.3 Software shall provide:

.1 System Security

.2 Scheduling; daily, weekly and exception (holiday) schedules. The contractor shall create schedules for each piece of equipment (not just provide the capability to do so).

.3 Binary and analog alarms.

.4 Alarm Reporting.

.5 Remote Communication

.6 Demand Limiting.

.1 The demand-limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter or from a watt transducer or current transformer attached to the building feeder lines.

.2 The demand-limiting program shall predict the probable power demand such that action can be taken to prevent exceeding the demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates the demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.

.3 Demand reduction shall be accomplished by the following means:

.1 Reset air-handling unit supply temperature set point up by 1ºC (2ºF).

.2 Reset space temperature set points up by 1ºC (2ºF).

.3 De-energize equipment based upon priority.

.4 Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which the local power company computes demand charges.

.5 Provide the means for an operator to make changes on-line.

.6 Provide the following information and reports, to be available on an hourly, daily, and monthly basis:

.1 Total electric consumption.

.2 Peak demand.

.3 Date and time of peak demand.

.4 Daily peak demand.

.7 Maintenance Management.

.8 Sequencing.

.9 PID Control.

.10 Staggered Start.

.11 Energy Calculations.

.12 Anti-Short Cycling.

.13 Run-Time Totalization.

2.5 Building and Custom Application Controllers

.1 Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

.2 This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall support the following BACnet BIBBs:

.1 Data Sharing

.1 Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)

.2 Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)

.3 Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)

.4 Data Sharing-Write Property Multiple- Execute (DS-WPM-B)

.5 Data Sharing-COV- Initiate, Execute (DS-COV-A,B)

.6 Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)

.2 Scheduling

.1 Scheduling-Internal- Execute (SCHED-I-B)

.2 Scheduling-External- Execute (SCHED-E-B)

.3 Trending

.1 Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)

.2 Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)

.3 Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)

.4 Trending-Automated Trend Retrieval- Execute (T-ATR-B)

.4 Network Management

.1 Network Management-Connection Establishment- Initiate (NM-CE-A)

.5 Alarming

.1 Alarm and Event-Notification- Initiate (AE-N-A)

.2 Alarm and Event-Notification Internal- Execute (AE-N-E-B)

.3 Alarm and Event-Notification External- Execute (AE-N-E-B)

.4 Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)

.5 Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)

.6 Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)

.7 Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)

.6 Device Management

.1 Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)

.2 Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)

.3 Device Management-Device Communication Control- Execute (DM-DCC-B)

.4 Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)

.5 Device Management-Text Message- Initiate, Execute (DM-TM-A,B)

.6 Device Management-Time Synchronization- Execute (DM-TS-B)

.7 Device Management-Reinitialize Device- Execute (DM-RD-B)

.8 Device Management-Backup and Restore- Execute (DM-RD-B)

.9 Device Management-List Manipulation- Execute (DM-RD-B)

.10 Device Management-Object Creation and Deletion- Execute (DM-OCD-B)

.7 The Building Level Controller shall support the following Data Link Layers:

.1 BACnet IP Annex J

.2 BACnet IP Annex J Foreign Device

.3 MS/TP Master (Claus 9)

.8 The Building Level Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:

.1 Calendar – Creatable, Deletable

.2 Command – Creatable, Deletable

.3 Event Enrollment – Creatable, Deletable

.4 Notification Class – Creatable, Deletable

.5 Schedule - Creatable, Deletable

.9 The Building Level Controller shall support transmitting and receiving segmented messages.

.10 The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

.11 The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.

.3 This level of controller shall be used for the following types of systems:

.1 Chiller plant systems

.2 Heating plant systems

.3 Cooling Towers

.4 Pumping systems

.5 VAV air handlers

.6 Air handlers

.7 Systems with over 24 input/output points

.4 Computing power and memory minimum:

.1 A 32-bit, stand-alone, multi-tasking, multi-user, real-time 100MHz digital control microprocessor module.

.2 Inputs shall be 16-bit minimum analog-to-digital resolution

.3 Outputs shall be 10-bit minimum digital-to-analog resolution

.4 Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.

.5 Real time clock and battery

.6 Data collection/ Data Trend module sized for 10,000 data samples.

.7 Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.

.5 Onboard or Modular hardware and connections:

.1 Primary Network communication module, if needed for primary network communications.

.2 Secondary Network communication module, if needed for secondary network communications.

.3 RJ45 port 10/100Mbaud

.4 RS485 ports for subnetworks and point expansion

.5 Man to Machine Interface port (MMI)

.6 USB Port

.6 Input and Output Points Hardware

.1 Input/output point modules as required including spare capacity.

.2 Monitoring of the status of all hand-off-auto switches.

.3 Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.

.4 Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

.5 Graduated intensity LEDs or analog indication of value for each analog output.

.7 Code compliance

.1 Approvals and standards: UL916; CE; FCC

.2 Provide UL864-UUKL where called for in the sequences of operations.

.8 Accessories:

.1 Appropriate NEMA rated metal enclosure.

.2 Power supplies as required for all associated modules, sensors, actuators, etc.

.9 Keypad.

.1 A local keypad and display shall be provided for each floor controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

.10 The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.

.11 Each Building Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

.12 Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

.13 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

.14 Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.

.15 Building Level Controllers shall have the capability to serve as a gateway between Modus subnetworks and BACnet objects. Provide software, drives and programming.

.16 Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

.17 Spare Capacity: Provide enough inputs and outputs to handle future floor VAV boxes connection to DDC system. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

.18 Environment.

.1 Controller hardware shall be suitable for the anticipated ambient conditions.

.2 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

.3 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

.19 Immunity to power and noise.

.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

.3 Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

.1 RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.

.2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.

.3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.

.4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

.4 Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:

.1 IEEE Standard 587 1980

.2 UL 864 Supply Line Transients

.3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.6 Advanced Application Controllers

.1 Provide all necessary hardware for a complete operating system as required. The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

.2 This controller shall have the BTL listing and meet the BACnet device profile of an Advanced Application Controller (B-AAC) and shall support the following BACnet BIBBs:

.1 Data Sharing

.1 Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)

.2 Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)

.3 Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)

.4 Data Sharing-Write Property Multiple- Execute (DS-WPM-B)

.5 Data Sharing-COV- Initiate, Execute (DS-COV-A,B)

.6 Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)

.2 Scheduling

.1 Scheduling-Internal- Execute (SCHED-I-B)

.2 Scheduling-External- Execute (SCHED-E-B)

.3 Trending

.1 Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)

.2 Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)

.3 Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)

.4 Trending-Automated Trend Retrieval- Execute (T-ATR-B)

.4 Network Management

.1 Network Management-Connection Establishment- Initiate (NM-CE-A)

.5 Alarming

.1 Alarm and Event-Notification- Initiate (AE-N-A)

.2 Alarm and Event-Notification Internal- Execute (AE-N-E-B)

.3 Alarm and Event-Notification External- Execute (AE-N-E-B)

.4 Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)

.5 Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)

.6 Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)

.7 Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)

.6 Device Management

.1 Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)

.2 Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)

.3 Device Management-Device Communication Control- Execute (DM-DCC-B)

.4 Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)

.5 Device Management-Text Message- Initiate, Execute (DM-TM-A,B)

.6 Device Management-Time Synchronization- Execute (DM-TS-B)

.7 Device Management-Reinitialize Device- Execute (DM-RD-B)

.8 Device Management-Backup and Restore- Execute (DM-RD-B)

.9 Device Management-List Manipulation- Execute (DM-RD-B)

.10 Device Management-Object Creation and Deletion- Execute (DM-OCD-B)

.7 The Advanced Application Controller shall support the following Data Link Layers:

.1 BACnet IP Annex J

.2 BACnet IP Annex J Foreign Device

.3 MS/TP Master (Claus 9)

.8 The Advanced Application Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:

.1 Calendar – Creatable, Deletable

.2 Command – Creatable, Deletable

.3 Event Enrollment – Creatable, Deletable

.4 Notification Class – Creatable, Deletable

.5 Schedule - Creatable, Deletable

.9 The Advanced Application Controller shall support transmitting and receiving segmented messages.

.10 The Advanced Application Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

.3 The Advanced Application Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP. This level of controller shall be used for the following types of systems:

.1 Secondary Pumping systems

.2 Systems with over 12 controlled points

.3 Systems with custom sequences

.4 Each System Level Control Panel shall, at a minimum, be provided with:

.1 Appropriate NEMA rated metal enclosure.

.2 A 32-bit, stand-alone, multi-tasking, multi-user, real-time digital control microprocessor module.

.3 Inputs shall be 16-bit minimum digital resolution

.4 Outputs shall be 10-bit minimum digital resolution

.5 Primary Network communication module, if needed for primary network communications.

.6 Secondary Network communication module, if needed for secondary network communications.

.7 Memory module (4 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.

.8 Real time clock and battery

.9 Data collection/ Data Trend module sized for 10,000 data samples.

.10 Power supplies as required for all associated modules, sensors, actuators, etc.

.11 Input/output point modules as required including spare capacity.

.12 Software modules as required for all sequences of operation, logic sequences and energy management routines. Relay logic is not acceptable.

.13 Monitoring of the status of all hand-off-auto switches. The status of the hand-off-auto switch shall be available as a BAS data point.

.14 Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.

.15 Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

.16 Graduated intensity LEDs or analog indication of value for each analog output.

.17 Approvals and standards: UL916; CE; FCC

.18 Provide UL864-UUKL where called for in the sequences of operations.

.5 Each System Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

.6 Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

.7 Each Advanced Application Control Panel shall provide battery backup to support the real-time clock and RAM memory, such as trend logs, for a minimum of 100 hours.

.8 Each System Level Control Panel shall support firmware upgrades without the need to replace hardware.

.9 System Level control panels shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications.

.10 Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

.11 Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be “future” on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2.7 Application Specific Controllers

.1 Each Application Level Control Panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each application specific controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.

.2 This controller shall have the BTL listing and meet the BACnet device profile of an Application Specific Controller and shall support the following BACnet BIBBs:

.1 Data Sharing

.1 Data Sharing-Read Property-B (DS-RP-B)

.2 Data Sharing-Read Property Multiple-B (DS-RPM-B)

.3 Data Sharing-Write Property-B (DS-WP-B)

.2 Device Management

.1 Device Management-Dynamic Device Binding-B (DM-DDB-B)

.2 Device Management-Dynamic Object Binding-B (DM-DOB-B)

.3 Device Management-Device Communication Control-B (DM-DCC-B)

.3 The Advanced Application Controller shall support the following Data Link Layers:

.1 MS/TP Master or Slave (Claus 9)

.3 Provide an Application Specific Control Panel for all other equipment that is part of this project and presently connected to the existing DDC system.

.4 Each Application Specific Controller shall, at a minimum, be provided with:

.1 Appropriate NEMA rated enclosure

.2 Floor Level network communications ability

.3 Power supplies as required for all associated modules, sensors, actuators, etc.

.4 Software as required for all sequences of operation, logic sequences and energy management routines.

.5 A portable operator terminal connection port

.6 Auxiliary enclosure for analog output transducers, isolation relays, etc. Auxiliary enclosure shall be part of primary enclosure or mounted adjacent primary enclosure

.7 Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time

.8 Each controller measuring air volume shall include a differential pressure transducer

.9 Approvals and standards: UL916; CE; FCC

.5 Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The Application Specific Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication to the system.

.6 Provide each Application Specific Controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPSs) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

.7 The Application Specific Controller shall be powered from a 24 VAC source provided by this contractor and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. Install plenum data line and sensor cable in accordance with local code and NEC. The controllers shall also function normally under ambient conditions of 32 to 122 F (0 to 50 C) and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

2.8 Routers

.1 Provide a router for each subnetwork to connect the floor level network to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet.

.2 The router shall be capable of handling all of the BACnet BIBBs that are listed for the controller that reside on the subnetwork.

2.9 Base Building Backbone Ports

.1 On each floor, and mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.

2.10 Control Panels

.1 Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.

.2 Mount on walls at an approved location or provide a free standing rack.

.3 Panels shall be constructed of 16 gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.

.4 Provide power supplies for control voltage power.

.5 Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations.

.6 Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.

.7 All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.

.8 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.

.9 All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.

2.11 Provide a pocket to hold documentation. Input/output Interface

.1 Hardwired inputs and outputs may tie into the BAS through building, custom application, or application specific controllers.

.2 All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, without damage to the controller.

.3 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

.4 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

.5 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with—and field configurable to— commonly available sensing devices.

.6 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

.7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

.8 Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

.9 Input/Output points shall be the universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

.10 System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.12 Power Supplies and Line Filtering

.1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

.1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA approved.

.2 Power line filtering.

.1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

.1 Dielectric strength of 1000 volts minimum

.2 Response time of 10 nanoseconds or less

.3 Transverse mode noise attenuation of 65 dB or greater

.4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz

2.13 Electric Damper/Valve Actuators.

.1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.

.2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.

.3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.

.4 All 24 VAC/VDC actuators shall operate on Class 2 wiring

.5 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank for this purpose.

2.14 Pneumatic Damper/Valve Actuators and Positioners.

.1 Pneumatic actuators shall be piston-rolling diaphragm type or diaphragm type with easily replaceable, beaded, molded neoprene diaphragm.

.2 Actuator housings may be molded or die-cast zinc or aluminum. Exception: Actuator housings for terminal unit zone control dampers or valves may be of high-impact plastic construction with an ambient temperature rating of 10°C to 60°C (50°F to 140°F) minimum. However, any plastic devices located in return air (ceiling) plenums shall be isolated from plenums with an auxiliary metal enclosure having a quick-opening access panel.

.3 Actuator size and spring ranges selected shall be suitable for intended application.

.4 Rate pneumatic actuators for a minimum 140 kPa (20 psig).

.5 Damper actuators shall be selected in accordance with manufacturer's recommendations to provide sufficient close-off force to effectively seal damper and to provide smooth modulating control under design flow and pressure conditions. Furnish a separate actuator for each damper section.

.6 Valve actuators shall provide tight close-off at design system pressure and shall provide smooth modulation at design flow and pressure conditions.

.7 On sequencing applications, valve and damper actuators shall be sized for a maximum of 14 kPa (2 psi) shift in nominal spring range. Spring ranges shall be selected to prevent overlap or positive positioners shall be provided.

.8 Positive positioners to have the following performance characteristics:

.1 Linearity: ±10% of output signal span

.2 Hysteresis: 3% of the span

.3 Response: 1/4 psig input change

.4 Maximum pilot signal pressure: 140 kPa (20 psig)

.5 Maximum control air supply pressure: 420 kPa (60 psig)

.9 Positive positioners shall be provided on actuators for inlet vane control and on any other actuators where required to provide smooth modulation or proper sequencing.

.10 Positive positioners shall be high-capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for particular actuator.

.11 Positive positioners shall use full control air pressure at any point in stem travel to initiate stem movement or to maintain stem position. Positioners shall operate on a 20 to 100 kPa (3 to 15 psig) input signal unless otherwise required to satisfy the control sequences of operation.

2.15 Binary Temperature Devices

.1 Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) set point range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.2 Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.3 Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

2.16 Temperature Sensors.

.1 Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.

.2 Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m^2 (10 ft^2) of duct cross section.

.3 Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

.4 Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port as shown.

.5 Provide matched temperature sensors for differential temperature measurement.

2.17 Humidity Sensors

.1 Duct and room sensors shall have a sensing range of 20% to 80%.

.2 Duct sensors shall be provided with a sampling chamber.

.3 Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of □40°C to 75°C (□40°F to 170°F).

.4 Humidity sensor’s drift shall not exceed 1% of full scale per year.

2.18 Flow Switches

.1 Flow-proving switches shall be either paddle or differential pressure type, as shown.

.2 Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.

.3 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

.4 Provide vapour tight enclosure for chilled water applications.

2.19 Relays

.1 Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.2 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

2.20 Current Transmitters

.1 AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden.

.2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.

.3 Unit shall be split-core type for clamp-on installation on existing wiring.

2.21 Current Transformers

.1 AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.

.2 Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

.3 Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

2.22 Voltage Transmitters

.1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.

.2 Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ±1% full-scale accuracy with 500 ohm maximum burden.

.3 Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

2.23 Voltage Transformers

.1 AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.

.2 Transformers shall be suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and shall provide ±0.5% accuracy at 24 VAC and a 5 VA load.

.3 Windings (except for terminals) shall be completely enclosed with metal or plastic material.

2.24 Current Switches

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2.25 Local Control Panels.

.1 All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.

.2 Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

.3 Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.26 Wiring and Raceways

.1 General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

.2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

2.27 Fibre Optic Cable System

.1 Optical cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. The sheath shall be UL Listed OFNP in accordance with NEC Article 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

.2 Connectors: All optical fibers shall be field-terminated with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

2.28 Compressed Instrument Air Supply - Pneumatic

.1 Air Compressor:

.1 Furnish and install a duplex temperature control type air compressor where indicated on plans. Oil carryover shall not exceed 4 ppm.

.2 Both compressors shall be mounted on a single ASME receiver tank, with the tank sized according to manufacturer's recommendations, 115 L (30 gal) minimum, six starts per hour maximum. Each compressor is to be sized for no more than 33% run-time.

.3 Provide factory-installed duplex starter/automatic alternator package with separate motor feeds, arranged for automatic start of standby compressor.

.4 Provide OSHA belt guards, operating pressure switches, tank pressure gauge, intake filters, ASME safety relief valves, check valves, shutoff valve, and vibration isolation pads for each air compressor unit.

.5 Provide electric solenoid type (normally closed) automatic receiver tank drain valve with built-in timers for operating frequency and duration.

.2 Refrigerated Air Dryer:

.1 Provide continuously operating, hermetic compressor refrigerated type air dryer, UL Listed, sized for maximum dew point of □9.5°C (15°F) with 38°C (100°F) saturated inlet air at 550 kPa (80 psig) at maximum rated flow.

.2 Dryer package shall include operating/failure status indication, manual bypass service valve, inlet and outlet pressure gauges, and automatic condensate drain trap with manual override.

.3 Regenerative Desiccant Compressed Air Dryer:

.1 Unit shall be wall-mounted, complete with two drying towers containing desiccant beds sized to ensure that air velocity across the desiccant bed is not greater than 0.3 m/s (60 fpm) at 700 kPa (100 psig). Bed shall be sized so that the effects of desiccant aging during the first year are negated. Each tower shall be furnished with fill and drain ports to facilitate desiccant replacement.

.2 Unit shall be complete with On/Off switch, solid-state timer, control valves, and check valves. Purge air shall be exhausted through mufflers to reduce noise levels.

.3 Unit shall have a 3 psi maximum pressure drop and provide dry air with a □40°C (□40°F) dew point.

.4 Unit shall be sized to match required air consumption, 2.5 L/s (5 cfm) minimum.

2.29 Positive Displacement Flow Meters (Liquid)

.1 AWWA C700, revenue grade (± 1.5% accurate) positive displacement disc type suitable for fluid with bronze case and cast iron bottom cap, hermetically sealed register, remote reading to AWWA C706.

.2 Meter: Brass body meter with magnetic drive register.

.1 Service: Cold water, 50°C (122°F).

.2 Nominal Flow: to suit application.

.3 Pressure Drop at Nominal Flow: 35 kPa (5 psi).

.4 Maximum Operating Pressure: 860 kPa (125 psi).

.5 Accuracy: 1½ percent.

.6 Maximum Counter Reading: 100 million litres.

.7 Size: As required – see drawings/piping schematic.

.8 Output signals shall be BACnet®, BACnet/IP, or via individual analog and pulse outputs.

.3 Application: domestic water sub metering.

2.30 Combustible Gas Flow Meters

.1 Application:

.1 Provide an Inline Thermal Mass Flow Meter for line sizes $^{3}/_{4}$NPS to $1^{1}/_{4}$NPS.

.2 Provide an Insertion Thermal Mass Flow Meter for line sizes 1½ NPS and larger.

.2 General:

.1 Meters shall be complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.

.2 A certificate of NIST* traceable calibration shall be provided with each system.

.3 A certificate of calibration shall be provided with each flow meter.

.4 Provide flow conditioner if required to meet manufacturer's minimum upstream pipe run requirements.

.3 Warranty:

.1 Each flow meter shall be covered by the manufacturer's two-year warranty.

.4 The Insertion flow meter shall be hand insert able up to 1724 kPa (250 psi).

.5 Materials of construction for wetted metal components shall be 316 SS.

.6 The flow meter shall provide SFPM* flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation.

.7 Accuracy shall be within:

.1 ± 1% of rate from 500-7000 SFPM

.2 ± 2% of rate from 100-500 SFPM

.3 Overall turndown shall exceed 1000:1.

.8 Output signals shall be a minimum of:

.1 (1) analog 4-20mA output

.2 (1) scalable pulse output for totalization.

.9 Integral mounted graphical display.

.1 Flow rate and total flow.

.2 Output signals shall be BACnet®, BACnet/IP, or via individual analog and pulse outputs.

3. EXECUTION

3.1 Installation

.1 Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the project scope of work to maintain existing system operational, as is now. All field wiring shall be by this contractor.

.2 Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.

3.2 Electrical Wiring Scope

.1 This contractor shall be responsible for all power and control wiring on this project. Control contractor is to hire directly an electrical contractor.

.2 This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

.3 Interlock wiring shall be run in separate conduits from BAS associated wiring.

.4 Provide network wiring for equipment that is called to be integrated to the BAS.

3.3 Electrical Wiring and Connection Installation

.1 All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

.2 Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.

.3 Install raceways, boxes, and cabinets as required in accordance with NEC.

.4 Install building wire and cable according to NEC.

.5 Installation shall meet the following requirements:

.1 Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.

.2 Install exposed cable in raceway or conduit.

.3 Install concealed cable using plenum rated cable.

.4 Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

.5 Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

.6 Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

.7 All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.

.6 Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.

.7 Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

.8 Install conduit adjacent to machine to allow service and maintenance.

.9 Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

.10 Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

.11 Ground equipment.

3.4 Communication Wiring

.1 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

.2 Do not install communication wiring in raceway and enclosures containing Class 1 wiring.

.3 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

.4 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

.5 Cable bundling:

.1 RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.

.2 RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.

.3 RS485 cabling run between floors shall be in a communication only conduit.

.4 RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.

.5 Ethernet cabling shall be in a communication only conduit.

.6 Ethernet and RS485 can be run together.

.7 Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.

.6 RS485 Cabling

.1 RS485 cabling shall be used for BACnet MS/TP networks.

.2 RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.

.3 The shields shall be tied together at each device.

.4 The shield shall be grounded at one end only and capped at the other end.

.5 Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.

.7 Ethernet Cabling

.1 Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.

.2 CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.

.3 Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.

.4 When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

.8 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

.9 All runs of communication wiring shall be unspliced length when that length is commercially available.

.10 All communication wiring shall be labeled to indicate origination and destination data.

.11 Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.5 Installation of Sensors

.1 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

.2 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

.3 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

.4 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m2 (1 ft of sensing element for each 1 ft2) of coil area.

.5 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

.6 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

.7 Differential air static pressure.

.1 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

.2 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

.3 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.6 Installation of Actuators

.1 Mount and link control damper actuators according to manufacturer's instructions.

.1 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

.2 Provide all mounting hardware and linkages for actuator installation.

.2 Electric/Electronic

.1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

.3 Pneumatic Actuators

.1 Size pneumatic damper actuator to operate the related control damper(s) with sufficient reserve power to provide smooth modulating action or two-position action. Actuator also shall be sized for proper speed of response at the velocity and pressure conditions to which the control damper is subject.

.2 Pneumatic damper actuators shall produce sufficient torque to close off against the maximum system pressures encountered. Size the pneumatic damper actuator to close off against the fan shutoff pressure, as a minimum.

.3 Where two or more pneumatic damper actuators are installed for interrelated operation in unison, such as dampers used for mixing, provide the dampers with a positive pilot positioner. The positive pilot positioner shall be directly mounted to the pneumatic damper actuator and have pressure gauges for supply input and output pressures.

.4 The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating. Provide at least one actuator for each damper section. Each damper actuator shall not power more than 2 m2 (20 ft2) of damper.

.5 Use line shafting or shaft couplings (jackshafting) in lieu of blade-to-blade linkages or shaft coupling when driving axially aligned damper sections.

3.7 Fiber Optic Cable System

.1 Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

.2 All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

.3 All terminations shall to be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.

3.8 Identification

.1 Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows: CAUTION This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to “Off” position before servicing.

.2 Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows: CAUTION This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

.3 Control Equipment and Device labeling:

.1 Tag all new equipment as well as existing (that has not yet been tagged) that is part of this control upgrade scope of work.

.2 Labels and tags shall match the unique identifiers shown on the as-built drawings.

.3 All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.

.4 All sensors and actuators not in occupied areas shall be tagged.

.5 Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.

.6 Duct static pressure taps shall be tagged at the location of the pressure tap.

.7 Each device inside enclosures shall be tagged.

.8 Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:

.1 First, the design drawings, or

.2 Second, the control as-builts, or

.3 Third, the DDC addressing scheme

.9 Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

.4 Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12 point height minimum.

.5 Manufacturers’ nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

.6 Identification of Wires

.1 Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.

.2 Tag each network wire with a common identifier on each end.

.3 Tag each 120V power source with the panel and breaker number it is fed by.

.7 Identification of Conduits:

.1 Identify the low voltage conduit runs as BAS conduit, including power feeds.

.2 Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.

.3 For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.

.4 Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.

.5 Identify all BAS communication conduits the same as above.

3.9 Field Quality Control

.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

.1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

.2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.

.3 Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

.1 Delete first paragraph below if factory-authorized service representative is not required.

.2 Engage a factory-authorized service representative to perform startup service.

.3 Replace damaged or malfunctioning controls and equipment.

.1 Start, test, and adjust control systems.

.2 Demonstrate compliance with requirements, including calibration and testing, and control sequences.

.3 Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.10 System Checkout and Startup

.1 Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.

.2 After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:

.1 Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.

.2 Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.

.3 Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.

.4 Inspect the reading of each status switch to verify the DDC reads the open and close correctly.

.5 Command each relay to open and close to verify its operation.

.6 Command each 2-position damper actuator to open and close to verify operation.

.7 Command each 2-position valve to open and close to verify operation.

.8 Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.

.9 Ramp each modulating output signal, such as a VFD speed, to verify its operation.

.10 Test each safety device with a real life simulation, for instance check freezestats with ice water, water detectors with water, etc.

.3 Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.

.4 Verify that each DDC controller communicates on its respective network correctly.

.5 After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:

.1 Start systems from DDC.

.2 Verify that each setpoint can be met by the system.

.3 Change setpoints and verify system response.

.4 Change sensor readings to verify system response.

.5 Test safety shutdowns.

.6 Verify time delays.

.7 Verify mode changes.

.8 Adjust filter switches and current switches for proper reactions.

.9 Adjust proportional bands and integration times to stabilize control loops.

.6 Perform all program changes and debugging of the system for a fully operational system.

.7 Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.

.8 After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.11 System Commissioning, Demonstration and Turnover

.1 The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Departmental Representative, the BAS contractor shall completely test the BAS using the approved test procedure.

.2 After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Departmental Representative and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).

.3 The BAS contractor shall fix punch list items within 30 days of acceptance.

.4 When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.12 Project Record Documents

.1 Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

.1 Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.

.2 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.

.3 Operation and Maintenance (O & M) Manual.

.1 As-built versions of the submittal product data.

.2 OM manuls to be linked on DDC graphics

.3 Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.

.4 Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

.5 Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

.6 Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

.7 Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.

.8 Graphic files, programs, and database on electronic media.

.9 List of recommended spare parts with part numbers and suppliers.

.10 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.

.11 Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.

.12 Licenses, guarantees, and warranty documents for equipment and systems.

.2 Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:

.1 Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.

.2 Description of manual override operation of all control points in system.

.3 BMS system manufacturers complete operating manuals.

.3 Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

.1 Complete as-built installation drawings for each building system.

.2 Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.

.3 Photographs and/or drawings showing installation details and locations of equipment.

.4 Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.

.5 Parts list with manufacturer's catalog numbers and ordering information.

.6 Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.

.7 Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.

.8 Maintenance and repair instructions.

.9 Recommended spare parts.

.4 Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:

.1 Complete programming manuals, and reference guides.

.2 Details of any custom software packages and compilers supplied with system.

.3 Information and access required for independent programming of system.

3.13 Training

.1 During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

.2 At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 16-hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:

.1 Explanation of drawings and operator’s maintenance manuals.

.2 Walk-through of the job to locate all control components.

.3 Operator workstation and peripherals.

.4 DDC Controller and ASC operation/sequence.

.5 Operator control functions including scheduling, alarming, and trending.

.6 Explanation of adjustment, calibration and replacement procedures.

.3 Additional 8-hours of training shall be given after the 30 day shakedown period.

.4 Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer’s standard pricing such as transportation, meals, etc.

3.14 Identification

.1 Comply with Section 23 05 53 Identification for HVAC Piping and Equipment

.2 Permanent warning labels shall be affixed to all equipment that can be automatically started by the BAS.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N

This equipment is operating under automatic control and may start or stop at any time without warning.

.3 Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N

This equipment is fed from more than one power source with separate disconnects.

.4 All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the BAS address or termination number.

.5 All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.

.6 Permanently label or code each point of field terminal strips to show the instrument or item served.

.7 Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.8 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

.9 Identify room sensors relating to terminal box or valves with nameplates.

.10 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

END OF SECTION

1. GENERAL

1.1 Section Scope

.1 A description of the sequence of operation for each system, including ramping periods and reset schedules.

1.2 Related Requirements

.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 Section 21 05 01 – Common Work Results for Mechanical.

.3 Section 23 08 10 – Measurement and Verification Requirements.

.4 Section 25 05 00 – Common Work Results for Integrated Automation.

.5 Section 25 09 -02 – Measurement and Verification Software.

1.3 General

.1 The control sequences contain a general description of the operational intent for the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 Refer to control diagrams and equipment schedules in the contract drawings for additional requirements. Refer to Mechanical Motor list and points list in the contract drawings, and detailed specification sections for additional requirements.

.3 The Controls Contractor shall provide all necessary programming and equipment required to meet this sequence of operation.

.4 Contractor shall not remove or override any manufacturer's safeties.

.5 This Section includes control sequences for HVAC, lighting, external shading systems, subsystems, and equipment. The section also includes control sequences for integration of other building systems unrelated to the HVAC systems.

.6 Note that the sequences in this section outline overall operational intent. Coordinate all interface requirements with equipment for the sequences in this section to be successfully executed.

.7 Consult with the Mechanical Departmental Representative during the shop drawing stage to finalize the control sequences for each system. The controls contractor shall submit the final sequence of operation during shop drawing phase.

.8 Coordinate the sequence of operation in all Life Safety modes. Mechanical systems shall have hard-wired interface to the Fire Alarm Control Panel (FACP). During activation of Smoke Exhaust mode (as signaled by the FACP), all required fans and dampers are to operate via the Smoke Exhaust sequence as defined in this section and noted on the drawings. Only where absolutely necessary shall this Smoke Exhaust sequence involve the BMS Direct Digital Controls system. Fail-safe sequences (such as interrupting power to spring-return dampers) shall be utilized as much as possible. Special interfaces to fire mode terminals on Variable Frequency Drives for fan operation shall also be used to ensure the highest level of reliability.

.9 Hard-wired pressure safeties: The controls contractor shall provide static pressure safety via pressure sensors mounted upstream and downstream of all fans that have the capability of over-pressurizing AHU casings or ductwork (systems that have motorized dampers or fire smoke dampers that would “seal” the system on either the inlet or outlet side of the fan system). These safeties shall all have adjustable setpoints, be hardwired to shut down the fan system, and have manual reset type control. This applies to all systems with fans that are capable of generating a static pressure of 500 Pa (2” W.G).

1.4 Abbreviations

.1 The following abbreviations may be used in graphics, schematics, point names, and other control applications where space is at a premium.

AC	Air Conditioning		HTEX	Heat Exchanger
ACU	Air Conditioning Unit		HW	Hot Water
AHU	Air Handling Unit		HWP	Hot Water Pump
AI	Analog Input		HWR	Hot Water Return
AO	Analog Output		HWS	Hot Water Supply
AV	Analog Value		MAX	Maximum
AVG	Average (mean)		MIN	Minimum
AUTO	Automatic		MISC	Miscellaneous
AUX	Auxiliary		N/C	Normally Closed
C	Common		N/O	Normally Open
CHW	Chilled Water		OA	Outdoor Air
CHWP	Chilled Water Pump		OAT	Outdoor Air Temperature
CHWR	Chilled Water Return		OAH	Outdoor Air Humidity
CHWS	Chilled Water Supply		PIU	Powered Induction Unit
COND	Condenser		RA	Return Air
CW	Condenser Water		RF	Return Fan
CWP	Condenser Water Pump		RH	Relative Humidity
CWR	Condenser Water Return		RTU	Roof-top Unit
CWS	Condenser Water Supply		SA	Supply Air
DA	Discharge Air		SF	Supply Fan
DI	Digital Input		SP	Static Pressure
DO	Digital Output		TEMP	Temperature
DV	Digital Value		UH	Unit Heater
EA	Exhaust Air		UV	Unit Ventilator
EF	Exhaust Fan		VAV	Variable Air Volume
EVAP	Evaporator		VVTU	ariable Volume Terminal Ur
FCU	Fan Coil Unit		W/	With
HOA	Hand / Off / Auto		W/O	Without
HP	Heat Pump		WSHP	Water Source Heat Pump
HRU	Heat Recovery Unit			

1.5 Programming Requirements

.1 Provide all programming required to implement the control sequences and to make system operational, as well to meet design intent.

.2 Programs shall be modular in nature and shall be as structured as the language will permit.

.1 Unconditional “GOTO” statements shall be used sparingly and shall always jump forwards. All jumps from the body of a module shall target the end of that module. Similarly, jumps from the body of a sub-module shall target the end of that sub-module.

.2 All conditional "GOTO" statements, which make a single choice from multiple choice sub-module options, shall form the opening lines of code of the module. Each succeeding conditional jump shall direct the execution of software to the relevant sub-module which shall be in the reverse order of the conditional jump statement. The exit from each sub-module shall jump to the end of the module.

.3 All conditional "GOTO" statements, for "AND"/"OR" choices between sub-modules, shall form the opening line of code in each sub-module which the conditional statement controls.

.4 Do not use double negatives in programming language.

.3 All programs must include a sufficient number of comments to allow another person to make changes to the strategies at a later time.

.4 Additional programming may be provided by the Contractor as desired, so long as it does not affect the intended operation of the specified sequences. Ensure that all equipment will operate in a safe manner.

.5 Programming required for equipment safety may be installed by the Contractor as necessary. The Owner shall be notified of these changes as soon as practical.

.6 All deviations from the specified programming, except those related to equipment safety, must receive prior written approval from the Mechanical Departmental Representative.

.7 All control loops shall be tuned such that they are stable through all seasons and operating conditions including start-up.

.8 All HVAC controls shall implement Building operating modes. Unit system description is modifications to the Building operation modes.

.9 Staggered starting:

.1 Motors must not be allowed to start at the same time. Under all conditions of start-up, return from power failure or panel reset, there must be at least a 15 second delay between the time one motor starts and another is allowed to start.

.10 Motor and equipment status:

.1 All mechanical equipment motors that are enabled by the BMS shall be provided with status and alarm indication by a current sensor. This includes all pumps, fans and electric motor driven devices.

.2 Equipment status may also be indicated by flow switches as an alternate status indication, with prior acceptance by the Departmental Representative, or where specifically indicated in the Contract Documents.

.3 Exclude small unitary bathroom exhaust fans, domestic range hoods and manually operated fans and devices, unless noted otherwise.

.4 Current sensors shall provide status and an out of range alarm.

2. PRODUCTS

.1 Refer to Section 25 09 01 – Control Systems.

3. EXECUTION

3.1 Building Operating Modes

.1 Four operating modes are required: Purge, Occupied, Unoccupied and Fire. Mode flags are required for the purge, occupied and fire modes. By definition unoccupied mode occurs when both purge and occupied mode flags are not set (i.e. off).

.2 An optimum start routine shall be used to determine when the air systems are to begin operation such that adequate comfort conditions are reached just before occupancy begins.

.3 Occupied Mode:

.1 The beginning and ending time of this mode shall be determined by a weekly schedule. An annual holiday schedule shall be used to bypass statutory holidays.

.2 One weekly/annual schedule is required. Required flags: OCCUP (units yes/no).

.3 During this mode all spaces within the building are to be at occupied comfort conditions. Air systems are to be running. Heating and cooling are to be used as required.

.4 The optimum start routine enables the occupied mode flag prior to scheduled occupancy. This allows the air systems to condition the spaces such that they are comfortable at the time of scheduled occupancy.

.4 Purge Mode:

.1 This mode, indicated by flag PURGE (units yes/no), is used to purge the spaces with cool morning air on warm days or general purge due to high chloramines levels.

.2 Purge is allowed to start as soon as 3 hours before normal occupancy and is stopped as soon as the occupied mode starts or the time is later than 9:00 am. Once started it shall not stop until at least 30 minutes have elapsed or occupied mode has begun.

.3 This mode is allowed only if the outside air temperature is above 8°C and is at least 5°C lower than the average space temperature for free cooling purge. Chloramine purge may happen any time however do not allow space temperature to drop below 23°C.

.4 During this mode no mechanical cooling or heating shall be allowed.

.5 Purging shall be optimized such that it is only active long enough to bring space temperatures well into the comfort range. A reasonable initial estimate of this time in hours is:

.1 (RTA - 22.5) / (RTa - (OAT + 2)) * 8

.1 Where RTA = average room temperature

.2 OAT = outside air temperature.

.5 Fire Mode:

.1 Refer to specific equipment control sequences and drawings in addition to the requirements of this sub-section.

.2 Fire Alarm Systems in buildings will override BMS control of designated equipment in an alarm condition. The BMS shall monitor a set of contacts output from the fire alarm system for status indication of a building fire alarm. Control sequences of all components that participate during all Fire Alarm modes (such as Smoke Exhaust) shall be hard-wired where possible. Where not possible (such as position of dampers in various positions depending on fire alarm mode), once the signal has been received from the fire alarm control panel the BMS system shall modulate the Fan speed and damper positions as noted below to put the systems in fire mode before fire alarm control panel is to operate unit. The BMS Controls Contractor shall coordinate building equipment that is shut down by the Fire Alarm System.

.3 Prior to control of systems by the fire alarm control panel the following operations are be performed by the BAS system:

.1 Supply and return fans are to operate at design air flow speed as noted on the mechanical equipment schedules.

.2 Outside air and relief air dampers are to open up 100%.

.3 Mixed air damper is to close.

.4 The supply and return fan high duct pressure cut off shall remain active to protect the fan and ductwork.

.4 Upon detection of air handling unit shut down the BMS shall close associated valves and stop associated pumps unless otherwise noted.

.5 Alarms shall be annunciated by the BMS to indicate the equipment failure/shut down and the building fire alarm condition. The BMS shall not annunciate nuisance alarms for monitored input points on systems shut down by the BMS or fire alarm system (e.g. high supply air temperature, low duct static pressure, etc.).

.6 Equipment shut down by the fire alarm system shall not be automatically restarted until the following has occurred:

.1 Building fire alarm condition has been cleared and a registered signal has been received from the fire alarm panel to the BMS.

.2 BMS Operator acknowledges the fire alarm.

.3 BMS Operator with appropriate access level resets the BMS system shut down software point.

.7 Once the above conditions have been satisfied and the BMS receives a Post Fire Alarm Equipment restart command the BMS shall initiate the restart of any equipment shut down by the fire alarm system. The restart sequence shall provide an orderly start-up of the motors for each individual system with time delay between restarts of individual systems. Start of systems shall be according to normal system start up sequences. Only those motors which should be operational in accordance with the Occupancy Schedule or application software programming requirements shall be restarted.

3.2 Outside Air Conditions (OAT)

.1 Monitor outdoor air conditions using an outdoor air temperature sensor. Outdoor air temperature sensor value to be shown on control graphic. Connect via MODBUS router.

3.3 Variable Frequency Drive (VFD) Interface

.1 All variable frequency drives (VFDs) shall be native BACnet.

.2 The VFD interface shall be connected directly to the main BMS network trunk to monitor, display, trend ad report the following minimum points. VFD interface shall not be networked indirectly to the main BMS through equipment controllers:

.1 Speed Output

.2 Hand / Auto selection indication

.3 Drive Amps

.3 kW (compare instantaneous value, the connected motor nameplate HP/kW (constant) and the ratio).

.1 kWh

.2 Operating hours

.3 Warnings

.4 Faults

.4 The following points shall be hardwired to the BMS independently of Serial Communications interface so they can be monitored in the event network connection has failed.

.1 VFD Start/Stop

.2 VFD speed and feedback

.3 VFD Fault

3.4 Zone Sensors, Setpoints and Control Loops

.1 General:

.1 Refer to electrical drawings for locations and quantity of motion sensors and daylighting sensors.

.2 Zone Temperature

.1 Each zone shall have separate unoccupied and occupied setpoints, and separate heating and cooling setpoints. All setpoints shall be adjustable.

.2 Unless noted otherwise the occupied heating setpoint shall be 21°C and the occupied cooling setpoint shall be 25°C. The unoccupied heating setpoint shall be 16°C and the unoccupied cooling setpoint shall be 30°C.

.3 Room Temperature Occupied Set-points

Room Type	Set point (°C)	
	summer	winter
Pool Hall	27 (50-60% RH)	24 (50-60% RH)
Change room	24	24
Multi purpose room / Meeting Room	20-24	20-24
Seniors Lounge, Youth, Games, Arts room	20-24	20-24
Pre-school, indoor play area	22	22
Active studio	19	19
Gymnasium	22	20
Fitness room	19	18
Administration	25	22
Lobby	26	22
Mechanical room	uncontrolled	8
Offices /Classrooms	20-24	20-24

.1 Setpoint Overlap Restriction:

.1 The software shall maintain a minimum 2°C (adj.) deadband between the heating and cooling setpoints at all times.

.2 Each zone shall have a local occupant setpoint adjustment knob / button limited in software and active only in occupied mode:

.1 As a default, the occupied cooling setpoint shall be limited between 24°C and 26°C (adj.).

.2 As a default, the occupied heating mode setpoint shall be limited between 18°C and 22°C (adj.).

.3 The adjustment shall move both the existing heating and cooling set points upward or downwards by the same amount unless the limit has been reached.

.3 In zones that have 2 or more temperature sensors, the BMS operator shall be able to easily select (globally and individually) between min-average-max comparative control functions. The default shall be set for average unless noted otherwise.

.4 Daylight Sensor

.1 Provide daylight sensor(s) for each zone as noted on the electrical drawings and in the Sequence of Operations.

.5 Control Loops:

.1 Two separate control loops shall operate to maintain space temperature at setpoint, the Cooling Loop and the Heating Loop. Both loops shall be continuously active. The Cooling Loop shall maintain the space temperature at the active cooling set point. The output of the loop shall be a virtual point ranging from 0% (no cooling) to +100% (full cooling). The Heating Loop shall maintain the space temperature at the active heating set point. The output of the loop shall be a virtual point ranging from 0% (no heating) to -100% (full heating).

.2 Loops shall use proportional + integral logic or fuzzy logic. Proportional-only control is not acceptable, although the integral gain shall be small relative to the proportional gain. P and I gains shall be adjustable from the Operator Workstation.

.3 Control Modes:

.1 Heating Mode: when the output of the space heating control loop is less than zero.

.2 Cooling Mode: when the output of the space cooling control loop is greater than zero and the output of the heating loop is equal to zero.

.3 Dead band Mode: when not in either the Heating or Cooling Mode.

.6 Zone Modes:

.1 Occupied Mode: A zone is in occupied mode when the time of day is between the system's scheduled occupied start and stop times AND occupancy is detected by the zone motion sensor.

.2 Stand-By Mode: A zone is in stand-by mode when the time of day is between the system's scheduled occupied start and stop times AND occupancy has not been detected in the zone for more than 15 minutes (adj.).

.3 Occupant Override Mode: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule. The time of temporary occupied mode shall be initially set to 60 minutes. Timer shall reset each time the zone override button is pressed.

.4 Optimal Start: The unit shall use an adaptive optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the warm-up or cool-down response time for the next unoccupied period. Refer to the Air handling unit sequence of operation for more information.

.5 Unoccupied Mode: A zone is in unoccupied mode when not in any other mode.

.7 Alarms

.1 High zone temperature: if zone temperature is greater than cooling setpoint by 3°C (adj.) for a minimum of 60 minutes (adj.) continuously, modulate damper to maximum position and annunciate alarm.

.2 Low zone temperature: if zone temperature is less than heating setpoint by 3°C (adj.) for a minimum of 60 minutes (adj.) continuously, modulate damper to minimum position and annunciate alarm.

.3 High Zone CO2 concentration: if the zone CO2 concentration is greater than 10% (adj.) above setpoint for more than 30 minutes (adj.) annunciate alarm.

.4 Unstable PID loop: If any PID loop continues to cycle its output more than 40% or its range (adj.) 3 times (adj.) in any 60 minute interval, annunciate alarm.

.5 Inhibit alarms after zone set point is changed for a period of 20 minutes per degree of change (e.g. if set point changes from 21°C to 23°C, inhibit alarm for 40 minutes after the change) and while the System is in Warm-up or Cool-down Modes.

.8 Points List

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Zone Temp	X							X		X
Zone CO2 concentration	X							X		X
Zone relative humidity	X							X		X
Zone daylight sensor	X							X		X
Zone motion detection			X					X		X
Zone override			X					X		X
Zone heating setpoint					X			X		X
Zone cooling setpoint					X			X		X
Heating loop output					X			X		X
Cooling loop output					X			X		X
Zone dewpoint temp					X			X		X
Zone Environmental Index					X			X		X
Schedule							X			
High Zone Temp									X	
Low Zone Temp									X	
High Zone CO2 concentration									X	

3.5 Zone Interface

.1 Provide a 225mm (7”) touch screen display for user interface and display.

.2 Provide a low-voltage momentary switch or dimmer, as noted on the electrical drawings, to allow for user activation of lighting upon entering room.

.3 As a default, the touch screen shall:

.1 Display the time, space temperature, space humidity and space CO2 concentration.

.2 Provide interface for user control of light dimming, manual control of operable shades, and user adjustment of space temperature setpoint.

.4 Allow for three “scene” control functions to be determined at time of construction. Scenes will include pre-set adjustments to lighting levels and operable shades.

.5 Allow for software icon at bottom of screen to pull up energy and water display. Screen shall default to normal display after 20 seconds (adj.) of inactivity.

3.6 Air Handling Unit, Scheduled (AHU-1, AHU-2, AHU-3)

.1 General:

.1 In general air handling units shall provide ventilation to the space, maintain temperature set point (adjustable) within the space and provide heating and cooling. Air handling units will be provided with packaged heating and cooling. Each air handler will be provided with a manufacturer's control package. Controls must be compatible with the packaged controllers.

.2 Run Conditions – Scheduled:

.1 The air handling units shall run according to a user defined and adjustable schedule.

.2 Default schedule shall be 24/7, 7 days per week fully programmable with night setback

.3 SAT set-point shall be set to 20°C (adjustable).

.3 Alarms:

.1 Air Handling Unit Failure: Commanded on, but the status is off.

.2 Air Handling Unit in Hand: Commanded off, but the status is on.

.4 Fire Alarm:

.1 Shut-off units via the BMS when a fire event is registered at the BMS control panel.

.5 Points:

.1 Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Unit Status			X					X		X
Unit Start/Stop				X				X		X
Schedule							X			X
Unit Failure			X						X	X
Unit Hand			X						X	X

3.7 Ceiling Fans, Scheduled (CF-1, CF-2)

.1 General:

.1 Ceiling fans to operate to minimize temperature stratification in the building. All ceiling fans will be provided with a single controller for all the ceiling fan control. Controls must be compatible with packaged ceiling fan controller.

.2 Run Conditions – Scheduled:

.1 The fan shall run according to a user defined and adjustable schedule.

.2 Default schedule shall be 24/7, 7 days per week.

.3 Fan:

.1 The fan shall run and stop as scheduled.

.2 The controller shall monitor the fan status.

.4 Alarms:

.1 Fan Failure: Commanded on, but the status is off.

.2 Fan in Hand: Commanded off, but the status is on.

.5 Fire Alarm:

.1 Shut-off units via the BMS when a fire event is registered at the BMS control panel.

.6 Points:

.1 Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Fan Status			X					X		X
Fan Start/Stop				X				X		X
Schedule							X			
Fan Failure									X	

3.8 Domestic Hot Water System, Scheduled (DHWT-1)

.1 General:

.1 The domestic hot water system is served by a single gas-fired (propane) water heater complete with integrated controls. Recirculation pump, P-1, will provide hot water recirculation for the domestic hot water system.

.2 Controls Description:

.1 Gas fire DHWT heaters have internal controls to maintain internal tank water temperature. Supply water temperature to be set by local controller.

.2 DDC system is to operate DHW recirc pump P-1 to maintain a return water temperature of 49°C, measured just upstream of the pump via aquastat. Monitor DHW temperature supplied to the building

.3 Should the tank temperature or leaving water temperature not be at set point for more than a 30 minute period, BMS shall alarm for operator to investigate.

.3 Fire Alarm:

.1 Shut-off units via the BMS when a fire event is registered at the BMS control panel.

.4 Points:

.1 Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Supply Temperature	X							X		X
Return water Temperature	X							X		X

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Return water Temperature setpoint					X			X		X
P-1 Schedule							X			
Pump P-1 Status			X					X		X
Pump P-1 Start/Stop				X				X		X
DHWT Supply Temperature alarm			X						X	
DHWT-* temperature alarm			X						X	

3.9 Interior Lighting

.1 General:

.1 All low voltage interior lighting shall be controlled directly through the BMS. Refer to the Electrical drawings for control sequence. All variable shall be adjustable via the graphics.

.2 Provide full graphics for all interior lighting zones including status, dimming output, schedule, photocell input and occupancy mode.

3.10 Exterior Lighting

.1 General:

.1 All exterior lighting shall be controlled directly through the BMS. Refer to the Electrical drawings for control sequence. All variables shall be adjustable via the graphics.

.2 Provide full graphics for all exterior lighting zones including status, schedule and photocell input.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section describes the Common Work Results applicable to electrical disciplines.

1.2 GENERAL

.1 The general conditions and general requirements together with all amendments and supplements contained in the General Specifications shall form an integral part of the electrical specification and will be made part of this contract.

.2 Reference to “Electrical Divisions” shall mean all Divisions 26, 27, 28, 33, 34 and 48.

.3 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.

.4 Confirm with the architectural plans and specifications the extent and nature of the work and how it will affect the electrical work. Include in the bid price for any complications or additional work described therein.

.5 Review mechanical plans and specifications for the extent of electrical work required to make mechanical systems complete and include this work in the bid price.

.6 Review structural plans for limitations of penetrations or inclusions of electrical equipment. In the bid price, allow for avoiding critical areas with electrical equipment.

.7 Review existing record plans and site conditions for limitations of penetrations or inclusions of electrical equipment. In bid price, allow for avoiding critical areas with electrical equipment.

.8 Comply with the requirements of the General Contract, and coordinate the installation with all other trades on site.

.9 Confirm on-site the exact location of equipment, outlets, and fixtures and the location of outlets for equipment supplied by other trades.

1.3 SEPARATE PRICE

.1 Include in bid price itemized price for fire alarm system.

1.4 WORK INCLUDED

.1 This work shall include the supply and installation of all the necessary materials and apparatus for complete operating systems as indicated on the plans or mentioned in this specification, with the exception of materials or apparatus specifically mentioned to be omitted or to be supplied by Departmental Representative.

.2 Items obviously necessary or reasonably implied to complete the work, shall be included as if shown on drawings and noted in the specifications.

.3 All materials, tools, appliances, scaffolding, apparatus and labour necessary for the execution, erection and completion of the systems described herein shall be furnished. This includes providing lighting and power for own work.

.4 This contract shall include, but is not confined to, the following scope of work:

.1 Main power service
.2 Power distribution equipment
.3 Power connections and outlets
.4 Fault, Coordination and Arc Flash Hazard Studies
.5 SPD system
.6 Mechanical equipment connections
.7 Lighting system
.8 Lighting controls system
.9 Exit signs
.10 Emergency lighting
.11 Fire alarm system
.12 Data/Communications systems and Equipment

.5 Complete all electrical connections to equipment and accessories pertaining to this contract and leave all in operating condition to the Departmental Representative's satisfaction.

.6 Remove all existing electrical equipment and material made redundant by this contract or in conflict with work to be carried out. Reroute, reinstall or replace existing electrical material that becomes necessary due to work carried out by this contract so a complete working electrical system will be retained in all areas affected by this installation.

.7 Whether indicated or not on electrical plans, provide a dedicated 120 volt circuit fed from a 15 amp 1-pole circuit breaker to all DDC control panels. Confirm final locations and quantities with Mechanical Contractor and Mechanical Drawings.

.8 Provide 120 volt power source to mechanical equipment for internal lights and receptacles, whether indicated on electrical plans or not. Confirm final locations and quantities with Mechanical Contractor and Mechanical Drawings.

1.5 WORK EXCLUDED

.1 The contract scope of work shall not include the following:

.1 Low voltage mechanical systems control wiring where indicated in electrical and mechanical specifications to be done by controls contractor shall be excluded from the electrical contractor work as noted.

1.6 DRAWINGS AND SPECIFICATIONS

.1 The drawings and specifications compliment each other and what is called for by one is binding as if called for by both. If there is any doubt as to meaning or true intent due to a discrepancy between the electrical drawings and specifications, and all other contract documents, obtain written ruling from Departmental Representative prior to tender closing. **Failing this, the most expensive alternative is to be allowed for.**

.2 The plans show the approximate location of outlets and apparatus but the right is reserved to make such changes in location as may be necessary to meet the emergencies of construction in any way. No extra will be allowed for such changes to any piece of electrical equipment unless the distance exceeds 3 metres, or if the relocation is required after initial installation is complete.

.3 It is imperative that the contractor visit the site and completely familiarize himself as to the work to be undertaken.

1.7 CODES AND STANDARDS

.1 All electrical work shall be carried out in accordance with the latest edition of the CEC C22.1 (Canadian Electrical Code) as amended and adopted by the Province of British Columbia and to the satisfaction of the Electrical Inspection Authority having jurisdiction, except where specified or specifically stated otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1 latest edition, except where specified or specifically stated otherwise.

.3 All work shall be carried out in accordance with the National Building Code current edition (including all local amendments) to the satisfaction of local building inspector authority having jurisdiction.

.4 Any electrical material and/or equipment supplied by any contractor or sub-contractor for installation on this project must bear evidence of CSA approval or special CSA certification acceptable to the Chief Electrical Inspector for the Province of British Columbia.

1.8 CARE, OPERATION AND START-UP

.1 Instruct Departmental Representative in the 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 all aspects of its care and operation.

1.9 VOLTAGE RATINGS

.1 Operating voltages: to CAN3-C235 latest edition.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.10 PERMITS, FEES AND INSPECTION

.1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Pay all associated fees.

.3 Fees will cover all routine inspections by the District Electrical Inspector. Any fees for follow-up inspections found to be necessary by the District Electrical Inspectors as a result of incorrect work shall be borne by this contractor without any cost to the Departmental Representative.

.4 Notify Departmental Representative of changes required by Electrical Inspection Department prior to making changes.

.5 Furnish Certificates of Acceptance from Electrical Inspection Department on completion of work to Departmental Representative.

.6 Submit to Electrical Inspection Department necessary number of drawings and specifications for examination and approval prior to commencement of work. Obtain electrical permit and pay associated fees.

.7 Furnish to Departmental Representative on completion of work Certificates of Acceptance from Electrical Inspection Department.

1.11 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with the Construction Waste Management Plan as established by the Construction Manager.

.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 approved by Departmental Representative.

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

1.12 SINGLE LINE ELECTRICAL DIAGRAMS

.1 Provide single line electrical diagrams under plexiglass in glazed frames as follows:

.1 Electrical distribution system: locate in main electrical room.

.2 Electrical power generation and distribution systems: locate in power plant rooms.

.2 Drawings: 500mm x 350mm minimum size.

1.13 FIRE ALARM RISER

.1 Provide fire alarm riser diagram, plan and zoning of building in glazed frame at fire alarm control panel.

.2 Drawings: 500mm x 350mm minimum size.

1.14 LOCATION OF OUTLETS

.1 Locate outlets in accordance with these specifications and as indicated on the Architectural and Electrical drawings.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm 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. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

.5 Provide 120 volt power to all Direct Digital Control (DDC) panels indicated on Mechanical Drawings and Specifications, where shown or not on Electrical Drawings.

1.15 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 on the Architectural and Electrical drawings.

.1 Local switches: 1200 mm.

.2 Wall receptacles:

.1 General: 400 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.

.4 Telephone and interphone outlets: 300 mm.

.5 Pay Telephone Outlets: 1194mm

.6 Wall mounted telephone and interphone outlets: 1500 mm.

.7 Fire alarm stations: 1200 mm.

.8 Fire alarm bells: 2100 mm (or if in conflict with ceiling, 300mm below ceiling).

.9 Television outlets: 300 mm.

.10 Wall mounted speakers: 2100 mm.

.11 Clocks: 2100 mm.

.12 Door bell pushbuttons: 1500 mm.

1.16 LOAD BALANCE

.1 Measure phase current to panelboards with normal loads (lighting and mechanical) 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 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State voltage, time and date at which each load was measured.

1.17 CONDUIT AND CABLE INSTALLATION

.1 Install flashing and gooseneck assembly for all roof penetrations for running cables to serve roof mounted equipment.

.2 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be sized for free passage of conduit, and protruding 50mm each side.

.3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.4 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

1.18 EXTRA WORK

.1 Any extra work ordered to be done shall be governed by this specification unless specific instructions or clauses are contained in the Change Order. In such cases, these instructions or clauses shall supersede those of the specification for this particular application only.

1.19 FIELD QUALITY CONTROL

.1 All electrical work to be carried out by qualified, licensed electricians or supervised apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks. The activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.

.2 The work of this division to be carried out by a contractor who holds a valid Electrical Contractor License as issued by the Province that the work is being conducted.

.3 Conduct and pay for following tests:

- .1 Power distribution system including phasing, voltage, grounding and load balancing.
- .2 Circuits originating from branch distribution panels.
- .3 Lighting and lighting control.
- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: access control, intrusion, fire alarm system, communications.

.4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.5 Insulation resistance testing:

- .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
- .2 Megger 350V - 600 V circuits, feeders and equipment with a 1000V instrument.
- .3 Check resistance to ground before energizing.

.6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.7 Submit test results for Departmental Representative’s review.

1.20 CO-ORDINATION OF TRADES

.1 Consult with Construction Manager and all subtrades involved to confirm the location of the various outlets and equipment, and cooperate fully to ensure that no conflict arises during the installation.

.2 Special care shall be taken that equipment, outlets, junction boxes or pullboxes will not be obstructed by other structure, equipment, pipes or ducts installed under this general contract by other trades.

.3 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra

cost to the Departmental Representative, without the Departmental Representative's written approval.

.4 The drawings indicate the general location and route to be followed by the electrical services. Where details are not shown on the drawings or only shown diagrammatically, the services shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All services in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All electrical services shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

.5 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Architect and the Departmental Representative and all affected parties.

.6 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Departmental Representative of space problems before installing any material or equipment. Demonstrate to the Departmental Representative on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.21 SUBSTITUTIONS

.1 Unless otherwise noted on the plans or specifications, substitutions may be approved by the Departmental Representative if requested by the contractor or by equipment suppliers, for items specified by the manufacturer's catalogue number.

.2 Requests for approval of such substitutions shall be submitted at least ten (10) working days prior to the tender closing date.

.3 Complete description and data sheets of proposed substitution shall accompany the application and supplier must be prepared to submit samples for approval on short notice.

.4 Proposed substitutions must be at least of equal quality to that of the specified item. The manufacturer's specification of the specified item shall apply for comparison if no other clause of this specification applies. The decision of the Departmental Representative to accept or reject shall be final.

.5 Off-the-shelf items such as standard boxes, EMT, which are specified by description only or indicated on the drawings, without any manufacturer, model, type or catalogue number, do not require approval prior to the tender closing date.

.6 Submit list of alternates used, within one week after acceptance of tender.

1.22 PROTECTION OF EQUIPMENT

.1 This contractor shall provide and ensure maximum protection of electrical equipment on the site. Electrical equipment, including existing electrical equipment, shall be kept clean and dry at all times and caution shall be taken to ensure no mechanical damage is done to the equipment. Equipment shall not be

delivered to the site until it can be stored safely or placed in final position and the space is clean.

1.23 DAMAGES

.1 If the finish of electrical equipment is damaged either when received or during installation, have such equipment completely refinished and restored to its original condition at no cost to the Departmental Representative.

.2 Irreparably damaged equipment shall be replaced at no cost to the Departmental Representative.

1.24 SHOP DRAWINGS

.1 Submit shop drawings, product data and samples in accordance with the contract specifications.

.2 Shop drawings and product data shall indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.

.3 Where applicable, include wiring, single line and schematic diagrams.

.4 Include wiring drawings or diagrams showing interconnection with work of other sections.

.5 Prior to manufacture of any item made specifically for this job, submit detailed drawings of the item through the Construction Manager.

.6 Shop drawings must be received by the Departmental Representative at a date early enough to permit reasonable study prior to approval and manufacture, or to permit alterations where necessary. Late submissions of shop drawings will be sufficient reason for a stoppage of construction pending approval, or removal and replacement of any unsatisfactory item at the contractor's expense.

.7 Shop drawings/product data content:

- .1 Shop drawings submitted title sheet.
- .2 Data shall be specific and technical.
- .3 Identify each piece of equipment.
- .4 Information shall include all schedule data.
- .5 Advertising literature will be rejected.
- .6 The project and equipment designations shall be identified on each document.
- .7 The shop drawings/product data shall include:
  - .1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with all equipment weights and mounting point loads.
  - .2 Mounting arrangements.
  - .3 Control explanation and internal wiring diagrams for packaged equipment.
  - .4 A written description of control sequences relating to the schematic diagrams.

1.25 CUTTING AND PATCHING

.1 This contractor is responsible for all cutting or blocking out required to install electrical equipment.

.2 If this contractor makes excessive cuts or does not coordinate work so that finished work requires cutting or patching, then this contractor shall pay for all patching to original condition.

.3 Any dispute resulting from this shall be referred to the Departmental Representative for decision.

.4 Prior to any major cutting of walls or floor, review the proposed location, size and method with the Departmental Representative. This includes notification when cutting or coring into any fire rated construction.

1.26 FIRE STOPPING

.1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 01 33 00.

.2 Submit material safety data sheets provided with product delivered to job-site.

.3 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture’s products per specified requirements. A supplier’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

.4 The work is to be installed by a contractor with at least one of the following qualifications:

.1 FM 4991 Approved Contractor

.2 UL Approved Contractor

.3 Accredited Fire Stop Specialty Contractor

.5 Installer shall have minimum 3 years of experience with fire stop installation.

.6 Seal all openings for conduit or sleeve penetrations in fire rated and smoke rated separations using approved materials.

.7 All block outs and access slots to be sealed using approved fire stopping assembly. Provide full details for all fire stopping applications as they relate to each application.

.8 Provide shop drawings for all fire stopping products, including assembly details as it relates to each application. Products shall be ULC approved as an assembly.

.9 Allow for the destructive testing of 10% of fire stopping applications. Should installations not conform to manufacturer’s details, an additional 25% of installation will be destructively tested and should there be more failures, the contract OR will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the Departmental Representative.

1.27 PROTECTION OF EXPOSED LIVE EQUIPMENT

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.

.3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

1.28 SPRINKLER PROTECTION

.1 Provide drip covers or CSA Type 2 enclosure for all new surface mounted panelboards and cabinets in sprinklered rooms.

.2 Provide drip covers for all communications backboards in sprinklered rooms.

.3 Provide sprinkler covers for all communications racks in sprinklered rooms.

1.29 INSPECTIONS AND TESTS

.1 Notify the Departmental Representative and authorities having jurisdiction at least five (5) working days in advance when the installations will be ready for inspection or testing.

.2 Test reports, signed by all attending authorities, shall be submitted to the Departmental Representative through the General Contractor after successful completion of an inspection or test.

.3 Conduct all tests in a thorough and complete manner to the satisfaction of the Departmental Representative and pay for any fees incurred to complete tests.

.4 Furnish the Departmental Representative with a copy of Certificate of Inspection from B.C. Electrical Safety Branch indicating that all work has been satisfactorily completed and issued prior to final connection.

1.30 CLEAN UP

.1 Vacuum clean all new raceways and any electrical equipment. Ensure that no debris or spare parts are left in any electrical equipment.

.2 Any scrap material shall be removed from the site and disposed of by the Contractor.

.3 At time of final cleaning, clean lighting reflectors, lenses and other lighting surfaces that have been exposed to construction dust and dirt.

1.31 SURPLUS MATERIALS

.1 All material removed from existing site and not being reused in this contract shall be the property of the Departmental Representative and delivered as directed by the Departmental Representative. Material as it becomes surplus shall be reviewed by the Departmental Representative and that part considered of value to the Departmental Representative shall be classed as surplus material, all other becomes scrap material, and shall be disposed of by the contractor.

1.32 SPARE PARTS

.1 This contract calls for spare parts or material. These are to be provided new in unopened cartons to the Departmental Representative at the time of substantial completion of the contract.

.2 Provide Departmental Representative with spare lamps in unopened cartons. Quantity of each lamp source type to be 10% of total project amount.

.3 Obtain a signed receipt from the Departmental Representative for all these parts or materials and include a copy in the front of the maintenance manual. Without

this receipt these items will be treated as a deficiency and the cost withheld at twice the estimated value by the Departmental Representative.

1.33 AS BUILT DRAWINGS

.1 Obtain two (2) sets of white prints for the sole purpose of recording changes in installation as they occur. One (1) set is to be used in the field for day-to-day recording, and one (1) set for submittal after completion.

.2 These plans shall be kept up-to-date as changes occur and shall be available to be inspected by the Departmental Representative.

.3 Arrange and pay for the incorporation of any "as-built" changes to digital PDF plans and AutoCAD plans on disks. These changes shall be of similar quality of presentation as the original plans. NOTE: All plans whether requiring as-built changes or not, shall be included in this disk.

.4 These amended drawings shall be given to the Departmental Representative at time of final inspections.

.5 "As-built" drawings shall include the location and circuit numbers of junction boxes in ceiling spaces, and all conduits placed in or under poured concrete. Note normal depth of conduits below top of concrete slab.

1.34 OPERATING AND MAINTENANCE MANUALS

.1 Submit **four sets** of operating and maintenance manuals for equipment or as requested by the general section of the contract. Include descriptive and technical data, all shop drawings, operating procedures, routine and preventative maintenance, wiring diagrams, spare parts lists, warranties, service companies, suppliers for replacement parts, test results, fire alarm certificate of verification, electrical inspection authority certificate and contract guarantee.

.2 Submit documentation in **green colored** heavy duty three ring binders, with lettering on spine identifying: "OPERATING AND MAINTENANCE MANUAL", project title and system names.

.3 Submit one copy for approval by Departmental Representative prior to assembly of final sets.

1.35 DEMONSTRATION OF SYSTEMS

.1 Instruct Departmental Representative and operating personnel in the operation, care and maintenance of equipment.

.2 Arrange and pay for services of manufacturer's factory service Departmental Representative to supervise start-up of installation, check, adjust, balance and calibrate components.

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

1.36 WARRANTY

.1 Within a period of one year from the date of final acceptance of work, replace or repair at own expense any defect in workmanship or material. Reused material shall be operating satisfactorily at the time of final acceptance but subsequent failures are not the responsibility of this contractor.

.2 Warranties for equipment having more than one year guarantee shall be made out to Departmental Representative, and copies shall be provided in the maintenance manuals.

1.37 PAINTING

.1 Arrange and pay for the painting of the devices noted in these specifications, in particular:

.1 Exposed conduits and conduit fittings.

.2 Painting shall be to match colour and finish of adjacent walls, with at least two coats of sprayed enamel paint to the satisfaction of the Departmental Representative.

1.38 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Provide a coordination/protective study and short circuit study of all equipment specified herein and submit for review.

.2 Include the following:

.1 All circuit breaker overcurrent, overload, and ground fault devices larger than 60 amps.

.2 All panelboards, MCCs, emergency generator and switchgear, connecting feeder cables

.3 Transformer damage curves, magnetizing currents for the transformer

.4 Locked rotor currents, acceleration times and damage curves for motors 75 HP and larger

.5 Generator overcurrent device, generator short circuit curves

.6 Any additional data necessary for successful completion of the coordination and short circuit study

.3 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker trippings time or otherwise.

.4 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.

.5 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.

.6 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.

.7 Include a list of recommended settings for each relay.

.8 Prepare an arc fault analysis including all labelling for equipment.

.1 Arc fault labels to indicate system voltage, fault level and PPE level required.

.9 Qualifications

.1 This study shall be performed by and bear the stamp and signature of a Professional Engineer registered in the Province of British Columbia.

.2 Relay style, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of this study and shall be included at no extra cost.

.10 Submittals

.1 Submit a preliminary study with proposed settings based on actual equipment being supplied as part of the initial shop drawing submittal process for review by the Departmental Representative.

.2 Submit the complete study for review prior to carrying out calibration and verification.

.3 Submit typed results of coordination and short circuit study in maintenance manuals.

1.39 ARC FLASH HAZARD ASSESSMENT

.1 The Electrical Contractor is to retain the services of an Electrical Engineer to perform an arc flash hazard assessment of electrical power distribution equipment installed under this contract in accordance with CSA-Z462-15 requirements and IEEE-1584 Guidelines.

.2 Provide a preliminary hazard assessment at the time of shop drawing submittals with expected values based on equipment provided and proposed wiring methods and routing. This report will be reviewed in conjunction with the electrical distribution submittals. Any areas of concern will be reviewed by the Departmental Representative at this time.

.3 A final report shall be submitted with actual installation conditions amended to the model providing and actual representation of the hazards in place at time of completion.

.4 Arc flash hazard assessment is to take place at time of completion of power distribution equipment installation and is to include power system wide short circuit and protective device coordination study of the electrical equipment installed to determine arc flash hazard threshold incident energy level boundaries and PPE requirements at each distribution panel installed.

.5 Printed warning labels to be provided for installation by the Electrical Contractor at each panel indicating the following:

.1 Flash hazard boundary (inches)

.2 Cal/cm^2 Flash hazard at 18 inches

.3 PPE level and required protective equipment

.4 Shock hazard in KV when cover is removed

.5 Available fault current level in KA

.6 Single line drawing of the power distribution system indicating let-through energy level of each protective device and required PPE at each piece of equipment will be provided by the Departmental Representative for posting by the Electrical Contractor under clear polycarbonate cover in the main electrical room.

.7 The arc flash hazard analysis shall be completed on all distribution points, panels, MCC, transformers, disconnect switches, and enclosures down to and including 120/208V systems. All bus levels shall be calculated; assumed values or exceptions based on kVA and voltage level will not be accepted.

.8 Use of forced clearing times or the ‘two second rule’ will not be accepted aside from specific conditions approved in advance by the Departmental Representative.

.9 The analysis shall include all possible combinations of utility, generator or other sources. Results shall be tabulated for all scenarios and labelling produced noting the worst case scenario.

.10 Include copy of arc flash assessment and all decals in with maintenance manuals.

1.40 BUILDING MANAGEMENT SYSTEM INTERFACE

.1 The interface between the Building Management System (BMS) and energy monitoring system is part of this contract. The division of work is as follows:

.1 Provide power to BMS/DDC panels and noted in the drawings and provide voice and data outlets as indicated on mechanical equipment schedule and electrical/mechanical drawings. Additional power or data outlets required due to the BMS contractors' system topology will not be at any additional cost to the project and must be coordinated between all sub trades.

Part 2 Products

2.1 MANUFACTURERS AND CSA LABELS

.1 Visible and legible, after equipment is installed.

2.2 MATERIALS AND EQUIPMENT

.1 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.

.2 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on the electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule.

.2 Control wiring and conduit is specified in Divisions 26, 27, 28, 33, 34 and 48 except for conduit, wiring and connections below 50 V which are related to control systems specified in Mechanical Specifications and shown on mechanical drawings.

2.4 WARNING SIGNS

.1 As specified and to meet the requirements of the BC Electrical Inspection Authority and the Departmental Representative.

.2 Decal signs, minimum size 175mm x 250mm.

2.5 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

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

2.6 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.2 Nameplates:

.1 Lamicoid 3mm thick plastic engraving sheet, mechanically attached with self tapping screws.

.2 Nameplate colors shall be as follows:

.1 Normal power: Black face with white letters;

.2 Life safety emergency power: Red face with white letters;

.3 Standby power: Blue face with white letters.

.3 Nameplate sizes shall be as follows

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

.3 Labels:

.1 Embossed plastic labels with 6mm high letters unless specified otherwise.

.4 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.

.5 Allow for average of twenty-five (25) letters per nameplate and label.

.6 Identification to be English

.7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.8 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.9 Terminal cabinets and pull boxes: indicate system and voltage.

.10 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 code: to CSA C22.1 latest edition.

.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

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

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.

.2 The Seismic Engineer shall be able to provide a proof of professional insurance and the related practice credentials, upon request. The Seismic Engineer shall be familiar with SMACNA, ECABC & NFPA guidelines as well as the BC Building Code requirements.

.3 The Contractor's Seismic Engineer shall submit original signed BC Building Code "Letters of Assurance" "Model Schedules S-B and S-C" to the 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 Engineer, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.

.5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper accommodations for such conditions in the tender.

.6 The Seismic Engineer shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.

.7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.

.8 The Seismic Engineer shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.

.9 Include all costs associated with the Seismic installation and certification in the bid price.

1.4 SHOP DRAWINGS & SUBMITTALS

.1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic Engineer.

.2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Engineer.

Part 2 Products

2.1 SLACK CABLE SYSTEMS

.1 Slack cable 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^{o} to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45^{o} 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^{o} 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 Departmental Representative and inspection authority having jurisdiction.

.4 Coordinate requirements of slack cables with suppliers prior to installation.

Part 3 Execution

3.1 GENERAL

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

3.2 CONDUITS

.1 Provide restraint installation information and details on conduit and equipment as indicated below:

.2 Vertical Conduit:

.1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.

.2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m 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 intervals for tubing.

.4 Provide transverse bracing at 12.2 m intervals maximum unless otherwise noted. Provide bracing at all 90^{o} bend assemblies, and pull box locations.

.5 Provide longitudinal bracing at 24.4 m intervals maximum unless otherwise noted.

.6 Do not brace conduit runs against each other. Use separate support and restraint system.

.7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.

.8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.

.9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

.10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.

.11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic Engineer and submit shop drawings to Departmental Representative for their reference.

3.3 FLOOR MOUNTED EQUIPMENT

.1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally

through the center of gravity to a seismic force of 0.5g. For equipment that may be subject to resonances, use a nominal 1.0 g seismic force.

.2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

3.4 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 seismic cables that 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 seismic cables.

.3 Fixtures that 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 that are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

.1 The purpose of this section is to guide the electrical contractor with responsibilities in the commissioning process, which are being directed by the Commissioning Authority. Other electrical systems testing is specified in other electrical sections.

.2 Commissioning requires the participation of the Electrical Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in the Commissioning Authority's Commissioning Plan. The Electrical Contractor shall be familiar with all parts of the commissioning plan issued by the Commissioning Authority, and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

.3 Electrical systems requiring testing and commissioning include the following:

	Commission for Commissioning Authority	Commission Under General Contract
.1 Lighting and Lighting Controls	Yes	Yes
.2 Fire Alarm System	No	Yes
.3 Data/Communications System	Yes	Yes
.4 Power Distribution Equipment	Yes	Yes
.5 Exit Signs & DC Emergency Lighting	Yes	Yes
.6 Intrusion Alarm System	Yes	Yes
.7 Grounding and Bonding	Yes	Yes

1.2 RESPONSIBILITIES

.1 Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows *(all references apply to commissioned equipment only)*:

.1 Construction and Acceptance Phases

.1 Include the cost of commissioning in the contract price.

.2 In each purchase order or subcontract written, include requirements for submittal data, O&M data, and training.

.3 Attend a commissioning scoping meeting and other necessary meetings scheduled by the Commissioning Authority to facilitate the commissioning process.

.4 Electrical shop drawings to be reviewed by the Departmental Representative and forwarded to the Commissioning Authority.

.5 Provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Authority for development of start-up and functional testing procedures.

.1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance

procedures, full details of any Departmental Representative -contracted tests, performance expectations, full factory testing reports, if any, and full warranty information, including all responsibilities of the Departmental Representative to keep the warranty in force clearly identified.

In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.

.2 The Commissioning Authority may request further documentation necessary for the commissioning process.

.3 This data request may be made prior to normal submittals.

.4 Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, to the Departmental Representative, who will review and reject or approve, then forward the approved manual to the Commissioning Authority for review and approval.

.5 Contractors shall assist (along with the Departmental Representative) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.6 Provide to the Departmental Representative and the Commissioning Authority the specific functional performance test procedures required for the commissioning. Subs shall review test procedures to ensure feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.

.7 Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to Commissioning Authority for review.

.6 Conduct and Record Equipment and System Commissioning:

.1 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present in accordance with the agreed-upon schedules, and for sufficient duration, to complete the necessary tests, adjustments and problem solving.

.2 During the startup and initial checkout process, execute and document the electrical-related portions of the pre-functional checklists for all commissioned equipment.

.3 Perform and clearly document all completed startup and system operational checkout procedures, and provide a completed and signed copy to the Departmental Representative and the Commissioning Authority.

.4 Address current A/E punch list items before functional testing.

.5 Perform functional performance testing under the direction of the Departmental Representative and the Commissioning Authority for the specified equipment. Assist the Departmental Representative and Commissioning Authority in interpreting the monitored data and test results, as necessary.

.6 Correct deficiencies (differences between specified and observed performance) as interpreted by the Departmental Representative and the Commissioning Authority, PM and A/E and retest the equipment.

.7 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original equipment, performance and sequences of operation to as-built conditions.

.8 Prepare red-line, as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.

.9 Provide training of the Departmental Representative's operating personnel as specified.

.10 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

.11 Prior to Final Completion of the Work, the responsible contractors shall certify that they have provided all the materials, installation and/or services specified in the Contract Documents, Addendums and Change Orders. Completion of the following sheet, with signatures of the contractually responsible parties, is required and represents such certification.

.2 Warranty Period

.1 Execute seasonal or deferred functional performance testing, witnessed by the Commissioning Authority, according to the specifications.

.2 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

Part 2 PRODUCTS

2.1 TEST EQUIPMENT

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

Part 3 EXECUTION

3.1 SUBMITTALS

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

3.2 STARTUP

.1 The electrical contractors shall follow the start-up and initial checkout, as approved by the Commissioning Authority. The Electrical Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design and performance objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Departmental Representative.

.2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the Commissioning Authority. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.3 FUNCTIONAL PERFORMANCE TESTS

.1 Perform function performance tests for all electrical systems.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

.1 Provide testing documentation as required by the Departmental Representative and Commissioning Authority.

.2 Collect shop drawings for equipment, maintenance procedures and recommended maintenance schedules for equipment, switchgear schedules, and warrantees from all contractors.

.3 Compile 3 copies of all the items mentioned in the preceding sentence. Enclose these in labelled 3-ring binders. Submit 3 copies to Departmental Representative for review. Make modifications until Departmental Representative and Commissioning Authority approve these O&M Manuals.

3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS

.1 The Electrical Contractor shall compile and prepare documentation for all equipment and systems covered in the Electrical contract for inclusion in the O&M manuals.

.2 The Commissioning Authority shall receive a copy of the O&M manuals (after approval by the Departmental Representative) for review.

3.6 TRAINING OF DEPARTMENTAL REPRESENTATIVE PERSONNEL

.1 The Commissioning Authority and the Departmental Representative and shall be responsible for overseeing and approving the content and adequacy of the training

of Departmental Representative's personnel for commissioned equipment or systems.

.2 Electrical Contractor. The electrical contractor shall have the following training responsibilities:

.1 Provide the Commissioning Authority with a training plan two weeks before the planned training.

.2 Provide designated Departmental Representative personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.

.3 Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

.4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

.5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, are required. More than one party may be required to execute the training.

.6 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

.7 Training shall include:

.1 Use the printed installation, operation, and maintenance instruction material included in the O&M manuals.

.2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance; special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover, and any emergency procedures.

.3 Discuss relevant health and safety issues and concerns.

.4 Discuss warranties and guarantees.

.5 Cover common troubleshooting problems and solutions.

.6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.

.7 Discuss any peculiarities of equipment installation or operation.

.8 Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and maintenance of all pieces of equipment.

.9 The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2No.18 latest edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.2 CSA C22.2No.65 latest edition, Wire Connectors.

.2 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.

.2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded copper conductors.

.2 Clamp for stranded copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper conductors.

.5 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2No.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 C22.2 No.65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies copper conductors rated 0-1000 Volts and the most common electrical insulation and covering materials.

.2 This section does not include fire rated building wire to ULC S139 and CSA C83, marine, hazardous, mining, instrumentation, communication and fire alarm wiring.

1.2 REFERENCES

.1 CSA C22.2 No .0.3 latest edition, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 131 latest edition, Type TECK 90 Cable.

1.3 GENERAL REQUIREMENTS

.1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.

.2 Aluminium conductors are not permitted. 100 A. All conductor sizes indicated on drawings are based on copper conductors unless otherwise noted.

.3 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having PVC jacket with FT-4 flame spread rating.

.4 Flexible AC90 armoured cabling (BX) shall not be used for the general wiring system other than final drops to recessed light fixtures in concealed locations.

.5 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.

.6 Refer to Equipment Schedule(s) for detailed responsibilities.

.7 Non-metallic sheathed wiring is not to be used on this project.

Part 2 Products

2.1 WIRE AND CABLE GENERAL

.1 Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.

.2 Insulation to be 600 volt RW90XLPE (X link) for the general building wiring in conduit.

.3 Use RWU90XLPE for underground installations.

.4 Site services sub-circuits, including site lighting, to be minimum #10 AWG for power and #12 for controls. Increase wiring size for lengthy and/or loaded circuits so that system will not exceed the maximum voltage drop as recommended by the Canadian Electrical Code CSA 22.1 latest edition.

.5 Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

.6 Armoured AC90 (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. Use anti-short connectors. Cable from luminaire to luminaire is not acceptable. Allow nominally 1000mm extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.

.7 TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes.

.8 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors not to be painted.

2.2 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131 latest edition.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Type: ethylene propylene rubber.

.2 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: polyvinyl chloride material.

.7 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1000 mm centers.

.3 Threaded rods: 6 mm dia. to support suspended channels.

.8 Connectors:

.1 Watertight or explosion-proof approved for TECK cable.

2.3 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminum strip.

2.4 ARMOURED FIRE ALARM CABLE

.1 Use flexible armoured fire alarm cable from junction box to ceiling mounted fire alarm device.

.2 Type: Armoured FAS cable, fire rated to CSA FT4 requirements.

.3 Armour: interlocked aluminum tape armour. Cable armour shall be colour coded "red".

2.5 CONTROL CABLES

.1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.

.2 600 V type: stranded copper conductors, sizes as indicated with R90 (x-link) ethylene-propylene rubber insulation type over each conductor and overall covering of PVC jacket.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.

.2 In underground ducts in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.

.3 In wireways and auxiliary gutters in accordance with Section 26 05 37 - Wireways and Auxiliary Gutters.

.4 All wires are to be pulled in together in a common raceway, using liberal amounts of water based lubricant.

.5 All power circuits connected to isolated ground type receptacles are to have individual separate neutral c/w insulated bonding conductor.

.6 No combining of circuits onto common neutral will be permitted. Use 2 pole or 3 pole breakers for combined circuits, no connector clips will be allowed.

.7 Ensure that all single phase loadings are reasonably closely balanced over the main feeders.

.8 All dimmer circuits are to have individual neutral conductors for each circuit.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

.1 Install cables.

.1 Group cables wherever possible on channels.

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

3.3 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible.

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

3.4 INSTALLATION OF CONTROL CABLES

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

.2 Ground control cable shield.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies the materials and installation for grounding electrical systems rated 750V or less.

1.2 REFERENCES

.1 ANSI/IEEE 837- 2004 – Standard for Qualifying Permanent Connections Used in Substation Grounding.

.2 CSA C22.2 No. 41 - 2007 – Grounding and Bonding Equipment.

Part 2 Products

2.1 EQUIPMENT

.1 Rod electrodes: copper clad steel 19 mm dia by 3 m long.

.2 Ufer ground electroide: Copper, bare, 2/0 minimum 6 meters of length.

.3 Grounding conductors: bare stranded copper, soft annealed, size as indicated.

.4 Insulated grounding conductors: green, type TW.

.5 Ground bus: copper, size as required, complete with insulated supports, fastenings, connectors.

.6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Thermit welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where conduit is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Install Ufer ground electrode in bottom 50mm of footing concrete pour.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections, and connections to conductive water main, electrodes, using permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

.8 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.

.9 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.10 Install separate ground conductor to outdoor lighting standards.

.11 Connect building structural steel and metal siding to ground.

.12 Make grounding connections in radial configuration only. Avoid loop connections.

.13 Bond single conductor, metallic armoured cables to cabinet at supply end and load end.

.14 Ground secondary service pedestals.

3.2 ELECTRODES

.1 Install rod electrodes and make grounding connections.

.2 Bond separate, multiple electrodes together. Connect new rod electrodes to existing ground in FSS using 3/0 copper.

.3 Use size 3/0 AWG copper conductors for connections to electrodes.

.4 Make special provision for installing electrodes that will give resistance to ground values that meet CEC requirements where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

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

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 2/0 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 Provide dedicated communications ground bus with connection to ground electrode using #3 copper conductor.

3.7 FIELD QUALITY CONTROL

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

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies U shape support channels either surface mounted. Suspended or set in poured concrete walls or ceilings.

Part 2 Products

2.1 SUPPORT CHANNELS

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

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to surfaces with lead anchors or nylon shields as required.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps.

- .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.7 Suspended support systems.

- .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
- .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use channels at 1.5m on centre spacing.

.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.

.13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 PRODUCT DATA

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

.2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.

.3 Shop Drawings: submit shop drawings for custom manufactured items showing materials, finish, dimensions, accessories, layout, and installation details.

Part 2 Products

2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

.1 Sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood backboard (if required) for surface or flush mounting as required.

Part 3 Execution

3.1 SPLITTER INSTALLATION

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

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor.

.3 Install terminal blocks as required.

.4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.3 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 20 05 00 – Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name, voltage and phase, as appropriate to clearly indicate the enclosure use.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES - GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi-gang device boxes for flush installation, minimum size 76 x 51 x 38 mm or as indicated.

.2 Larger 102 mm square x 54mm deep outlet boxes to be used for single gang when more than one conduit enters one side, for telecommunication outlets (for slack storage), or for flush mounting devices in finished plaster and/or tile walls. Provide raised device covers as required.

.3 For larger boxes (those requiring more wiring space, MUTOAs, etc.) use pre-ganged 102 mm high x 51 mm deep solid type as required. Allow extra gang for telecommunication outlets.

.4 For larger boxes for special receptacles (multi-phase, high ampacity) use 102 mm square or 119 mm square boxes 54 mm deep with appropriate cover(s).

.5 Boxes for surface mounted switches, receptacles, or telecommunications outlets to be 102 mm square, or 102 mm high utility, boxes, with rounded corners and raised surface covers. Minimum 38 mm (54 for telecom.) deep

.6 Lighting fixture outlets: 102 mm square outlet boxes or octagonal outlet boxes.

.7 Provide extension and plaster rings as required.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi gang type shallow or deep boxes for devices flush mounted in exposed block walls, minimum 95 mm high x 63 mm deep.

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 FLOOR BOXES

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with flanged cover assemblies and faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.

.2 Cover assemblies to be die-cast aluminum, provide barriers between the power and low voltage sections. A minimum of two (2) gangs for power and two (2) gangs for communications devices.

.3 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm and 21 mm conduit. Minimum size: 73 mm deep

2.6 SURFACE CONDUIT BOXES

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

2.7 FITTINGS – GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of foreign materials.

.3 Conduit outlet bodies for conduit up to 35 mm. Use pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

.1 Typical outlet box mounting heights are indicated in Section 26 05 00 – Common Work Results, or refer to wiring device and communication specification sections and to architectural layouts for particular mounting heights of outlet boxes where indicated.

.2 Support boxes independently of connecting conduits.

.3 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.

.4 Fill open boxes with paper, sponges, foam or similar approved material to prevent entry of construction material. Remove upon completion of work.

.5 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not to be used.

.7 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.

.8 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.

.9 No sectional or handy boxes to be installed.

.10 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.

.11 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.

.12 Outlets installed back to back in party stud walls to be off-set by one stud space.

.13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.

.14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.

.15 Where outlet boxes penetrate an assembly with a fire-resistance rating (fire separation), ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire. Such boxes may not exceed 0.016 mm2 per NBCC 3.1.9.2.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware: to CSA C22.2 No. 18.

.2 Rigid metal conduit (RMC): to CSA C22.2 No. 45.

.3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.

.4 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.5 PVC (DB2) conduit: to CSA #C22.1 211-1.

.6 Flexible metal conduit (FMC): to CSA C22.2 No. 56.

.7 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.

1.3 BASIC WIRING METHODS

.1 Underground or in concrete exterior to building:

.1 All wiring shall be in Schedule 40 RPVC conduit.

.2 Concrete walls and slabs interior to building:

.1 All wiring shall be in Schedule 40 RPVC conduit.

.3 Partition walls and ceilings:

.1 All wiring to be run in EMT conduit for:

.1 Branch circuits.

.2 Fire alarm.

.3 Low voltage systems.

.4 Distribution feeders and sub-feeders.

.5 Surface wiring in electrical and mechanical rooms.

.4 T-bar ceilings:

.1 EMT to junction box with flexible armoured cable drops for individual luminaires. No feed through wiring to luminaires allowed, except for where luminaires butted together. Allow adequate cable to relocate luminaire one T-bar space in any direction.

.5 Motors, transformers and all vibrating equipment:

.1 Short (600mm to 1200mm) PVC jacketed flexible conduit with liquid tight connectors shall be used. Allow sufficient slack to avoid strain on connectors at extreme extension of equipment movement.

.6 Surface raceways - interior:

.1 All surface raceways shall be EMT, except if located without protection in areas susceptible to damage, which shall be rigid steel conduit.

.7 Surface raceways - exterior:

.1 All surface raceways shall be UV compensated Schedule 40 RPVC conduit, protected from damage and excessive heating to the Departmental Representative's satisfaction.

1.4 LOCATION

.1 Electrical drawings are diagrammatic and do not show all conduits, wire, cable, etc. Electrical contractor to provide conduit, wire cable, etc., for a complete operating job to meet in all respects the intent of the drawings and specifications.

.2 Outlet positions shown on architectural drawings (plans and elevations) to take precedence over locations and mounting heights indicated on electrical plans or in specifications.

.3 Locate electrical devices on walls with regard given for convenience of operation and conservation of wall space. Switches, receptacles, fire alarm pull stations, etc. generally to be vertically lined up where items are in the same general location. Adjacent common devices to be installed in common outlet box.

.4 Review the exact location criteria of each electrical outlet and device with the Departmental Representative prior to rough-in. Relocate any item installed without architectural confirmation as required by the Departmental Representative at no cost to the Departmental Representative as long as the relocation is within 3m of the location originally shown on the electrical drawings.

.5 Do not install outlets back-to-back in party walls; allow a minimum of one stud space horizontal clearance between boxes. Install behind all outlets in party walls a Lowry Acoustic backing pad.

.6 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.

.7 All outlets located on exterior walls to be complete with moulded plastic vapour barriers to maintain integrity of wall vapour barrier system.

.8 All raceways and wiring shall be installed concealed in building fabric, except for mechanical and electrical rooms where they shall be installed on the surface.

.9 All outlet boxes, junction boxes, and cabinets to hold electrical devices shall be mounted so the equipment can be flush mounted unless indicated otherwise.

.10 All junction boxes and other raceway access devices shall be mounted to avoid being visible from public areas. Obtain approval from Departmental Representative for any and all junction boxes that, due to the building design, cannot be concealed.

.11 All junction boxes mounted, out of necessity, on surface of solid walls shall be painted to match adjacent surface, with junction boxes painted to match designated systems.

Part 2 Products

2.1 RIGID PVC RACEWAY SYSTEM

.1 Rigid PVC fittings shall be of the same manufacturer as the conduit.

.2 PVC boxes and covers shall be Sceptre "F" Series or equivalent complete with all components and adaptors.

.3 PVC junction boxes exceeding the size of "F" Series shall be Sceptre: "JB" Series boxes and be complete with junction box adaptors.

.4 All fittings with removable covers shall be complete with VC gaskets and brass securing screws and inserts. All metal components shall be brass or stainless steel.

2.2 PVC DUCT RACEWAY

.1 PVC duct fittings shall be of the same manufacturer as duct.

.2 PVC duct shall be colour coded white for communications, grey for power.

2.3 EMT RACEWAY

.1 Electrical Metallic Tubing (EMT) shall be galvanized steel of sufficient quality and thickness to allow smooth field formed bends.

.2 EMT couplings, connectors and fittings shall be steel. Cast type units shall not be used on this installation.

2.4 PVC JACKETTED FLEXIBLE CONDUIT

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

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

2.5 FLEXIBLE ELECTRIC NON-METALLIC (ENT) TUBING

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

2.6 OUTLET BOXES AND JUNCTION BOXES

.1 Except as noted for rigid PVC raceways, all outlet boxes and junction boxes shall be one piece formed or welded.

.2 Outlet boxes to be galvanized steel.

.3 Junction boxes to be galvanized steel or aluminum.

2.7 INNERDUCTS

.1 Provide and install innerducts in underground conduits where called for on plans.

.2 Innerducts to be outdoor corrugated high density polyethylene type complete with pullstring, cable plugs, blank plugs for unused innerducts, and quadraplex sealing plugs.

2.8 ACCESS HATCHES

.1 Provide and install access hatches in drywall ceilings to access junction boxes. Coordinate with other trades and check locations with Departmental Representative before installing.

.2 Access hatches shall have the following specifications:

.1 Door: aluminum frame with gypsum board inlay.

.2 Frame: Recessed aluminum

.3 Finish: to receive the same finish and paint as the surrounding surface.

.4 Hinge: concealed, non-corroding.

.5 Latch: flush screwdriver cam latch.

.3 Access hatches to be of a size to suit but not less than 305mm square.

2.9 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1500mm oc.

.4 Threaded rods, 6 mm dia., to support suspended channels.

2.10 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.

.3 Watertight connectors and couplings for EMT in all exterior applications. Set-screws are not acceptable.

2.11 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.3 Use rigid galvanized steel threaded conduit where required for mechanical protection or as noted in drawings.

.4 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.

.5 Use rigid PVC conduit underground, in corrosive areas, and surface mounted in wet areas not subject to damage.

.6 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

.7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.8 Use explosion proof flexible connection for connection to explosion proof motors.

.9 Install conduit sealing fittings in hazardous areas. Fill with compound.

.10 Minimum conduit size for lighting and power circuits: 19mm.

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

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

.13 Install fish cord in empty conduits.

.14 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in junction boxes in ceiling space.

.15 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.16 Dry conduits out before installing wire.

.17 Conduits shall be installed mechanically continuous from outlet to outlet and without pockets. All the necessary standard bushings, elbows and bends shall be provided. All conduit bends shall have a radius of not less than six (6) times the internal diameter of the conduit and in no case shall the equivalent of more than four quarter bends from outlet to outlet be made. For all conduit sizes to be used for low voltage raceway, the conduits shall have a minimum bending radius of 230mm.

.18 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.

.19 On surface wall runs, all conduit shall be installed in true vertical or horizontal direction and on ceilings in true 90 degree angles or parallel to the walls. Crossings of conduits shall also be made at 90 degree angles. Parallel running conduit shall be kept on equal spacing on the entire length of run including bends.

.20 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).

.21 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all manufacturer's fittings to secure channel to structure and to conduit.

.22 Raceways extending out concrete slabs shall be securely protected using rebar stubs or similar material. All duct stubs are to be kept sealed during construction

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Locate to suit reinforcing steel. Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

.5 Do not place conduits is slabs in which slab thickness is less than 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

.8 Do not install conduits in slabs/concrete floors in lab areas.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

.2 Do not install conduits in slabs/concrete floors in lab areas.

3.6 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.7 FIRE STOPPING

.1 Apply ULC approved fire stopping assembly to all conduit penetrations passing through fire rated walls and floors.

.2 Provide shop drawings showing details for each type of application on the project. Shop drawings shall include catalogue data and installation details.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section specifies materials and installation for metal cabletroughs and fittings.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA FG 1, Fibreglass and Cable Tray Systems.

.2 NEMA VE 1, Metal Cable Tray Systems.

.3 NEMA VE 2, Cable Tray Installation Guidelines.

1.3 PRODUCT DATA

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

.2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.

.3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.

.4 Identify types of cable trays used.

Part 2 Products

2.1 Cable Tray

.1 All ventilated tray to be aluminum, complete with angles, offsets, corners, saddles, tees, etc. as indicated and required to suit the installation. Radii on fittings shall be 300mm minimum.

.2 All tray shall have 45 or 90 degree corners at all vertical and horizontal corners, tees and width change locations.

.3 Cable tray shall be CSA Class D and suitable for mounting or suspension on 3 meter intervals at 179 kg/m.

.4 Cable tray to have a minimum cable loading depth of 128mm. Cable tray width to be 305mm wide.

.5 Cable tray to be support on structural brackets and supports from building elements. Coordinate installation with structural drawings for support points and mounting arrangements.

.6 Provide full height barrier mounted along entire length of the cable tray. Barrier to be mounted in the middle. Barrier is to be continuous metal dividers for entire length of the tray.

.7 Fire Barrier Pillows to be self contained firestop product for use in through-penetration firestops. Product to achieve up to three (3) hours fire rating in accordance with ASTM E 814 tests.

2.2 SUPPORTS

.1 Provide splices and supports for a continuously grounded system as required.

Part 3 Execution

3.1 General Installation – Power & Communications

.1 **This cable tray is NOT for installation of any wiring, cabling or conduits noted within this contract.** Conduits for power wiring noted within this contract can share mounting points so long as structural consideration and coordination is made. These cable trays are to be used for the communications cabling and for use by the tenant once the project is completed.

.2 Provide cable tray in location and general routing as shown on drawings.

.3 Provide dropouts when cables exiting all horizontal cable trays.

.4 Support suspended cable tray from trapeze style hangers with hangers spaced as recommended by the manufacturer based on a maximum load capacity for the tray. Support trays at all corners, offsets and tee fittings

.5 Where shown and appropriate, support cable tray from wall using a cantilever support arrangement. Cable trays may be supported using wall mounted support on masonry walls or from the building steel only.

.6 Cable tray location and mounting heights to be coordinated on site with other trades to provide minimum headroom and serviceability. Verify drawing details to allow for all services run in ceiling spaces. Provide vertical and horizontal offsets as required to suit job site conditions.

.7 Cable tray sections shall be joined by approved connector plates and rust-resistant (plated) hardware. Torque all hardware as per manufacturer's recommendations.

.8 Unless otherwise indicated, bond all cable tray with a minimum #6 AWG copper bonding conductor installed continuously within the full length of all cable trays. Securely connect the bond wire to the tray at each end and at a minimum of 15m intervals. Connect bonding conductor to the building ground system at one or both ends.

.9 Where cable tray passes through fire separations install fire pillows as required to maintain proper fire rating.

.10 Cable tray may require installation of risers, bend, etc. to adjust tray up or down as well as sideways for the tray routing to fit within limits of space available, and to clear other services, ducts, pipes etc. along the route. Routing may be adjusted somewhat as necessary to enable installation of services under other trades.

.11 Where tray runs change elevation, trays shall overlay each other when manufactured waterfall assemblies can not be used. To prevent cables stress install drop-outs on the top tray when overlap method is to be used. Further, tray sections shall be coupled together to provide some rigidity. This coupling maybe made by using a short length of tray and adjustable elbows or may be coupled by means of common support rods at the tray overlap.

.12 Sharp metal edges in cable trays which could cut the cable shall be smoothed and the cable dressed away from these edges. Manufacturer surface imperfections shall be touched up with a cold galvanizing coating before installing cable.

.13 There shall be no wiring joints or splices within the cable tray.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSAC22.2No.26-R1999, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

1.3 PRODUCT DATA

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

Part 2 Products

2.1 WIREWAYS

.1 Wireways and fittings: to CSA C22No.26.

.2 Sheet steel with hinged cover to give uninterrupted access.

.3 Finish: baked grey enamel.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

Part 3 Execution

3.1 INSTALLATION

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, connections to minimum.

.3 Install supports, elbows, tees, connectors, fittings.

.4 Install barriers where required.

.5 Install gutter to full length of equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 Canadian Standards Association, (CSA International)

.2 Insulated Cable Engineers Association, Inc. (ICEA)

Part 2 Products

.1 Not applicable.

Part 3 Execution

3.1 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.1 Do not pull spliced cables inside ducts.

.2 Install multiple cables in duct simultaneously.

.3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.6 After installation of cables, seal duct ends with duct sealing compound.

3.2 FIELD QUALITY CONTROL

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

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests.

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.7 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies photoelectric lighting control equipment for exterior use only.

1.2 PRODUCE DATA

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

Part 2 Products

2.1 PHOTOELECTRIC LIGHTING CONTROL

.1 Wall mounting.
.2 Capable of switching 1000 W of lighting at 120 V.
.3 Voltage variation: plus or minus 10%.
.4 Temperature range: minus 40°C to plus 40°C.
.5 Switching on lights at 70 lux.
.6 Switching off lights at 105 lux.
.7 Rated for a minimum of 5000 operations.
.8 Options:
  .1 Lightning arrester.
  .2 Fail-safe circuit completed when relay de-energized.
  .3 Twist-lock type receptacle.
  .4 Terminal strip.
  .5 Sensitivity adjustment.
.9 Switching time delay of 0 to 30 s.
.10 Wall mounting bracket.
.11 Colour coded leads: size 10 AWG, 500mm long.

2.2 CONTACTOR

.1 Cabinet mounting.
.2 Capable of switching multiple lamp circuits with total lighting load of 6000 W.
.3 Waterproof enclosure.
.4 Manual override.

Part 3 Execution

3.1 INSTALLATION

.1 Install photoelectric controls in accordance with manufacturer's instructions.
.2 Install on the building exterior as indicated on plans.
.3 Install contactors and manual override switch in a wall cabinet inside the main electrical room.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section specifies the materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 REFERENCES

.1 Use transformers of one manufacturer throughout the project.

.2 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2 No.47, Air Cooled Transformers (Dry Type).

.2 CSA C9, Dry Type Transformers.

1.3 PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal procedures.

Part 2 Products

2.1 STANDARD TRANSFORMERS

.1 Type: ANN, 208 volts, 3 phase delta primary.

.2 Primary taps: 2 x 2 1/2% full capacity taps above and 2 x 2 1/2% taps below the nominal voltage.

.3 Secondary: 3 phase, 60 Hz 277/480V 4 wire Y (see drawings for kVA rating). Electrostatic shielded grounded star secondary. Other voltages and winding arrangements as noted on drawings.

.4 Class H, 220°C insulation with temperature rise not exceeding 115°C maximum in 40°C ambient.

.5 K rating: minimum K-13.

.6 Efficiency: Energy Star rating & NEMA Premium

.7 Basic Impulse Level (BIL): standard.

.8 Hipot: standard.

.9 Windings: High grade copper windings, VPE or VPI type.

.10 Impedance: per ANSI recommendations but must not be less than 4%.

.11 Average Sound Level: Noise emission shall not exceed requirements per ST20 standard.

.12 Impedance at 170 degrees C: standard.

.13 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.

.14 Mounting: provide external vibration isolator kit. Provide neoprene isolation pads.

.15 Finish: in accordance with Section 26 05 00 – Common Work Results - Electrical.

.16 Scott-T connected transformers not acceptable.

Part 3 Execution

3.1 MOUNTING

.1 Mount dry type transformers on floor unless otherwise noted on drawings.

.2 Provide 100 mm 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.

.7 Provide concrete board or approved alternate if installed closer than 300mm from any combustible surface.

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 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 26 05 00 – Common Work Results - Electrical.

.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 then 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 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.3 Section 01 78 00 - Closeout Submittals.

.4 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 CAN/CSA-C22.2 No.31-M89 (R2000), Switchgear Assemblies.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate on shop drawings.

.1 Floor anchoring method and foundation template.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned position and size of bus.

.4 Overall length, height and depth.

.5 Dimensioned layout of internal and front panel mounted components.

.3 Include time-current characteristic curves for circuit breakers and fuses.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for service entrance board for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Submit maintenance data for complete assembly including components.

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 packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 SERVICE ENTRANCE BOARD

.1 Service Entrance Board: to CAN/CSA-C22.2 No.31.

.2 Rating: 120/208 V, 3 phase, 4 wire, 800 A, short circuit current 32 kA (rms symmetrical).

.3 Cubicles: wall-mounted, free standing, dead front, size as indicated.

.4 Provision for installation of customer metering in barriered section.

.5 Distribution section.

.6 Hinged access panels with captive knurled thumb screws.

.7 Bus bars and main connections: 99.3% copper.

.8 Bus from load terminals of main breaker to main lugs of distribution section.

.9 Identify phases with colour coding.

2.2 MOULDED CASE CIRCUIT BREAKERS

.1 To Section 26 28 21 Moulded Case Circuit Breakers.

.2 All circuit breakers shall be complete with integral pad lock hasp for lockout purposes.

.3 Provide space for six (6) additional 3 pole breakers up to 200 amps in frame size.

.4 Provide spare breakers as noted in single line drawing or panel schedule.

2.3 GROUNDING

.1 Copper ground bus extending full width of cubicles and located at bottom.

.2 Lugs at each end for size 3/0 grounding cable.

2.4 CUSTOMER METERING

.1 Separate compartment and metal raceway for metering.

2.5 FINISHES

.1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.

.1 Service entrance board exterior: gray.

2.6 EQUIPMENT IDENTIFICATION

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

.2 Nameplates:

.1 White plate, black letters, size 7.

.2 Complete board labelled: "347/600V MDC-6."

.3 Main disconnect labelled: "Main Breaker

.4 Branch disconnects labelled: as indicated.

2.7 SOURCE QUALITY CONTROL

.1 Departmental Representative to witness final factory tests.

.2 Notify Departmental Representative in writing 5 days in advance that service entrance board is ready for testing.

Part 3 Execution

3.1 INSTALLATION

.1 Locate service entrance board and fasten to wall.

.2 Connect main secondary service to line terminals of main breaker disconnect switch. Connect load terminals of distribution breaker's to feeders.

.3 Check factory made connections for mechanical security and electrical continuity.

.4 Run one grounding conductor 3/0 AWG bare copper from ground bus to building ground electrodes.

.5 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section specifies standard and custom panelboards and their installation.

1.2 SCOPE OF WORK

.1 Provide and install panelboards as indicated on the drawings, single line diagram, panel schedules and these specifications.

.2 Types of panelboards in this section include the following:

.1 CDP type Power distribution panelboards.

.2 Lighting and power panelboards

1.3 PRODUCT INFORMATION

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

.3 Shop drawings to include matching tub and trim details for factory installed low voltage relay cabinets where specified.

1.4 PLANT ASSEMBLY

.1 Install circuit breakers in panelboards before shipment from plant.

.2 In addition to CSA requirements, manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.3 All panelboards to be of a common manufacturer.

1.5 FINISH

.1 Apply finishes in accordance with Section 26 05 00 – Common Work Results - Electrical.

.2 Panel finish in electrical and equipment rooms and closets to be standard ASA Grey baked enamel. Confirm with Departmental Representative prior to shop finishing panels.

.3 Panels in finished and/or public areas to be either as clause .2 above or prepared to accept painting to closely match surroundings as directed by the Departmental Representative. In the later instance, the final paint coat to be done by Division 09 but coordinated by the Electrical Division, in particular for protection and masking of locks and sensitive parts. Confirm with Departmental Representative prior to paint finishing panels.

Part 2 Products

2.1 PANELBOARDS, DOORS AND TRIMS

.1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.

.2 Bus and breakers unless otherwise indicated on the drawings and in the specifications, shall be rated for:

.1 Minimum 10 kA at 208Y/120V.

.2 Minimum 18 kA at 600Y/347V.

.3 Tin plated aluminum bus with full size neutral.

.4 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.

.5 Mains capacity, number of circuits and number and size of branch circuit breakers as indicated.

.6 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.

.7 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.

.8 Panelboards to have flush doors. (Gasketted where required for damp locations).

.9 Provide two keys for each panelboard and key similar voltage and system panelboards alike.

.10 Panel tubs to be typically 600mm wide.

.11 Provide "sprinkler-proof" design in areas where sprinkler fire protection is installed. In any event, all surface mounted enclosures to be complete with sprinkler drip cover.

.12 Provide door within door trims where indicated to facilitate ease of service maintenance Each tub trim cover to be hinged and self supporting and to swing out to expose breaker cable terminations and wireways. Hinged trim shall be secured with cover screws on opening side by concealed machine screws. Hinged breaker cover shall be recessed into the hinged overall tub cover. Breaker cover shall have latch type closures. Submit details on shop drawings prior to manufacturing.

.13 Panels to have integral Surge Protection Device (SPD) where indicated. See drawings for quantities and locations.

.14 Provide 200% rated neutrals for panelboards with 5 conductor feeders, where indicated on single line diagram.

2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

.1 Relay section(s) on side(s) of lighting panels as indicated or required for installation of low voltage control switching components. Coordinate with lighting controls equipment supplier

.2 Double stack panels as indicated.

.3 Contactors in mains as indicated.

.4 Feed through lugs as indicated.

.5 Provide ground bus as indicated. Ground bus to be similar to neutral.

2.3 BREAKERS

.1 All breakers to be:

.1 For Lighting Panelboards: Bolt on type molded case, non-adjustable and non-interchangeable trip, single, two and three pole, 120/208V or 347/600V and with trip free position separate from "On" or "Off" positions.

.2 For Power Distribution Panelboards: Bolt on type molded case, adjustable and interchangeable trip, single, two and three pole, 120/208V or 347/600V and with trip free position separate from "On" or "Off" positions. Integral lock-off device.

.2 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard.

.3 Main breaker (where required) to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules or the Single Line Diagram.

.5 Provide spare circuit breakers as indicated on panel schedules or single line diagram as applicable. Provide minimum 10% spare breakers.

.6 Provide breaker type Ground Fault Interrupter(s) (GFI) as indicated.

.7 Provide Lock-on devices as indicated and for Fire Alarm circuits, Security Equipment circuits, Exit sign circuits and Emergency Battery Equipment circuits.

2.4 PANELBOARD IDENTIFICATION

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

.2 Nameplate for each panelboard size 5 (2 line) engraved as indicated and include panel designation and voltage/phase.

.3 Complete updated circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a “letter sized” paper copy of each directory in the project maintenance manual.

.4 Provide a plasticized typewritten information card fixed to the back of the each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a “letter sized” paper copy of each information card in the project maintenance manual.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.

.2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.

.3 Mount panelboards to height given in Section 26 05 00 – Common Work Results – Electrical, or as indicated.

.4 Connect loads to circuits as indicated.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

.6 Install 4x27mm empty conduits (or equivalent) from each flush mounted panelboard single tub to ceiling space above and 2x27mm empty conduits (or equivalent) from each flush mounted panelboard single tub down to ceiling or space below where space exists.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CAN/CSA C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).

.3 The Munsell System of Colour Notation

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC.

1.3 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

Part 2 Products

2.1 MATERIALS

.1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2, Munsell Notation 7.5GY3.5/1.5, size as indicated.

.2 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m5 area without rupture of material.

.3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.

.4 Equip enclosure with hot dipped galvanized mounting rails 1.3 m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.

.1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.

.2 Holes in side panel flanges in 60 mm increments for vertical adjustment.

.5 Cover: tamperproof, bolt-on, domed to shed water.

.6 Door: 3 point latching, with padlocking means.

.7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign

.8 Enclosure construction such as to allow configuration of single or ganged enclosures.

.9 Enclosure capable of being shipped in knocked-down condition.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.

.2 Mount equipment in enclosure.

.3 Label electrical cabinets and enclosure to Section 26 05 00 - Common Work Results for Electrical.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 PRODUCT DATA

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

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

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

Part 2 Products

2.1 COLOUR

.1 All devices to be decora style white.

.2 Receptacles that are switched via occupancy control or similar automatic controls shall be gray unless noted otherwise in the drawings.

2.2 SWITCHES

.1 Heavy duty specification grade.

.2 20 A, 120 V, single pole, double pole, three-way, four-way switches as indicated.

.3 Manually-operated general purpose ac switches as indicated and with following features:

- .1 Terminal holes approved for No.10 AWG wire.
- .2 Silver alloy contacts.
- .3 Urea or melamine molding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .5 White toggle (red toggle for emergency power circuits).

.4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.

.5 Switches of one manufacturer throughout project.

2.3 RECEPTACLES – GENERAL

.1 Heavy duty specification grade.

.2 Duplex receptacles, CSA type L5-15 R, 125 V, 15 A, U ground, with following features:

.1 White nylon molded housing (red for emergency power circuits)
.2 Suitable for No.10 AWG for back and side wiring.
.3 Break-off links for use as split receptacles.
.4 Eight back wired entrances, four side wiring screws.
.5 Triple wipe contacts and non riveted grounding contacts.

.3 Receptacles of one manufacturer throughout project.

2.4 RECEPTACLES – PARTICULAR APPLICATION

.1 Surge Suppression TVSS 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, blue face, parallel blade, U ground, impact resistant nylon face audible and LED alarm.

.2 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button.

.3 20 Amp Receptacles (Housekeeping) Duplex receptacles – T-slot type CSA type L5-20R 125V. 20 Amp u ground with features matching 15 Amp rated Receptacles.

.4 Safety Tamper Resistant Receptacles. Receptacles indicated with an ‘S’ on the drawings shall be Tamper Resistant type.

.5 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.

2.5 INTERVAL TIMERS

.1 Range: 0-30 minutes.
.2 Spring wound or digital without hold feature.
.3 Single pole 120 volt, 20 Amp contacts to open at end of timing cycle.
.4 Flush mounting.
.5 White finish.

2.6 ELECTRIC CAR CHARGERS

.1 Design and manufactured to meet J1772 electric vehicle connection and charging standards.

.2 Weatherproof, complete with single or dual mount pedestal as noted in drawings.

.3 Level 2 charger, 30 amps at 208/240V single phase. 4 meter vehicle connector cable.

2.7 COVER PLATES

.1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. Outlets in labs or as indicated in the drawings or specifications.

.2 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.

.3 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.

.4 All plates to be beveled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.

.5 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Cover plates to fasten to box by four screws.

.7 Gaskets: resilient rubber or close cell foam urethane.

.8 Cover plates for all wiring devices to be from one manufacturer throughout project.

.9 All flush mounted devices are to be installed with stainless steel cover plates & all surfaces mounted devices are to be installed with sheet steel cover plates.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Mount wiring devices to height specified in Section 26 05 00 – Common Work Results – Electrical, or as indicated.

.2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.

.3 All plates to be installed parallel or perpendicular to building lines.

3.2 INSTALLATION PARTICULAR

.1 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.2 Receptacles:

.1 Install all receptacles in the vertical plane unless otherwise noted.

.2 Generally install the L5-15/20R U ground pin down unless otherwise noted. Neutral up when receptacle in mounted horizontal.

.3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.

.4 Where split receptacles has one portion switched, mount vertically and switch the upper portion.

.5 Surge suppression duplex receptacles to be provided for all communication and computer terminal equipment backboards and cabinets including fire alarm, telephone, public address, door security, nurse call, central dictation, RF television, security television, etc. Provide dedicated neutral conductors for each surge suppression receptacle.

.6 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.

.3 Cover plates:

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

.2 Install suitable common cover plates where wiring devices are grouped.

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA C22.2No.248.12-94, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Submit fuse performance data characteristics for each fuse type and size above 30A. Performance data to include: average melting time-current characteristics.

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, and with the Waste Reduction Workplan.

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

.2 Ensure emptied containers are sealed and stored safely for disposal away from children.

.3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

1.5 DELIVERY AND STORAGE

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in moisture free location.

1.6 MAINTENANCE MATERIALS

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

.2 Three spare fuses of each type and size installed above 30A.

.3 Six spare fuses of each type and size installed up to and including 100 A.

Part 2 Products

2.1 FUSES GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer for entire project.

2.2 FUSE TYPES

.1 Class L fuses (formerly HRC-L).

.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type L2, fast acting.

.2 Class J fuses (formerly HRCI- J).

.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type J2, fast acting.

.3 Class R -R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and its= peak let-through values not to exceed limits of UL 198E-1982, table 10.2.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.4 Class -C fuses (formerly HRCII- C).

Part 3 Execution

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.

.1 Install Class R rejection clips for HRCI-R fuses.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies equipment and components for ground fault circuit interrupters (GFCIs).

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

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

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA PG 2.2 - latest edition, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 PRODUCT DATA

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

.2 Submit product data and shop drawings.

.3 Submit test report for field testing of ground fault equipment to Departmental Representative and a certificate that system as installed meets criteria specified herein.

Part 2 Products

2.1 MATERIALS

.1 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

.1 Single or two pole ground fault circuit interrupter for indicated voltage c/w test and reset facilities.

2.3 GROUND FAULT LIFE PROTECTOR

.1 Circuit breaker to supply power to mains of phase panel and complete with:

.1 Automatic shunt trip breaker.

.2 Zero sequence current sensor.

.3 Facilities for testing and reset.

.4 CSA Enclosure Type 2, surface mounted, or as indicated.

.5 Ground fault trip indicator light.

2.4 GROUND FAULT PROTECTOR UNIT

.1 Self-contained with 15 A, 120 V circuit interrupter and duplex receptacle complete with:

.1 Solid state ground sensing device.

.2 Facility for testing and reset.

.3 CSA Enclosure Type 2, flush mounted with face plate, or as indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Do not ground neutral on load side of ground fault relay.

.2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

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

.2 Arrange for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.

.3 Demonstrate simulated ground fault tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.2 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).

1.3 SUBMITTALS

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

.2 Include time-current characteristic curves for breakers with ampacity of 50 A and over.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers and Ground-fault circuit-interrupters to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers to have adjustable electronic trips as indicated.

.7 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as noted in drawings or on panel schedules.

2.2 THERMAL MAGNETIC BREAKERS

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

2.3 SOLID STATE TRIP BREAKERS

.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time and instantaneous tripping for phase and ground fault short circuit protection.

2.4 OPTIONAL FEATURES

.1 Include:

.1 Auxiliary switch.

.2 On-off locking device.

.3 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

.2 Adjust trip units on all circuit breakers as per coordination study and recommendations from arc flash hazard analysis.

.3 Confirm breaker settings to be appropriate with actual running current of mechanical equipment.

END OF SECTION

Part 1 General

1.1 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.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible, non-fusible, horsepower rated disconnect switch in CSA Enclosure 1/12 or 3R/4X, to CAN/CSA C22.2 No.4 size as indicated, or as required to suit loads.

.2 Provision for padlocking in on-off switch position by three locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage.

.5 Fuseholders: to CSA C22.2 No.39, relocatable and suitable without adaptors, for type and size of fuse indicated.

.6 Quick-make, quick-break action.

.7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

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

.2 Ensure that switch/fuse ratings are suitable for the connected load.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CSA C22.2 No.14-10, Industrial Control Equipment.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 2-2000 (R2005), Controllers, Contactors and Overload Relays Rated 600 V.

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 contactors and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for contactors for incorporation into manual.

.3 Include operating information required for start-up, synchronizing and shut-down of generating units.

1.4 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 CONTACTORS

.1 Contactors: to CSA C22.2 No.14.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.

.3 Breaker combination contactor as indicated.

.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 1/2 or 3R/4Xunless otherwise indicated.

.6 Include following options in cover:

.1 Red and Green indicating lamp.

.2 Stop-Start pushbutton.

.3 Hand-Off-Auto selector switch or

.4 On-Off selector switch.

.7 Control transformer: factory wired and installed in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

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

.2 Size 4 nameplate indicating name of load controlled.

Part 3 Execution

3.1 INSTALLATION

.1 Install contactors and connect power wires and auxiliary control devices.

.2 Identify contactors with nameplates or labels indicating panel and circuit number.

.3 Test contactors in accordance with 26 05 00 - Common Work Results for Electrical.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by contactor installation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section describes manual and magnetic motor starters for motors up to 600 volts

1.2 REFERENCES

.1 International Electrotechnical Commission (IEC)

.1 IEC 947-4-1-latest edition, Part 4: Contactors and motor-starters.

.2 Canadian Standards Association (CSA)

.1 CAN/CSA – C22.2 No.14-latest edition, Industrial Control Equipment.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.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.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 – Common Work Results - Electrical.

.2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

.1 Provide listed spare parts for each different size and type of starter:

.1 3 contacts, stationary.

.2 3 contacts, movable.

.3 1 contacts, auxiliary.

.4 1 control transformer.

.5 1 operating coil.

.6 2 fuses.

.7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MANUAL MOTOR STARTERS

.1 Single and Three 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 Overload heaters, manual reset, trip indicating handle.

.2 Accessories:

- .1 Pushbutton: heavy duty, oil tight, labelled as indicated.
- .2 Indicating light: standard heavy duty, oil tight, type and colour as indicated.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.2 FULL VOLTAGE MAGNETIC STARTERS

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated, rapid action type.
- .2 Motor overload protective device in each phase, manually reset from outside enclosure.
- .3 Wiring and schematic diagram inside starter enclosure in visible location.
- .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:

- .1 Locking in "OFF" position with up to 3 padlocks.
- .2 Independent locking of enclosure door.
- .3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

- .1 Selector switches: heavy duty, oil tight, labelled as indicated.
- .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
- .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.3 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.5 EQUIPMENT IDENTIFICATION

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

Part 3 Execution

3.1 INSTALLATION

.1 Install starters, connect power and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and manufacturer's instructions.

.2 Operate 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 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 UL61010B-1 Measuring, Testing and Signal Generation Equipment

.2 CAN3-C17- latest edition, Alternating - Current Electricity Metering

.2 National Electrical Manufacturers Association (NEMA)

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

.3 International Electrical Standards (IEC)

.1 IEC62052-11: Electricity metering equipment (AC) – general requirements, tests and test conditions

.2 IEC61010-1 (EN61010-1): Safety requirements for electrical equipment for measurement, control, and laboratory use

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Include schematic, wiring, interconnection diagrams.

1.3 QUALITY ASSURANCE

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

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Submittal Procedures.

.2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DIGITAL POWER METERS

.1 Current/Voltage Inputs

.1 Have no less than 4 voltage inputs and 4 current inputs

.2 Shall be able to accept 600VAC LL / 347VAC LN without using potential transformers.

.3 Shall support nominal current ratings of 1A, 2A, 5A, 10A, and/or 20A and an overcurrent rating of 500A for 1s (5A nominal mode) or 200A for 1s (1A nominal mode).

.2 Power Supply

.1 95 to 240VAC (±10%) @ 47 to 440Hz / 120 to 310 VDC

.3 Measured Values

.1 Digital Meter shall provide at minimum the following voltage values:

.1 Voltage L–L Per-Phase

.2 Voltage L-L 3-Phase Avg

.3 Voltage L–N Per-Phase

.4 Voltage 3-Phase Avg

.5 Voltage % unbalanced

.2 Digital Meter shall provide at minimum the following current values:

.1 Current Per-Phase

.2 Current, Neutral (measured)

.3 Current 3-Phase Avg

.4 Current % Unbalanced

.3 Digital Meter shall provide at minimum the following power values:

.1 Real Power (Per-Phase, 3-Phase Total)

.2 Reactive Power (Per-Phase, 3-Phase Total)

.3 Apparent Power (Per-Phase, 3-Phase Total)

.4 Power Factor – True (Per-Phase, 3-Phase Total)

.5 Power Factor – Displacement (Per-Phase, 3-Phase Total)

.4 Digital Meter shall provide at minimum the following energy values:

.1 Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)

.2 Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)

.3 Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)

.4 Reactive Energy by Quadrant

.5 Digital Meter shall be capable of deriving values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (or equivalent PLC capabilities):

.1 Arithmetic functions: division, multiplication, addition, subtraction, power, absolute value, square root, average, max, min, RMS, sum,

sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.

.2 Trigonometric functions: COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, LOG10

.3 Logic functions: =, =>, <=, <>, <, >, AND, OR, NOT, IF

.4 Thermocouple linearization functions: Type J, Type K, Type R, Type RTD, Type T

.5 Temperature conversion functions: C to F, F to C

.4 Demand

.1 Digital Meter shall be able to provide min/max demand, present demand interval, running average demand, and predicted demand on multiple demand channels.

.2 Digital Meter shall be able to perform multiple accepted demand calculation methods including block, rolling block, and thermal demand with user-programmable demand period lengths.

.5 Accuracy

.1 Digital Meter shall meet ANSI C12.20 accuracy class 0.2.

.2 Digital Meter shall provide 4-quadrant metering

.3 Digital Meter shall be certified and sealed to Revenue Canada standard as applicable for devices to be used for reselling of energy.

.6 Sampling

.1 Digital Meter shall sample at 64 (or more) samples/cycle.

.2 Digital Meter shall be able to perform high speed sag/swell detection of voltage disturbances on a cycle-by-cycle basis, providing the duration of the disturbance, the minimum, maximum, and average value of the voltage for each phase during the disturbance. Disturbances less than one cycle in duration can be detected.

.7 Logging

.1 Digital Meter will store all critical internal and revenue data upon sudden power loss and shall have non-volatile memory.

.2 Digital Meter shall have a time-stamped event log with the following features:

.1 The number of records in the log is programmable.

.2 Each event is recorded with the date and time of the event, the cause and effect of the event, and the priority of the event.

.3 All events relating to setpoint activity, relay operation and self-diagnostics is recorded in the event log.

.4 Time stamps have a resolution of 1 millisecond.

.5 Time stamps can be synchronized to within 100 ms between devices on the same serial communications medium.

.6 Minimum event recording response time is ½ cycle (8.3ms 60Hz, 10ms 50Hz) for high speed events and 1 second for other events.

.7 The priority of setpoint events is programmable.

.3 Digital Meter shall be able to log any parameter in the meter including min/max and waveforms.

.8 Alarming

.1 Digital Meter have setpoint driven alarming capability

.2 Digital Meter shall be able to generate an email on an alarm condition.

.3 Digital Meter shall have millisecond timestamp resolution on alarm entries.

.4 Digital Meter shall support consecutive high-speed alarm conditions which trigger on a cycle-by-cycle basis with no “dead” time between events (i.e. no need for a rearming delay time between events).

.5 Digital Meter shall be able to operate relays on alarm conditions.

.6 Digital Meter shall be able to initiate datalog captures on alarm conditions.

.7 Digital Meter shall be able to control digital output relays in an AND or an OR configuration, using pulse mode or latch mode operation, for control and alarm purposes.

.8 Digital Meter shall be able to combine any logical combination of any number of available setpoint conditions to control any internal or external function or event.

.9 Communications

.1 The Digital Meter shall be capable of the following communications methods simultaneously and independently:

.1 Ethernet over copper media.

.2 Serial

.1 RS-232

.2 RS-485

.3 Serial

.1 RS-485

.4 Infra Red

.2 The Digital Meter shall support any one of the following communications protocols on any one port at any one time:

.1 ION

.2 Ethergate

.3 Modemgate

.4 DNP 3.0

.5 Modbus

.1 Modbus RTU

.2 Modbus TCP

.3 Modbus Mastering of serial RS485 slaves

.6 SMTP

.7 SNTP

.8 MV-90 compatibility

.9 XML compatibility

.10 SNMP

.11 HTTP (web pages)

.3 The PMS Instrument has an Modbus TCP gateway for reading Modbus serial devices connected to a serial port on the instrument

.4 The PMS Instruments that are equipped with an Ethernet port are internet enabled and supports the following functions:

.1 Automatically e-mail alarm notifications or scheduled system status updates. E-mail messages sent by the PMS instruments can be received like any ordinary e-mail message. Data logs can also be sent on an event-driven or scheduled basis.

.2 Built in web pages in the PMS instruments enables access to real-time values and basic power quality information using a standard web browser. Basic configuration of the PMS instruments can also be performed through the browser.

.3 Integration with custom reporting, spreadsheet, database and other applications with XML compatible data.

.1 The following logical nodes shall be supported in addition to LLN0 and LPHD (mandatory):

- MHAI - Harmonics
- MMTR - Metering
- MMXU - Measurement
- MSQI - Sequence and imbalance
- MSTA - Metering Statistics
- GGIO - The ability to view data from and control all I/O points in the meter.
- RDRE - Disturbance recorder function

.10 I/O Options

.1 Digital Meter shall be capable of having 4 digital inputs capable of ½ cycle timing resolution, and shall be fitted with 4 inputs.

.2 Digital Meter shall have digital outputs that support pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.

.3 Digital Meter shall have 4 optically isolated Form A outputs.

.11 Display

.1 Digital Meter shall have two display options: an integral display and a remote mounted display

.1 The integral display shall be a backlit LCD display

.2 The remotely mounted display shall be a color backlit LCD display, of similar size as to integral display

.3 The displays shall be suitable for NEMA 12 enclosures.

.2 Digital Meter shall support direct display of all parameters on the front panel.

.3 Digital Meter display shall support multiple languages, including English and French.

.12 Field Programmability

.1 Digital Meter is field programmable as follows:

.1 Basic parameters: Voltage input scale, voltage mode (Wye, Delta, single phase), current input scale, auxiliary input and output scales, and communications setup parameters are programmable from the front panel.

.2 All basic parameters described above, plus additional setpoint/relay and data log setup parameters may be programmed via the communications port using a portable or remotely located computer terminal.

.3 Custom configuration of all operating parameters is possible through a graphical, flexible programming language.

.4 The configuration of the device will be done using programmable modules. The modules can be linked together in an arbitrary manner to create arbitrary functionality. Some example module types include min, max, setpoint, digital input, and digital output.

.5 Programming through a computer can be secured by user ID and password.

.6 Programming through the front panel is secured by password.

.7 Programmability shall be sectioned such that when the meter is sealed, the meter shall still be configurable to an extent that does not affect the accumulation of revenue metering related data.

.13 Advanced Features

.1 The Digital Meter firmware shall be field upgradeable.

.2 Onboard meter clock can be paced by a choice of sources including GPS or internal clock.

.3 The Digital Meter shall have multi-level security which supports customized access for up to 16 users.

.4 The Digital Meter shall have revenue security capabilities including but not limited to the following:

.1 Password protected, no hardware lock, or

.2 Password protected and hardware locked, or

.3 The following data is protected from alteration when locked:

.1 kWh and kVARh (import, export, net and total)

.2 kVAh (total)

.3 kW, kVAR, kVA demand (thermal and sliding window)

.4 kWh, kVARh, kVAh pulse outputs

.5 The Digital Meter shall have provisions for creating periodic or non-periodic schedules for up to two (2) years. These schedules may be used to perform the following functions:

.1 Time of Use (TOU)

.2 Demand Control

.3 Load Scheduling

.4 Logging

.5 Periodic Resetting

2.2 CURRENT TRANSFORMERS

.1 Current transformers shall be C50 class, metering accuracy with 800:5 ratio, with 5 amp secondary current.

.2 Provide shorting terminals for safe isolation of meter or current transformers.

.3 Current transformers to be suitably mounted and not suspended from conductors.

Part 3 Execution

3.1 INSTALLATION

.1 Install Digital Meters in switchgear as noted in drawings. All installations shall be fully integrated to main assemblies at the factory and shall be completely tested for operation prior to shipping to site.

.2 Connect Digital Meters to communications means as noted in drawings using Ethernet and RS485 with twisted shielded cabling to DDC system.

.3 Where Digital Meters are connected to additional devices using RS 485 twisted shielded media, ensure grounding of shielded cables is done at one end only. Provide end of line resistors as required for reflection/error free communications at the highest transmission speeds the Digital Meters are capable.

.4 All potential inputs to Digital Meters shall be fitted with protection fuses. Fuses shall be mounted in flip-open style fuse holder that will also provide isolation means for Digital Meter.

.5 Provide power supply fusing protecting each meter independently. Fuses shall be mounted in flip-open style fuse holder that will also provide isolation means for Digital Meter. Fuse holders shall be rated for disconnecting meter power supply under load. Power may be taken from the 120/208V source being measured.

3.2 FIELD QUALITY CONTROL

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

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Manufacturer shall coordinate to provide a complete factory demonstration of fully operational equipment prior to disassembly and sending to site.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This specification describes the operation and functionality of a continuous duty, three-phase, solid-state, static Uninterruptible Power Supply (UPS) hereafter referred to as the UPS.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI S1.13-1995(R1999) Measurement of Sound Pressure Levels in Air.

.2 ANSI S1.4-1983(R2001) with Amd. S1.4A-1995, Specification for Sound Level Meters.

.2 Canadian Standards Association (CSA International)

.1 CSA C813.1-01, Performance Test Method for Uninterruptible Power Supplies.

.3 International Organization for Standardization (ISO):

.1 ISO 9001, "Quality Management Systems - Requirements."

.2 ISO 14001, “Environmental Management Systems - Requirements with Guidance for Use.”

.4 Institute of Electrical and Electronics Engineers, Inc. (IEEE):

.1 ANSI/IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters" (copyrighted by IEEE, ANSI-approved).

1.3 SYSTEM DESCRIPTION

.1 Included Features of the UPS:

.1 The UPS utilizes double conversion online topology.

.2 The UPS features internal bypass, external maintenance bypass and input power factor correction.

.3 The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverter), bypass and a battery charger. The control of power module and fault detection logic is microcontroller-based.

.1 The input disconnect and filter stage contains an input back-feed relay (in models with an input wire plug), input filter, transient suppression, and battery select switches (mechanical relay or solid-state).

.2 The input PFC power stage contains non-isolated power factor correcting AC/DC converters. This converter is capable of full power operation over a very wide input voltage range or from a nominal DC battery voltage.

.3 The energy storage stage is a split DC bus capacitor handling seamless transitions from battery to line and vice versa, as well as the low and high frequency power stages ripple.

.4 The output power (inverter) stage operates directly from the DC bus and produces a configurable AC output voltage of 120 V/208 V output. The output of the UPS is connected either to the inverter or through a bypass relay, contactor, or static switch to the filtered input line.

.4 The UPS contains a battery charger, which operates from the DC bus.

.5 The system also includes the following features.

.1 Field-replaceable battery modules

.2 Removable input/output wiring trays

.3 Battery disconnects

.4 Emergency Power Off (EPO)

.5 An integrated UPS Network Management Card 2 with Environmental Monitoring (AP9631).

.2 **Performance, Design, and Configurations:** The UPS and associated equipment operates in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for electronic equipment load.

.1 This specification describes the performance, functionality, and design of the UPS, the external Battery Systems, and connectivity solutions.

.2 All programming and miscellaneous components for a fully operational system as described in this section are available as part of the UPS.

1.4 SYSTEM DESCRIPTION

.1 Mechanical Design

.1 The UPS and battery cabinets are rack-mount configurations.

.2 The cabinet dimensions including terminations are listed below for tower, stack or rack-mount configurations. The side rack-mounting brackets increase the overall width to 482 mm.

.2 System Characteristics

.1 System Capacity:

.1 80 kVA or 80 kW 120/208V three phase output, whichever limit is reached first.

.2 **Efficiency:** The UPS efficiency stated here is at full load and without degradation of output regulation and shall meet or exceed 92%.

.3 Input:

.1 AC Input Nominal Voltage:

.1 120/208 VAC, single phase, hardwired.

.2 AC Input Voltage Window:

.1 160 – 280 Vac (any line to line) at full load.

.2 100 – 280 Vac (any line to line) at 50% load.

.3 **Input Frequency Range:** 45-65 Hz, auto-selecting.

.4 **Input Power Factor:** >0.95 @ 100% load

.5 **Input Current Distortion:**

.1 Maximum 6% at 100% load at nominal voltage.

.4 UPS Output:

.1 AC Output Nominal Voltage:

.2 120/208 V three phase with neutral.

.3 Output Connectors:

.1 Hardwire: 3-wire (3Ph + N + G)

.4 AC output voltage distortion:

.1 Maximum 2% @ 100% linear load; Maximum 5% @ 100% non-linear load

.5 AC output static voltage regulation:

.1 +/-1%.

.6 AC output dynamic voltage regulation:

.1 +/-5%, for 10 to 90% load step at <50 ms recovery time:

.7 Output Voltage Harmonic Distortion:

.1 <2% THD maximum for a 100% linear load

.2 <5% THD maximum for a 100% non-linear load

.8 Overload Rating:

.1 Normal Operation (Online):

.1 150% for 30 seconds

.2 125% for 1 minute

.3 105% continuous

.2 **Bypass Operation:** Overload is limited by the external input circuit breaker feeding the UPS:

.1 A supplementary 300 A circuit breaker is fitted at the input.

.9 Output Power Factor Rating:

.1 0.5 lagging to 0.5 leading.

.10 Output Frequency:

.1 50/60 +/- 3Hz (Tracking) or 50/60 +/- 0.1 Hz (free-running) or 50/60 +/- 1 Hz (free-running), user-selectable.

.11 Crest Factor: 3:1

1.5 MODES OF OPERATION

.1 **Normal:** The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) creates an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages do not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter). The input Power Factor Correction (PFC) power stage and the output power stage (inverter) operate in an on-line manner to continuously regulate power to the critical load. The input PFC stage is capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

.1 **Overload Capability:** The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for an indefinite length of time.

.2 **Output Contactor:** The output power stage (inverter) is equipped with an output mechanical relay to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter will be removed from the critical bus.

.3 **Battery Protection:** The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system.

.2 Battery: Upon failure of the AC input source, the critical load continues being supplied by the output inverter, which derives its power from the battery system. There is no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation. The UPS battery system consists of user-replaceable, hot-swappable cartridges.

.1 A minimum of two battery cartridges must be installed, providing 192 VDC nominal for the DC bus rail.

.2 The batteries of the UPS models in this specification are maintenance-free, leak-proof, valve-regulated lead-acid (VRLA) batteries with suspended electrolyte.

.3 The UPS shall incorporate a battery monitor system to continuously monitor the health of each removable battery module as well as external battery modules installed in extended run battery cabinets. This system shall notify the user in the event that a failed or weak battery module is found.

.4 UPS shall be expandable for additional runtime with additional battery packs. These packs and the modules within them are hot-pluggable, allowing for easy and quick installation or replacement without the need for electrical wiring, electrician services or powering down of the UPS.

.5 Each UPS Battery Module has a means of DC disconnect for transportation and to disconnect the battery module completely from the internal bus while the battery is installed in the UPS system.

.3 **Charging:** Upon restoration of the AC input source, the UPS simultaneously recharges the battery and provides regulated power to the critical load.

.1 The intelligent battery management system contains a temperature monitoring circuit and compensation algorithm that regulates the battery charging voltage and current so as to optimize battery life. The UPS shall monitor the temperature of all battery packs and use the highest one as a reference to adjust the battery float voltage.

.2 The battery charging circuit remains active when in bypass or online states.

.4 **Bypass:** During bypass operation the utility power is connected to the load, bypassing the internal converters. The system automatic bypass provides a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. The UPS constantly monitors the output current, as well as the bypass source voltage, and inhibits potentially unsuccessful transfers to automatic bypass from taking place. The design of the automatic bypass switch power path consists of a heavy-duty electromechanical bypass relay or contactor.

.1 **Automatic Transfers:** An automatic transfer of load to bypass takes place if the load on the critical bus exceeds the overload rating of the UPS, if both normal and battery operation modes are unavailable, if the UPS has an internal fault, or if for any reason the UPS cannot support the critical bus. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system or when other causes are corrected. If the bypass mode becomes unavailable, the UPS will automatically switch to mains power. In the event that mains power is unavailable the system will switch to battery power.

.2 **Manual Transfers:** Manually initiated transfers to and from bypass may be initiated through the UPS computer interface (via serial or USB communications) or by engaging the bypass switch on the rear panel of the unit.

1.6 INPUT PFC POWER STAGE

.1 **General:** The input Power Factor Correction (PFC) power stage of the UPS constantly rectifies the power imported from the mains input of the system, converting input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power

.2 **Input Current Total Harmonic Distortion:** The input current THD_I at full system load will be held to the following percentages while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This is true while supporting loads of both a linear or nonlinear type. This will be accomplished with no additional filters, magnetic devices, or other components.

.1 Input THD current shall be 6% or less

.3 Input Current Limit:

.1 The input converter shall control and limit the input current drawn from the utility supply to150% of the UPS output.

.2 During conditions where input current limit is active, the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation with mains deviation of up to +/-20% of the nominal input voltage.

.3 In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current shall not exceed 130% of UPS output current, while providing full battery recharge power and importing necessary power for system losses.

.4 Charging:

.1 The battery charging circuit contains a temperature monitoring circuit, which regulates the battery charging current to optimize battery life.

.2 The battery charging circuit remains active when the UPS is in automatic bypass and in normal operation.

.3 The battery charging system adjusts the charging current according to the number of battery modules and by monitoring the individual battery current.

1.7 OUTPUT POWER STAGE (INVERTER)

.1 **General:** The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT-driven power converters. In both normal operation and battery operation, the output power stage (inverter) creates an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages, shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).

.2 **Overload Capability:** The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for indefinite length of time.

.3 **Output Contactor:** The output power stage (inverter) is equipped with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter will be removed from the critical bus.

.4 **Battery Protection:** The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system.

1.8 DISPLAY AND CONTROLS

.1 **Control Logic:** The UPS is controlled by an embedded microcontroller which performs the following functions:

.1 Monitoring the quality of the output voltage

.2 Monitoring vital parameters of the UPS

.3 Executing the state machine

.4 Intelligent battery management

.5 Controlling the input and output power stage

.6 Remaining runtime calculation

.7 Self-diagnostics, self-test, and proactive fault detection

.8 Communication to the host server via a serial port

.9 Communication to the Network Management Card or another SmartSlot accessory card, if the UPS is equipped with such a card

.2 **Display/Control Unit**: Located on the front of the UPS is a display/control unit.

.1 **Control Functions for All Models:** The following controls functions can be accomplished by use of the pushbutton switches or LCD display:

.1 Turn the UPS on

.2 Turn the UPS off

.3 Initiate a self-test to test the battery condition

.4 Silence an audible alarm

.5 Cold-start the UPS

.6 Display the input RMS voltage

.7 **Display Data:** The following indicators are available on the Display/Control Unit:

.8 The UPS load LED bar

.9 The UPS is online

.10 The UPS is on battery

.11 The UPS is in bypass

.12 The UPS is overloaded

.13 The UPS is in fault state

.14 The battery needs to be replaced

.15 The battery capacity/utility voltage LED bar

.3 **Communication Interface:** The following are contained within the UPS for remote communications with a network via web browser or SNMP.

.1 An RJ-45 serial interface port.

.2 A pre-installed Network Management Card 2 with Environmental Monitoring (AP9631).

.4 **Bypass switch:** On the rear panel of the UPS there shall be a switch that when engaged forces the UPS into bypass state provided the input voltage and frequency are within acceptable limits.

.5 **Maintenance Bypass:** Externally mounted, fully rated bypass switch interlocked with UPS for correct operation.

.6 **EPO switch:** UPS shall be equipped with an Emergency Power Off (EPO) terminal that can be wired so as to provide the means to instantaneously de-energize the UPS and its load from a remote location in case of emergency.

.7 **Audible Alarms:** Using audio signal, the UPS will notify the user about important events. The following is the list of distinct audio alarms:

.1 The UPS is on battery

.2 The UPS is on battery and the remaining battery capacity is low

.3 The UPS has shut down due to low battery capacity

.4 The battery needs to be replaced

.5 The UPS is overloaded

.6 The UPS is in fault state

.8 **Potential Free (Dry) Contacts:** The following dry alarm contacts shall be available on the UPS:

.1 The UPS is on battery

.2 The UPS is on battery and the remaining battery capacity is low

.3 The UPS is off

.4 The battery needs to be replaced

.5 The UPS is in bypass

.6 The UPS is overloaded;

.7 The UPS is in fault state.

1.9 BATTERY

.1 The UPS battery is of modular construction made up of owner-replaceable, hot-swappable, fused, battery modules. Each battery module is monitored to determine the highest battery unit temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.

.2 The batteries are of the valve regulated lead acid (VRLA) type.

1.10 ACCESSORIES

.1 Software and Connectivity:

.1 **Network Management Card:** The Network Management Card allows one or more network management systems (NMSs) to monitor and manage the UPS in TCP/IP network environments. are equipped with a Network Management Card with Environmental Monitoring (AP9631) pre-installed.

.2 **Unattended Shutdown:** The UPS, in conjunction with a network interface card, is capable of gracefully shutting down one or more operating systems during the time when the UPS is on battery mode. The UPS is also capable of using an RS-232 port to communicate.

.2 **Remote UPS Monitoring:** The following methods of remote UPS monitoring shall be available:

.1 **Web Monitoring:** Remote monitoring is available via a web browser such as Internet Explorer. Connect to building ethernet network and integrate for local network access.

.2 **Dry Contact Monitoring and Control:** The UPS must be equipped dry contact monitoring. Extend contact to local junction box for future use.

1.11 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include:

.1 Outline sketch showing arrangement of meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

.2 Shipping weight

.3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.

.4 Description of system operation, referenced to schematic diagram, for:

.1 Manual control during initial start-up and load transfer to bypass and back to inverter output;

.2 Inverter;

.5 System performance and reliability:

.1 Consider any deviation from the required output power waveform as failure in UPS and include estimate, with supporting calculations, of the Mean Time Between Failures (MTBF) expressed in hours.

.2 Provide estimate with supporting data for Mean Time To Repair factor (MTTR).

.6 Full load kVA output at unity power factor.

.7 Efficiency of system at 25%, 50%, 75% and 100% rated load.

.8 Type of ventilation: natural or forced.

.9 Battery:

.1 Number of cells;

.2 Maximum and minimum voltages;

.3 Type of battery;

.4 Type of plates;

.5 Catalogue data with cell trade name and type;

.6 Size and weight of each cell;

.7 Cell charge and discharge curves of voltage, current, time and capacity;

.8 Derating factor for specified temperature range;

.9 Nominal ampere hour capacity of each cell;

.10 Maximum short circuit current;

.11 Maximum charging current expected for fully discharged condition;

.12 Recommended low voltage limit for fully discharged condition;

.13 Expected life.

.10 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.

.11 Cooling air required in m^3/s.

.12 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

.13 Typical operation and maintenance manual.

.14 Description of factory test facilities.

.15 Manufacturer's maintenance capabilities including:

.1 Willingness to undertake maintenance contract;

.2 Number of trained personnel available;

.3 Location of trained personnel and repair facilities.

1.12 QUALITY ASSURANCE

.1 Submit for approval to Departmental Representative, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01 33 00 - Submittal Procedures.

1.13 CLOSEOUT SUBMITTALS

.1 Provide data for incorporation into operation and maintenance manual specified in Section 26 05 00 – Common Work Results - Electrical.

.2 Submit interim, draft final, and final Operation and Maintenance (OM) Manual. Final manual approved by Departmental Representative. Submit interim copies to Departmental Representative prior to notification of factory test date.

.3 Operation and Maintenance Manual to include:

.1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.

.2 Technical data:

.1 Approved shop drawings;

.2 Characteristic curves for automatic circuit breakers and protective devices;

.3 Project data;

.4 Technical description of components;

.5 Parts lists with names and addresses of suppliers.

1.14 DELIVERY, STORAGE AND HANDLING

.1 Crating:

.1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.

.2 For tractor train or sea shipment use double layer of vapour barrier and 19 mm plywood covering.

.3 Subassemblies may be packed separately.

.4 Label crates:

.1 Shipping address.

.2 Weight and dimensions

.3 Serial number of unit and brief description of contents.

.4 Stencilled with durable paint on at least two sides of each crate.

.5 List of contents:

.1 In weatherproof envelope stapled on outside of each crate;

.2 Copy placed inside each crate.

1.15 SYSTEM START-UP

.1 Provide for:

.1 For factory service engineer to supervise start-up of system, checking, adjusting and testing on site;

.2 For instruction of Departmental personnel on theory, construction, installation, operation and maintenance of system:

.1 After installation and during site testing;

.2 Advise on:

.1 Expected failure rate of equipment;

.2 Type of expected failures;

.3 Estimated time between major overhauls based on 20 year equipment life;

.4 Estimated cost of major overhaul based on current costs and excluding travelling expenses;

.5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

Part 2 Products

2.1 UNINTERRUPTIBLE POWER SYSTEM

.1 Input power:

.1 120/208 V, three phase, 4 wire with ground, 60 Hz.

.2 Normal supply from ac mains.

.3 Emergency supply from standby automatic diesel-electric unit via upstream transfer switch.

.2 Output power:

.1 120/208 V, three phase, 4 wire, grounded neutral, 60 Hz.

.2 Full load output at 1.0, Unity power factor.

.3 Overload capability: 125% of rated full load current at 1.0 power factor and rated voltage for 10 min.

.4 Frequency - nominal 60 Hz:

.1 Adjustable from 58.5 to 61.5 Hz.

.2 Maximum variation from set value under load changes, including transients, not to exceed 0.3 Hz.

.3 Drift from set value - after two months normal operation within ambient temperature range of 0 degrees to 40 degrees C, not to exceed 0.6 Hz.

.5 Duration of full load output after mains failure not less than 15 min.

.6 Output voltage control:

.1 Continuously adjustable on load at least 5% from rated value.

.2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

.3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of ac input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.

.4 Harmonics over entire load range:

.1 Total rms value not to exceed 3% rms value of total output voltage.

.2 Single harmonic not to exceed 1.9% of total output voltage.

.5 Proper angular phase relation maintained within 2 electrical degrees at up to 80% load unbalance.

.7 Efficiency: Overall system efficiency at rated 100% load with battery fully charged not less than 95%. Overall system efficiency at rated 25% load with battery fully charged not less than 94%.

.8 Interference suppression:

.1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.

.2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

2.2 ELECTRICAL REQUIREMENTS

.1 In accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 No battery, other than main battery incorporated in design.

.3 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.

.4 Variable resistors: fine adjustment, rheostat type.

.5 Indicator lamps: long life LED, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.

.6 Solid state circuits used where more reliable than mechanical timers or control relays.

.7 Standard components available from commercial sources used throughout, with 10 years minimum shelf life.

.8 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.

.9 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.

.10 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.

.11 Components and sub-assemblies accurately made for interchangeability.

2.3 ENCLOSURE

.1 The space and installation area noted for the UPS is shown in the drawings. This vendor must ensure that the provided product can work within these parameters.

.2 Dead front free rack mounting minimum 2.5 mm thick, CSA Enclosure 1.

.3 Service Access from **front** only.

.4 Meters, indicating lamps and controls group mounted in panel front.

.5 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping. Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with 2 keys. Hinges to permit doors to be lifted off cubicle.

.6 Module sizes not to exceed number of rack units indicated in drawings for main module and battery modules.

.7 External cable connections at top or side of cubicle through bolted plate for drilling at site to suit.

.8 Ambient temperature range during operation -20 degrees C to +40 degrees C. Natural or forced ventilation as required. For forced ventilation power from inverter output and fan directly driven by motor mounted on vibration isolators. Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.

.9 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.

.10 Maximum operating sound level not to exceed 73 dbA as measured on sound level meter with A weighting and slow response, at distance of 1 meter.

.11 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

2.4 RECTIFIER

.1 Input power supply from:

- .1 Ac mains;
- .2 Automatic diesel engine driven generating unit.

.2 Input disconnect: bolt-on moulded case three pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

.3 Input transformer: connected between ac input and rectifier input

.4 Surge suppressor: to protect equipment from supply voltage switching transients.

.5 Rectifier:

- .1 Solid-state Pulse Width Modulation (PWM) rectifier utilizing Insulated Gate Bipolar Transister (IGBT)

.6 Filter: for rectifier dc output.

.7 Fuse: to protect dc output.

.8 Adjustments and controls:

- .1 Line voltage adjusting taps to allow for +/-10% variation from nominal.

.2 Manual adjustment of float voltage with range of +/-5%.

.3 Manual adjustment of equalizing voltage.

.4 Automatic current limiting on rectifier adjustable between 80 and 120% of normal rating.

.5 Provision to disconnect rectifier from inverter and battery if rectifier dc output exceeds safe voltage limits of battery.

.9 Performance of rectifier:

.1 Automatically maintain battery in fully charged state while mains power available, and maintain dc float voltage within +/-1% of setting, no load to full load, during mains voltage variations up to +15% to -20%.

.2 Battery charging rate such that after battery has provided full load power output for specified duration, charger returns battery to 95% of fully charged state in 4 hours.

.3 Programmable Automatic equalize charging circuit to initiate equalize charging of battery.

.4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 hours to return unit to float charge.

2.5 INVERTER

.1 Input power supply from:

.1 Rectifier dc output;

.2 Battery dc output.

.2 Input disconnect: bolt-on moulded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

.3 Input filter: with separately fused computer grade capacitor banks and indicator lights, to eliminate inverter source noise and restrictions on input cable length.

.4 Power stage: High efficiency Solid-state Pulse Width Modulation (PWM) rectifier utilizing Insulated Gate Bipolar Transistor (IGBT). Components, solid state devices capable of satisfactory operation under ambient conditions of -20 degrees C to +40 degrees C.

.5 Output filter: output of high frequency switching stage contains elements of carrier frequency which are filtered to low harmonic sine wave.

.6 Output disconnect: bolt-on, moulded case, three pole circuit breaker or magnetic contactor, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

2.6 BATTERY

.1 Battery to be sealed type.

.1 Discharge current to supply inverter at full load output, for 15 min.

.2 Battery modules and trays are replaceable without shutting down UPS or going into bypass.

2.7 STATIC BYPASS SWITCH

.1 Two solid state closed circuit automatic transfer switches.

.2 Logic unit with three normal source voltage sensors, which monitor overvoltage undervoltage and loss of voltage.

.3 High speed automatic transfer from normal voltage to alternate source when:

.1 Normal source voltage lost: transfer time and sensing 1/4 cycle;

.2 Normal source: undervoltage at 80% of nominal value; adjustable.

.3 Normal source: over voltage at 115% of nominal value.

.4 Loss of normal source static switch continuity.

.5 Short circuit on normal source trips normal source breaker.

.4 Return to normal source:

.1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.

.5 Switch position lights and contacts.

.6 Synchronizing verification light.

.7 Manual reset pushbutton.

.8 Transfer test switch.

.9 Alternate power source monitor light.

.10 Accessories:

.1 Manual bypass switch for maintenance and testing without load disturbance.

.2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.

.3 Alternate power source loss alarm contacts.

2.8 OPERATING DEVICES

.1 Operating accessories:

.1 Counter for number of failures of normal mains ac power: non-reset type, zero to 99,999 operations.

.2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.

.3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.

.2 Mode lights mounted on front panel to indicate:

.1 Ac output on inverter - green;

.2 Ac input available - green;

.3 Inverter and ac input synchronized - green;

.4 Inverter and ac input not synchronized - amber;

.5 Static bypass switch in bypass position - red;

.6 Overtemperature alarms:
- .1 Rectifier - red;
- .2 Inverter - red;
- .3 Bypass switch - red;

.7 Cooling fan fuse open - red;

.8 Inverter output over voltage - red;

.9 Inverter output under voltage - red;

.10 Battery over voltage - red;

.11 Battery under voltage - red;

.12 Inverter fuse/breaker open - red;

.13 Rectifier fuse/breaker open - red;

.14 Static bypass switch fuse/breaker open - red;

.15 UPS on battery operation - red;

.16 Rectifier in equalize mode - amber;

.17 Battery discharging indicator - red, to change from steady to flashing during final 5 to 10 min of battery duration.

.3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

2.9 FABRICATION

.1 Shop assemble:
- .1 Rectifier unit;
- .2 Inverter unit;
- .3 Bypass switch unit;

.2 Interconnect units, and add remote mode lights, alarms and controls to produce complete uninterruptible power system before requesting Departmental Representative to witness factory tests.

2.10 FINISHES

.1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Cubicles:
- .1 Inside finish: White or Beige;
- .2 Exterior finish: manufacturers standard colour;
- .3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

2.11 EQUIPMENT IDENTIFICATION

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

.2 For major components such as ac input breaker, inverter breakers, bypass switch: size 5 nameplates.

.3 For mode lights, alarms, meters: size 3 nameplates.

2.12 SOURCE QUALITY CONTROL

.1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested in presence of Departmental Representative.

.2 Notify Departmental Representative:

.1 One week in advance of date of factory test;

.2 That system has had preliminary testing and has met design requirements satisfactorily.

.3 Test procedures:

.4 Prepare blank forms and check sheet with spaces for recording data.

.5 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach meter recordings.

.6 Provide Departmental Representative’s signature on form to indicate concurrence in results reported.

.7 Duplicate given to Departmental Representative at end of test.

.8 Information from original presented as part of O&M Manual.

.3 Test equipment:

.1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.

.2 Dummy load for testing, adjustable to 150% of system rated output at 0.8 power factor lagging. Load on each phase adjustable from zero to 100 % so that unbalanced output maybe tested for 3 phase systems.

.4 Tests:

.1 Visual inspection to determine:

.1 Materials, workmanship, and assembly conform with design requirements;

.2 Parts are new and free of defects;

.3 Battery and components are not damaged;

.4 Battery cells are of identical construction;

.5 Electrolyte in each cell is at manufacturer's recommended full level;

.6 Each battery cell polarity and polarity of connections to inverter are correct;

.7 Proper size fuses are installed;

.8 Metres have suitable range;

.9 Accessories are present;

.10 Portable metres for acceptance tests are suitable and instrument transformers connected correctly.

.2 Demonstrate:

.1 System start-up and shut down;

.2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times;

.3 Adjustable settings;

.4 Record values measured at test points using oscilloscope, digital multimeter, and camera attachment;

.5 Protective devices and indications function as designed. Record actual settings, and note operation of remote indications and transfer to bypass. Tests to include:

.1 Annunciator lights correct indication;

.2 Overcurrent on inverter output;

.3 Over voltage and under voltage of inverter output;

.4 Dc input voltage to inverter too low. Gradually reduce dc input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.

.5 Simulate over temperature by applying heat to sensor with hot air blower.

.6 Simulate fuse blowing to test indication response.

.7 Simulate fan failure.

.8 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.

.9 Over voltage of rectifier dc output.

.3 Harmonic test:

.1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion meter at output terminals.

.2 Determine each harmonic magnitude with harmonic wave analyzer.

.3 Measure phase to neutral at 0.8 lagging power factor.

.4 Transients:

.1 With normal power input, apply full load to system.

.2 Remove one half load from each phase.

.3 Reapply one half load instantly.

.4 Record voltages and currents using oscilloscopes.

.5 Steady load:

.1 Switch system onto ac mains, start inverter and connect dummy 1.0, Unity power factor load.

.2 Operate system at full rated load for 24 hours and at 125% load for 10 min in ambient temperature of 40 degrees C.

.3 Record data at start of test and at half hour intervals thereafter; including:

.1 Input frequency;

.2 Input voltage;

.3 Input current;

.4 Input kW;

.5 Output voltage phase to phase, phase to neutral;

.6 Output current each phase;

.7 Output kW;

.8 Temperature of ventilating air-in;

.9 Temperature of ventilating air-out;

.10 Temperature at critical zones;

.6 Varying loads:

.1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.

.2 Calculate efficiencies of rectifier, inverter, and complete system.

.7 Unbalanced loads:

.1 Adjust loads on inverter to full load on two phases, 80% load on third phase.

.2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.

.3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.

.8 Battery:

.1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:

.1 Ambient temperature;

.2 Voltage of battery;

.3 Charging current;

.2 Discharge battery by operating uninterruptible power system with ac mains open, at full rated output for duration quoted in design requirements. Record, at 5 min intervals:

.1 Voltage of battery;

.2 Current;

.3 Ambient temperature;

.4 Battery temperature;

.3 Recharge battery automatically by closing ac mains supply to system for 4 hours period, with dummy load connected. Record at 15 min intervals.

.1 Battery voltage;

.2 Charging current.

.4 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 hours charge period.

.5 Recharge battery.

.9 Operating sound level:

.1 Measure sound level according to ANSI S1.13 using sound level meter with A weighting and slow response, conforming to ANSI S1.4.

.2 Operator to take reading by placing meter in front of him with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.

.3 Measure sound level during low ambient sound level.

Part 3 Execution

3.1 INSTALLATION

.1 Locate UPS modules and battery modules as indicated.

.2 Assemble and interconnect components to provide complete UPS as specified.

.3 Connect ac mains to main input terminal.

.4 Connect UPS output to load.

.5 Start-up UPS and make preliminary tests to ensure satisfactory performance.

3.2 TESTING

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and CSA-C813.1.

.2 Provide:

.1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.

.2 Dummy load adjustable to 150% of system rated output.

.3 Notify Departmental Representative 10 working days in advance of test date.

.4 Tests:

.1 Inspection of cubicles, battery rack and battery.

.2 Inspection of electrical connections.

.3 Inspection of installation of remote mode lights and alarms.

.4 Demonstration of system start-up and shut-down.

.5 Run UPS for minimum period of 4 hours at full rated load to demonstrate proper operation with ac mains input, emergency generator input, no ac input.

.6 Discharge battery by operating UPS with ac mains open for specified duration of full load. Record readings of temperature of each cell.

.7 Recharge battery automatically with full rated load on UPS for 4 hours and record readings of voltage of each cell.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

.1 CSA International

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

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 2-1996 (R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Make, model and type.

.2 Enclosure ratings and approvals

.3 Load classification.

.4 Single line diagram showing controls and connections.

.5 Description of equipment operation including:

.1 Interlocks

.2 Auxiliary contacts and status outputs

.3 Cable connectors and type

.4 Enclosure locking

.5 Lockout procedures

.6 Operating modes

.7 Mounting template.

1.4 QUALITY ASSURANCE

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

1.5 CLOSEOUT SUBMITTALS

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

.2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.

.3 Detailed instructions to permit effective operation, maintenance and repair.

.4 Technical data:

.1 Schematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.

.3 Certified copy of factory test results.

1.6 DELIVERY, STORAGE AND HANDLING

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

.2 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect transfer switches from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

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

2.2 ENCLOSURE

.1 Enclosure shall be constructed from fully welded stainless steel or Marine Grade aluminium (5000 series alloy), suitable for continuous exterior exposure.

.2 Doors will be arranged with hydraulic hold-opens holding doors at 180 degrees to closed position.

.3 Enclosure doors will have continuous gasketting made from neoprene rubber or similar providing a durable weather seal.

.4 Mounting tabs shall be provided such that all mounting hardware will not penetrate and/or compromise the weather resistant integrity of the enclosure.

2.3 RECEPTACLES

.1 Receptacles shall be sized and rated as noted in drawings and as noted herein. Terminations and connections shall be suitable for terminating using wire sizes as noted in drawings.

.1 120/208V Temporary Power Connection

.1 400 total amps, 3 phase 4 wire with ground

.2 ‘Cam Lock’ style single conductor DLO connectors, reverse pinning for ground and neutral positions. Connection arrangement suitable for feeding power into connection box from portable generator.

.3 NEMA 3R enclosure.

.2 Junction box, complete with terminal strip for connection of generator start/stop signals. NEMA 3R enclosure.

2.4 EQUIPMENT IDENTIFICATION

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

.2 Control panel:

.1 For selector switch and manual switch: size 5 nameplates.

Part 3 Execution

3.1 INSTALLATION

.1 Coordinate precise final location on site with Departmental Representative.

.2 Terminate all cabling and conduits into enclosure using weather proof connections suitable for location and wiring method.

3.2 FIELD QUALITY CONTROL

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

.2 Check out complete system for operational sequencing.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Supply and install 120/208 volt, 3 phase, 4 wire power conditioning filter on distribution equipment.

.2 Supply and install surge suppression receptacles as indicated on drawings.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results Electrical and Division 01 General Requirements.

.2 Include:

.1 Dimensioned drawings showing enclosure, mounting, lug sizes and bus size.

.2 Recommended breaker size.

Part 2 Products

2.1 TVSS PROTECTION UNITS

.1 Install unit in parallel with distribution panel bus to provide high energy power conditioning filter incorporating transient voltage surge suppression (TVSS) and high frequency electrical line noise filtering. The unit will also provide current diversion.

.2 Unit will be CSA certified.

.3 Operating temperature -20^{o}C to +60^{o}C.

.4 Unit will be unaffected with humidity between 5% to 95% non condensing.

.5 The unit shall not generate any audible noise or produce any magnetic fields.

.6 The unit will operate at system voltage and phase.

.7 The unit shall have a maximum continuous operating voltage not less than 115% of the nominal system voltage.

.8 The operating frequency of the unit should be 60 Hz ± 5%.

.9 The unit shall have a primary mode protection of line to neutral and a secondary mode of protection shall be neutral to ground.

.10 The maximum repetitive surge current capacity will be the following, based on ANSI/IEEE C62.41-1991:

Line to Line:	150,000
Line to Neutral:	150,000
Line to Ground:	75,000
Neutral to Ground:	75,000

.11 The main panel protection will have a life expectancy of at least 2500 ANSI/IEEE C62.41-1991 Category C surges without failing or degrading the surge suppression by more than 20%.

.12 The unit will be factory tested.

.13 The manufacturer will supply a minimum warranty of five years from the date of installation.

.14 The unit will come complete with a CSA Type One enclosure.

.15 Four lugs will be provided to accept a minimum #1/0 copper conductor.

.16 The unit will have LED status indicators for each phase.

.17 The main panel protection unit will have a high frequency filter to reduce transients on the line.

.18 TVSS mounted at Main Distribution shall be rated at 250KVA.

.19 Supplier shall advise on recommended circuit breaker size with contractor to coordinate as required.

2.2 TVSS SURGE SUPPRESSION RECEPTACLES

.1 Provide surge suppression receptacles as shown in drawings.

.2 Devices shall be complete with audible and visual indications.

.3 Device is blue in color.

.4 Unit will be CSA certified.

Part 3 Execution

3.1 INSTALLATION

.1 Connect TVSS units as indicated on drawings.

.2 TVSS Manufacturer shall recommend breaker ratings for the upstream breaker, to be included in this contract.

.3 Have a manufacturer's representative test and verity the correct operation of the system. Submit the test results and verification report to the Departmental Representative.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies the materials and installation for luminaires for the entire project including exterior lighting fixtures.

.2 Refer to the Luminaire Schedule on the electrical drawings.

1.2 REFERENCES

.1 CAN/CSA C22.1-09, Canadian Electrical Code, Part I.

.2 CAN/CSA C22.2 No.9.0, General Requirements for Luminaires.

1.3 GREEN INITIATIVES AND LEED™ CERTIFICATION

.1 There shall be no light trespass from the building and site. Luminaires to improve night sky access and reduce impact on nocturnal environments.

.1 All exterior luminaries with more than 1000 initial Lamp Lumens are shielded and all luminaries with more than 3500 initial Lamp Lumens meet the full cut-off IESNA classification.

.2 The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property.

.3 Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary.

1.4 PRODUCT DATA

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

.2 Submit complete photometric and heat dissipation data prepared by independent testing laboratory for proposed luminaires.

1.5 INTENT

.1 Provide lighting fixtures and accessories for all outlets as listed in the Luminaire Schedule and as shown on drawings.

.2 Lighting fixtures shall be structurally well designed and constructed, using new parts and materials of the highest commercial grade available.

.3 Ground all lighting equipment to grounding system.

.4 Verify all ceiling types and finishes before ordering fixtures and provide fixtures suitable for mounting in or on ceilings being installed in each area, as specified. Where fixture types specified are not suitable for ceiling being installed, obtain written instructions from the Departmental Representative before ordering fixtures.

.5 Fixtures of the same or similar type shall be supplied by the same manufacturer.

Part 2 Products

2.1 BALLASTS

.1 All ballasts shall be supplied with a rated voltage matching the supply voltage indicated on the drawings. Ballast output current and voltage shall match the current and voltage ratings of the lamp or lamps they are designed to operate. All ballasts to be built to CSA Standard C22.2 No.74.

.2 Ballasts shall comply with FCC and NEMA limits covering EMI and RFI and shall not interfere with operation of other normal electrical equipment.

.3 Minimum requirements for electronic ballasts:

.1 Sound rating of 'A'.

.2 High frequency operation (25 KHz or higher).

.3 Total harmonic distortion to be less than 10%.

.4 Current crest factor to be less than 1.7.

.5 Rated lamp life shall be maintained.

.6 High power factor of 90% or higher.

.7 High efficiency ballasts for linear fluorescent lamps.

.8 Input voltage as indicated on drawings.

.9 Ballasts used in exterior luminaires to have minimum starting temperature of -18^{o}C.

.4 Minimum requirements for electromagnetic ballasts:

.1 Pulse start type for metal halide.

.2 Current crest factor to be less than 1.7.

.3 Epoxy encased "super quiet" ballast assemblies for all interior fixtures ballast.

.4 Ballasts used in exterior luminaires to have minimum starting temperature of -30^{o}C.

2.2 LAMPS

.1 Provide and install lamps in all fixtures in the project.

.2 Install fluorescent lamps with the same Watt rating as indicated. Refer to schedule for lamp colour and colour rendering index.

.3 High Pressure Sodium lamps to be coated. Metal Halide lamps to be coated unless otherwise noted.

.4 Compact fluorescent lamps shall be 2700K colour temperature or as indicated.

2.3 SOLID STATE LIGHTING

.1 Solid state lighting rated correlated colour temperature (CCT) shall be with four (4) MacAdam ellipses of the specified CCT in the luminaire schedule. Colour consistency between lamps in the same fixture type shall be within four (4) MacAdam ellipses of the rated CCT.

.2 Solid state lighting shall have a CRI greater or equal to the value listed in the luminaire schedule. In addition the lamps shall have an R9 value greater than 50 measured under the same conditions as the CRI.

.3 Solid state lighting systems (including required drivers) shall have a power factor greater than 90 at full rated output.

.4 Solid state lighting lumen maintenance data shall be provided for L70 testing.

2.4 SOCKETS

.1 Sockets for incandescent fixtures shall be standard medium base.

.2 Sockets for fluorescent fixtures shall be standard medium bi-pin unless otherwise noted.

2.5 FIXTURES

.1 Accessories and components shall comply with relevant CSA Standards.

.2 Recessed downlight fixtures shall be of the approved prewired type with junction box forming an integral part of the fixture assembly and so located in relation to the fixture that the junction box is CSA approved for 75 degree C wire. The electrical trade shall supply and install all necessary plaster rings, supports, etc., required for complete and proper installation.

.3 Except where otherwise noted in the Luminaire Schedule, depth of recessed fluorescent fixtures shall not exceed 150 mm, including mounting yokes, or bridges. Design of reflector and lamp position shall be to provide high efficiency, even brightness and lack of lamp lines.

.4 All metal parts shall be thoroughly cleaned and finished in high reflectance baked enamel over corrosion-resistant primer. Finish as indicated in luminaire schedule.

.5 All internal fixture diffusers, lens panels, lens frames, etc., shall be securely and adequately supported and shall be removable without the use of tools for cleaning.

.6 Fixtures shall incorporate adequate gasketting, stops and barriers to form light traps and prevent light leaks.

.7 Fixtures shall be designed for adequate dissipation of ballast and lamp heat to avoid short ballast life, nuisance thermal tripping and decreased lamp output. Heat test reports by independent laboratories shall be provided where required by the Departmental Representative.

.8 Construction of all fixtures shall be such as to provide a rigid well aligned fixture. Formed or ribbed backplates, end plates, reinforcing channel, heavy gauge sockets, straps, etc., shall be used where required to accomplish this.

.9 The construction and performance of all fluorescent fixtures shall be subject to the acceptance of the Departmental Representative.

Part 3 Execution

3.1 INSTALLATION AND SUPPORTS

.1 Provide complete and proper support for all fixtures, fixture hangers, etc., including headers in ceiling space, where required, for proper support of outlet boxes and fixture hanger assemblies.

.2 Support fixtures as shown on the drawings, level, plumb and true with the structure and other equipment in a horizontal or vertical position as intended. Wall or side bracket mounted fixture housings shall be rigidly installed and adjusted to give a neat flush fit to the surface on which it is mounted.

.3 All hangers, supports, fastenings or accessory fittings shall be protected against corrosion. Care shall be taken during the installation to assure that insulation and corrosion protection is not damaged.

.4 Self aligning seismically rated ball joint hangers shall be used for rod suspended fixtures. Ceiling canopies or hood assemblies intended to cover the suspension attachments shall be installed to fit tightly to the ceiling without restricting the alignment of the hanger. Support fixtures by hangers and mounting arrangements which will not cause the fixture frame, housing, sides or lens frame to be distorted; or prevent complete alignment of several fixtures in a row.

.5 The suspension length of all ceiling mounted suspended types of lighting fixtures as listed in the Fixture Schedule shall be the overall length from the ceiling to the lowest point of the fixture body, reflector or glassware in its hanging position.

.6 Metal inserts, expansion bolts or toggle bolts in concrete slabs for stems which do not carry wiring must be accurately located in relation to the outlet boxes, to allow perfect alignment and spacing of suspension stems.

.7 Where fixtures are surface mounted on the underside of an inverted tee bar ceiling, the fixture shall be supported either directly from the building structure by means of rod hangers and inserts or by means of metal angle headers, supported from the tee bar framing structure above the tile. Fixtures shall be supported from the quarter points.

.8 Wiring from outlet boxes to fluorescent fixtures and wiring through fluorescent fixture channels shall be rated for 90 degrees C.

.9 Connection to incandescent fixtures shall be by means of approved fixture type wiring.

.10 All recessed fixtures to be installed so that they are removable from below to gain access to outlet box or prewired fixture box. Connect all recessed fixtures to boxes with flexible conduit and approved fixture wire. Provide approved drywall enclosures in insulated ceilings. Volume of enclosure to comply with Electrical Code.

.11 Install fixture lenses as late as possible to protect from dirt and dust. Remove and clean or replace lenses to the satisfaction of the Departmental Representative.

END OF SECTION

1. GENERAL

1.1 PRODUCT DATA

.1 Submit product data in accordance with Section 26 05 00 and 01 33 00 – Submittal Procedures. Requirements.

.2 Date to include system components product dimensions, mounting method, wiring diagrams, electrical characteristics.

2. PRODUCTS

2.1 UNIT EMERGENCY LIGHTING EQUIPMENT

2.2 INVERTER/BATTERY RACK– LINE VOLTAGE

.1 Line voltage inverter/battery system to CSA C22.2 No.141.

.2 120V single phase input,120 V output single phase

.3 5VA capacity.

.4 Noise level 65 dB @ 1 meter.

.5 120 minute run time.

.6 20 year Life Type Battery.

.7 Complete with integral 12 circuit panel with 15 amp moulded case circuit breakers.

.8 Battery: sealed, maintenance free.

3. EXECUTION

3.1 INSTALLATION

.1 Install inverter charging unit and battery rack as per manufacturers' instruction in mechanical/ electrical equipment 202 as shown on drawing.

.2 Connect input to Panel 2L; connect lighting loads to circuit breakers, circuit numbers as noted on drawings.

.3 Lighting loads shall be connected using shunt bypass relay such that lighting on inverter will automatically come on regardless of the state of lighting control devices.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies materials and installation for exit signs complete with directional arrows.

1.2 PRODUCT DATA

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

.2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.

Part 2 Products

2.1 EXIT SIGN TYPES

.1 All exit signs shall comply with CAN/CSA C860 (latest edition), CSA 22.2 #141 and National Building Code, 2015.

.2 Exit signs shall be complete with 10 year warranty on the batteries.

.3 Exit signs shall be LED and have a complaint green “Running Man” pictogram complete with directional arrows as noted on drawings.

2.2 MOUNTING TYPE

.1 Exit signs to be suitable for universal mounting. Allow for exit signs to be mounted as to best suit ceiling/wall type and architectural features:

- .1 Surface wall mounted
- .2 End wall mounted double face
- .3 Ceiling mounted single face
- .4 Ceiling mounted double face

.2 Exit signs to have direction arrows where indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Install exit signs as shown on plans complete with double face units where indicated.

.2 Connect to dedicated circuit as indicated on the plans.

.3 Exit signs must be clear of all visual obstruction.

.4 Contractor to confirm locations before final installation.

3.2 LOCATION

.1 Review locations of exit signs with engineer and Departmental Representative to ensure effectiveness and compatibility with decor before rough in. Failure to do so may result in relocation at no extra charge to the project.

□

3.3 MOUNTING HEIGHT

.1 Wall mounted signs shall be clear above doors and, if space allows, 2.4 metres to centre, but with 25mm clearance of ceiling.

.2 Ceiling mounted signs shall be mounted directly on ceiling, unless it is obstructed from view. Stem mount using two fixture rods (9.5mm white smooth type).

END OF SECTION

□

Part 1 General

1.1 DESCRIPTION

.1 Provide rough in and connection to the equipment noted herein, which typically include systems or equipment from other divisions.

.2 Scope of work includes equipment as noted on electrical and architectural drawings.

1.2 PRODUCT DATA AND SHOP DRAWINGS

.1 Submit product data and shop drawings in accordance with General Requirements.

Part 2 Products

.1 Not applicable.

Part 3 Execution

3.1 BAGGAGE CONVEYORS

.1 All cabling shall be installed in conduit inside a concealed or inaccessible wall or ceiling cavity. Extend all conduits to cable tray or into accessible ceiling as noted on drawings. NO EXPOSED CABLING OR CONDUITS WILL BE ACCEPTED.

.2 Provide **all line voltage conduits** required for operation of these systems. Refer to final shop drawings for motor quantity, location and finalized scope of work.

.3 Extend conduits to accessible ceiling spaces as required. Connect to wall mounted control panels as noted on electrical or architectural drawings.

.4 Confirm wiring installation requirements with appropriate trade and actual shop drawings to ensure correct conduit and cable sizes.

.5 Connect to remote switch control device and facilitate connection for automated control functions.

3.2 MOTORIZED BLINDS

.1 All cabling shall be installed in conduit inside a concealed or inaccessible wall or ceiling cavity. Extend all conduits to cable tray or into accessible ceiling as noted on drawings. NO EXPOSED CABLING OR CONDUITS WILL BE ACCEPTED.

.2 Electrical contractor shall extend a 120VAC circuit(s) as shown in the drawings to a location in a concealed or accessible ceiling space for extension or connection by the blind installer/vendor. Electrical contractor shall coordinate this location with the blind installer/vendor to ensure that this connection point is in a suitable location. Provide access covers when installed behind a gyproc ceiling.

.3 Blind installer/vendor shall provide all line and low voltage cabling and conduits required for operation of these systems beyond the line voltage connection shown in these drawings. The blind installer/vendor may engage the services of the base building electrical contractor for the installation of their wiring systems, but are otherwise obliged to provide their own electrical installer and electrical permit to install all line and low voltage wiring required for their systems. The blind installer/vendor must be on site during rough-in to ensure that all required wiring, cabling and conduits are concealed in the building fabric and not exposed.

.4 Provide roughed in conduits for future implementations as noted in drawings.

.5 Extend conduits to accessible ceiling spaces as required. Connect to wall mounted control panels as noted on electrical or architectural drawings.

.6 Confirm wiring installation requirements with appropriate trade and actual shop drawings to ensure correct conduit and cable sizes.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies empty telecommunications raceway systems with, cabletrough and conduit distribution system.

1.2 SYSTEM DESCRIPTION

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, cable tray, cabinets, conduits, cabletroughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

.2 Note that supply, installation and testing of communications cabling, as well as all hardware related to the communications system not noted in these documents shall be completed by Shared Services Canada.

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 and cabinets: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.4 Outlet boxes, conduit boxes, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.5 Fish wire: polypropylene type.

2.2 COMMUNICATION OUTLETS AND TERMINAL CONNECTIONS

.1 Data/communications outlets are to consist of 100 x 100 box c/w single gang plaster ring and flush mounted into walls unless indicated otherwise. Outlets to be complete with quantity of modular RJ45 jacks as indicated on plans.

.2 Where data/communications outlets are shown to be installed on steel, prefabricated or solid wood construction, conduits and boxes shall be surface mounted.

2.3 GROUND BAR

.1 Label bus bar connections.

.2 All patch panels, racks, and cable trays must be bonded to ground with #6 Cu. green insulated ground wire.

Part 3 Execution

3.1 INSTALLATION

.1 Provide minimum 27mm conduit to each data outlet extended to local cable tray or communications room.

.2 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.

.3 Provide pull string/fish wire in all conduits, cable tray and pathways.

.4 All pathways to be bonded to ground as per Canadian Electrical Code and as noted in these documents.

3.2 SPECIFIC LOCATIONS

.1 Where data outlets are shown to be installed in clean or cold rooms, these conduits shall extend from the outlet location through the prefabricated assembly and to the local cable tray nearby. Conduit shall be run continuous from outlet to cable tray with pull boxes as required such that maximum number of bends is not exceeded.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 NBC-latest edition, National Building Code of Canada.

.2 Government of Canada

.1 TB OSH Chapter 3-03, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire Protection Electronic Data Processing Equipment.

.2 TB OSH Chapter 3-04, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.

.3 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S524-latest edition, Installation of Fire Alarm Systems.

.2 ULC-S525- latest edition, Audible Signal Appliances.

.3 CAN/ULC-S526- latest edition, Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527- latest edition, Control Units.

.5 CAN/ULC-S528- latest edition, Manual Pull Stations.

.6 CAN/ULC-S529- latest edition, Smoke Detectors.

.7 CAN/ULC-S530- latest edition, Heat Actuated Fire Detectors.

.8 CAN/ULC-S531- latest edition, Smoke Alarms.

.9 CAN/ULC-S536- latest edition, Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537- latest edition, Verification of Fire Alarm Systems.

1.2 SCOPE OF WORK

.1 All fire alarm systems, including interim, shall be fully verified, connected to power and monitoring prior to acceptance or occupancy.

1.3 DESCRIPTION OF SYSTEM

.1 This system shall interface and connect to the existing Simplex fire and Mass Notification system throughout the existing site. The fire alarm panel shall be a Simplex 4100 series to ensure compatibility with the balance of this system. As-built drawings of this system will be provide to the contractor after contract award. The new fire alarm panel in the ATP Integration facility shall connect to the existing panel in the Site Services Building using a twisted shielded copper network.

.2 System shall be fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital and multiplexing techniques for data transmission.

.3 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to fire department.

.4 The system shall be fully addressable, zoned, non-coded single stage.

.5 System to be modular in design to allow for future expansion with a minimum of 6 spare zones and associated hardware in the panel.

.6 Operation of system shall not require personnel with special computer skills.

.7 System to include:

.1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.

.2 Power supplies.

.3 Initiating/input circuits.

.4 Output circuits.

.5 Auxiliary circuits.

.6 Wiring.

.7 Manual and automatic initiating devices.

.8 Audible and visual signalling devices.

.9 End-of-line resistors.

.10 Local and Remote annunciators and displays.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

.1 System:

.1 To TB OSH Chapter 3-04.

.2 Subject to Fire Commissioner of Canada (FC) approval.

.3 Subject to FC inspection for final acceptance.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include:

.1 Layout of equipment.

.2 Zoning.

.3 Complete wiring diagram, including schematics of modules.

1.6 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual.

.2 Include:

.1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Copy of sound pressure levels for each space.

.3 Technical data - illustrated parts lists with parts catalogue numbers.

.4 Copy of approved shop drawings.

.5 List of recommended spare parts for system.

1.7 EXTRA MATERIALS

.1 Provide maintenance materials as recommended by the system manufacturer. Submit recommended spare parts list to Departmental Representative for review in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include four (4) spare glass rods for manual pull box stations if applicable.

.3 Include for six (6) additional spare audible devices, wired and installed within 30m of the nearest audible device. Devices will be utilised where sound level readings during verification are below Building Code requirements. Unused devices are to be turned over to the Departmental Representative or credited to the contract.

1.8 MAINTENANCE

.1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.

.2 In accordance with applicable CAN/ULC standards.

2.2 SYSTEM OPERATION

.1 Single stage operation. Operation of any alarm initiating device to:

- .1 Cause audible signal devices to sound throughout building.
- .2 Transmit signal to fire department via fire alarm transmitter.
- .3 Cause zone of alarm device to be indicated on control panel and remote annunciator.
- .4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
- .5 Cause fire doors and smoke control doors if normally held open, to close automatically.

.2 Capability to program smoke detector status change confirmation on any or all zones in accordance with CAN/ULC-S527, Appendix C.

2.3 CONTROL PANEL

.1 Single stage operation.

.2 Zoned.

.3 Non-coded.

.4 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, full viewing window, flush lock and 2 keys.

.5 Provide 120 volt circuit and ceramic heater for all exterior mounted annunciator panels, whether indicated or not.

.6 Supervised, modular design with plug-in modules:

- .1 Alarm receiver with trouble and alarm indications provision for remote supervised annunciation, for class A and B initiating circuits.

.2 Spare zones: compatible with smoke detectors and open circuit devices.

.3 Space for future modules in addition to spare zones provided.

.4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.

.7 Components:

.1 Coded alarm receiver panel with trouble and alarm indications for class A and B initiating circuits.

.2 Single stage alarm pulse rate panels:

.1 Single stroke control type for output to signal control panel continuously.

.3 Common control and power units:

.1 Control panel containing following indications and controls:

.1 "Power on" LED (green) to monitor primary source of power to system.

.2 "Power trouble" indication.

.3 "Ground trouble" indication.

.4 "Remote annunciator trouble" indication.

.5 "System trouble" indication.

.6 "System trouble" buzzer and silence switch c/w trouble resound feature.

.7 System reset switch.

.8 "LED test" switch if applicable.

.9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.

.10 "Signals silenced" indication.

.2 Master power supply panel to provide 24Vdc to system from 120Vac, 60Hz input.

.3 Fire department connections:

.1 Plug-in module for shunt type municipal box.

.2 Fire department bypass switch c/w indicator for trouble at panel.

.4 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit.

.1 Contacts: 2.0A, 120Vac, for functions such as release of door holders or initiation of fan shut down.

.2 Contact terminal size: capable of accepting 22-12AWG wire.

2.4 NODE COMMUNICATIONS

.1 ATP fire alarm panel shall tie in to the existing Herzberg campus fire alarm network. The Site Services building connects to the Main Building using optical fiber. The ATP fire alarm panel node shall tie into the existing network at the Site Services Building using wired, twisted shielded pair cabling and associated network modules at each fire alarm panel. Provide all additional network modules,

wiring and integration at the existing Site Services and Main Building fire alarm panel as required for a complete, compliant and operational system.

2.5 POWER SUPPLY

.1 120V, ac, 60Hz input, 24Vdc output from rectifier to operate alarm and signal circuits, with standby power of gel cell batteries minimum expected life of 4 years, sized in accordance with BC Building Code.

2.6 MANUAL ALARM STATIONS

.1 Manual alarm pull stations: addressable, pull lever, wall mounted surface type, non-coded single pole normally open contact for single stage English signage.

.2 Manufacturer - Addressable manual pull station.

.3 Provide steel protective guards for pull stations installed where required by Departmental Representative.

2.7 AUTOMATIC ALARM INITIATING DEVICES

.1 Heat detectors, fixed temperature, non-restorable, rated 57°C.

.2 Thermal detectors, addressable, fixed temperature: 57°C.

.3 Smoke detector: addressable ionization type.

.1 Dual chamber, ionization, twistlock, plug-in type with fixed wire-in base assembly with integral red alarm LED. Detector to be addressable type c/w electronics to communicate detector's status and field adjustable address setting.

.4 Remote LED alarm indicator for concealed thermal and smoke detectors.

2.8 AUDIBLE SIGNAL DEVICES

.1 Audible notification appliances: 103mm cone speakers, ceiling or wall mount, red with 'Fire' lettering. 25 or 70 VRMS with 0.25, 0.5, 1 and 2 watt taps

.2 All audible signals must be a temporal pattern 3, as required by the BC Building Code.

2.9 END-OF-LINE DEVICES

.1 End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.10 REMOTE ANNUNCIATOR PANELS

.1 LED type with designation cards to indicate zone.

.2 LED's to annunciate alarm and trouble.

.3 Wired in multiple with main control panel.

.4 Supervised, including trouble signal for open circuit.

.5 LED test button.

2.11 VISUAL ALARM SIGNAL DEVICES

.1 Strobe type: flashing blue, 24Vdc.

.2 Designed for surface mounting on ceiling or walls as indicated.

2.12 SPRINKLER SYSTEM CONNECTION

.1 Provide waterflow/tamper modules for connection to sprinkler system for monitoring of flow switches and valves.

.2 Provide input modules for connection of pressure switches for monitoring.

.3 Provide alarm/trouble indication of heat tracing system at the control panel and remote annunciator panel.

.4 Provide input modules and connection to dry sprinkler monitoring and annunciation devices.

2.13 ISOLATION MODULES

.1 Addressable zone isolation modules.

2.14 MAGNETIC DOOR HOLD OPEN DEVICES

.1 Magnetic two-piece device. One piece flush mounted on wall and the other piece on door, 120V AC.

.2 Wire through Low Voltage Relay, to de-energize door holder, upon signal from fire alarm system.

2.15 ANCILLARY DEVICES

.1 Remote relay unit to initiate fan shutdown.

.2 Provide relay interlocks to fire alarm control panel to shut down fans as indicated on mechanical equipment schedule.

.3 Provide relay interlocks and control switches in main control panel and annunciator panels to enable smoke removal fans operation as described in the Mechanical Specifications.

.4 Provide relay contact to DDC system to signal the status of the fire alarm system.

2.16 WIRE AND CABLE

.1 All conductors shall be as per manufacturers recommendations for a compliant and noise free installation.

.2 Conductor Insulation: Minimum rating 300 volts. Single conductor RW90XLPE (X-link).

.3 Multi-conductor cables 105°C with outer PVC jacket, colour coded, FAS rated armoured cable where required.

.4 Conductor sizes as follows:

.1 To initiating circuits: #18 AWG minimum, and in accordance with manufacturer's requirements.

.2 To signal circuits: #16 AWG minimum, and in accordance with manufacturer's requirements.

.3 To control circuits: #12 AWG minimum, and in accordance with manufacturer's requirements.

.4 Size all fire alarm wiring for maximum 3% voltage drop at maximum load at last device in run.

.5 All wiring to be copper.

.6 All wiring to be tag identified at the points of connection.

.7 Provide a ground conductor with all system wiring and bond all metal parts including device boxes.

.8 All fire alarm system wiring to be in conduit except short drops from ceiling junction box to detectors mounted in T-Bar ceiling may be rated fire alarm system cable.

.9 Where noted, provide a 2 hour rated wiring method as recognized by CSA and Authority having jurisdiction.

Part 3 Execution

3.1 INSTALLATION

.1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.

.2 Install main control panel and connect to ac power supply.

.3 Locate and install manual alarm stations and connect to alarm circuit wiring.

.4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to main control panel.

.6 Locate and install signal devices, bells, chimes, horns and visual signal devices and connect to signalling circuits.

.7 Connect signalling circuits to main control panel.

.8 Install end-of-line devices at end of alarm and signalling circuits.

.9 Install remote annunciator panels and connect to annunciator circuit wiring.

.10 Locate and install door releasing devices.

.11 Locate and install remote relay units to control fan shut down.

.12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

.13 Provide quantity of six (6) spare speakers and allow for installation to within 10m radius of nearest speaker shown on plans to suit final fit-up sound level requirements.

.14 Provide quantity of two (2) spare manual pull stations and allow for installation within 10m radius of fire alarm system devices.

.15 Provide quantity of two (2) spare heat detectors and allow for installation within 10m radius of fire alarm system devices.

.16 Provide quantity of two (2) spare smoke detectors and allow for installation within 10m radius of fire alarm system devices.

3.2 FIRE ALARM ZONES

.1 Provide zoning for fire alarm detection devices as noted in drawings.

.2 Provide all required connections to all mechanical sprinkler system alarm and supervisory devices. Coordinate with Mechanical drawings and specifications.

.3 Provide and install minimum two bell circuits per floor. Confirm exact locations.

3.3 FIELD QUALITY CONTROL

.1 Perform tests as described herein and in accordance CAN/ULC-S537.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors, and sprinkler system transmit alarm to control panel and actuate general alarm ancillary devices.

.2 Check annunciator panels to ensure zones are shown correctly.

.3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

.4 Manufacturer's technician to verify all new devices and reconnected existing fire alarm system equipment and components in accordance with ULC Standard S537.

.5 Provide a Certification of Verification.

.6 After verification, demonstrate and spot test system as required by Departmental Representative and Fire Commissioner.

.7 Provide Departmental Representative with written verification report for review and include copies in maintenance manuals

.8 Class A circuits.

.1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.9 Class B circuits.

.1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

3.4 TRAINING

.1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

END OF SECTION

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 31 32 19.0 - Geotextiles.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C117-13, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.3 ASTM D422-63(2007)e2, Standard Test Method for Particle-Size Analysis of Soils.

.4 ASTM D698-12ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ;) (600 kN-m/m ;).

.5 ASTM D1557-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ;) (2,700 kN-m/m ;).

.6 ASTM D4318-10e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 Canadian Standards Association (CSA International)

.1 CAN/CSA-A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.1 CSA-A3001-13, Cementitious Materials for Use in Concrete.

.2 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.4 U.S. Environmental Protection Agency (EPA)/Office of Water

.1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 DEFINITIONS

.1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.

.1 Rock: solid material in excess of 1.00m ; and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15m; bucket. Frozen material not classified as rock.

.2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.

.2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.

.3 Topsoil:

.1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

.2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.

.4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.

.5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.

.6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.

.7 Unsuitable materials:

.1 Weak, chemically unstable, and compressible materials.

.2 Frost susceptible materials:

.1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136 : Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

.2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

.3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

.8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Quality Control: in accordance with Section 01 45 00 - Quality Control:

.1 Submit for review by Departmental Representative proposed dewatering methods as described in PART 3 of this Section.

.2 Submit to Departmental Representative written notice when bottom of excavation is reached.

.3 Submit to Departmental Representative testing, inspection, results and report as described in PART 3 of this Section.

.3 Preconstruction Submittals:

.1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.

.2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field.

.4 Samples:

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

.2 Inform Departmental Representative at least 4weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.

.3 Submit 70kg samples of type of fill.

.4 Ship samples to Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.

.5 At least 4 weeks prior to beginning Work, inform Departmental Representative of fly ash and submit samples to Departmental Representative

.1 Do not change source of Fly Ash without written approval of Departmental Representative

1.5 QUALITY ASSURANCE

.1 Qualification Statement: submit proof of insurance coverage for professional liability.

.2 Submit design and supporting data at least 2weeks prior to beginning Work.

.3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Province of British Columbia, Canada.

.4 Keep design and supporting data on site.

.5 Engage services of qualified professional Engineer who is registered or licensed in Province of British Columbia, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.

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

.7 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Section 01 35 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 Divert materials from landfill to local facility for reuse.

1.7 EXISTING CONDITIONS

.1 Examine soil report prepared by Geotcehnical Engineer in Appendix A of specifications

.2 Buried services:

.1 Before commencing work verify location of buried services on and adjacent to site.

.2 Contact utilities, Municipality, BC One Call, Public Works and Government Services Canada, and a utility locate company to help identify locations of underground services.

.3 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.

.4 Remove obsolete buried services within 2 m of foundations: cap cut-offs.

.5 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

.6 Prior to beginning excavation Work, notify applicable Departmental Representative establish location and state of use of buried utilities and structures.

.7 Confirm locations of buried utilities by careful test excavations or soil hydrovac methods.

.8 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.

.9 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing.

.10 Record location of maintained, re-routed and abandoned underground lines.

.11 Confirm locations of recent excavations adjacent to area of excavation.

.3 Existing buildings and surface features:

.1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, pavement, survey bench marks and monuments which may be affected by Work.

.2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative

.3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

Part 2 PRODUCTS

2.1 MATERIALS

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

.1 Crushed, pit run or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

.3 Table:

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

.2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.

.3 Unshrinkable fill: proportioned and mixed to provide:

.1 Maximum compressive strength of 0.4 MPa at 28 days.

.2 Maximum cement content of 25 kg/m ; to CSA-A3001, Type GU.

.3 Minimum strength of 0.07MPa at 24 h.

.4 Concrete aggregates: to CSA-A23.1/A23.2.

.5 Cement: Type GU.

.6 Slump:160 to 200 mm.

.4 Shearmat: honeycomb type bio-degradable cardboard 100 mm thick, treated to provide sufficient structural support for poured concrete until concrete cured.

Part 3 EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

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

3.2 SITE PREPARATION

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.3 PREPARATION/PROTECTION

.1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.

.2 Keep excavations clean, free of standing water, and loose soil.

.3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.

.4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.

.5 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

.1 Begin topsoil stripping of areas as indicated after area has been cleared of brush, weeds, tress, and grasses and removed from site.

.2 Strip topsoil to depths as indicated.

.1 Do not mix topsoil with subsoil.

.3 Stockpile in locations as directed by Departmental Representative.

.1 Stockpile height not to exceed 2 m and should be protected from erosion.

.4 Dispose of unused topsoil as directed by Departmental Representative.

3.5 STOCKPILING

.1 Stockpile fill materials in areas designated by Departmental Representative

.1 Stockpile granular materials in manner to prevent segregation.

.2 Protect fill materials from contamination.

.3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

.1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 29.06 - Health and Safety Requirements and WorkSafeBC

.1 Where conditions are unstable, Departmental Representative to verify and advise methods.

.2 Construct temporary Works to depths, heights and locations as indicated by Departmental Representative.

.3 During backfill operation:

.1 Unless otherwise indicated or directed by Departmental Representative remove sheeting and shoring from excavations.

.2 Do not remove bracing until backfilling has reached respective levels of such bracing.

.3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.

.4 When sheeting is required to remain in place, cut off tops at elevations as indicated.

.5 Upon completion of substructure construction:

.1 Remove cofferdams, shoring and bracing.

.2 Remove excess materials from site.

3.7 EXCAVATION

.1 Advise Department Representative at least 7 days in advance of excavation operations. Excavate to lines, grades, elevations and dimensions as indicated.

.2 Limit work area to a maximum of 3 meters from the edge of the excavation unless authorized in writing from Departmental Representative.

.3 Maintain at least on lane of traffic open at all times to ensure the uninterrupted operation of the NRC Herzberg Institute of Astrophysics and for access of emergency vehicles.

.4 Maintain active traffic control as per WorkSafeBC.

.5 Remove concrete, masonry, paving, walks, demolished, foundations and rubble and other obstructions encountered during excavation.

.6 Excavation must not interfere with bearing capacity of adjacent foundations.

.7 Do not disturb soil within branch spread of trees or shrubs that are to remain.

.1 If excavating through roots

.1 Engage a professional arborist, certified in the province of British Columbia.

.2 Have the arborist prepare a written report on how to proceed with excavation.

.3 Submit report to Departmental Representative for review and information.

.4 Follow the arborist's recommendations for excavating.

.8 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30m of trench in advance of installation operations and do not leave open more than 5m at end of day's operation.

.9 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.

.10 Restrict vehicle operations directly adjacent to open trenches.

.11 Dispose of surplus and unsuitable excavated material in approved location on site.

.12 Do not obstruct flow of surface drainage or natural watercourses. Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.

.13 Notify Departmental Representative when bottom of excavation is reached.

.14 Obtain Departmental Representative approval of completed excavation.

.15 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.

.16 Correct unauthorized over-excavation as follows:

.1 Fill under bearing surfaces and footings with concrete specified for footings Type 2 fill compacted to not less than 100% of corrected Standard Proctor maximum dry density.

.2 Fill under other areas with Type 2 fill compacted to not less than 95 % of corrected Standard Proctor maximum dry density.

.17 Hand trim, make firm and remove loose material and debris from excavations.

.1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

.2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative

.18 Install geotextiles in accordance with Section 31 32 19.01 - Geotextiles.

3.8 FILL TYPES AND COMPACTION

.1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D698 ASTM D1557.

.1 Exterior side of perimeter walls: use Type 3 fill to subgrade level. Compact to 95% of corrected maximum dry density.

.2 Within building area: use Type 2 to underside of base course for floor slabs. Compact to 100 % of corrected maximum dry density.

.3 Under concrete slabs: provide 150mm compacted thickness base course of Type 1 fill topped with shearmat filler as indicated to underside of slab. Compact base course to 100 %.

.4 Retaining walls: use Type 2 fill to subgrade level on high side for minimum 500mm from wall and compact to 95%. For remaining portion, use Type 3 fill compacted to 95 %.

.5 Place unshrinkable fill in areas as indicated.

3.9 BEDDING AND SURROUND OF UNDERGROUND SERVICES

.1 Place and compact granular material for bedding and surround of underground services as indicated.

.2 Place bedding and surround material in unfrozen condition.

3.10 BACKFILLING

.1 Do not proceed with backfilling operations until completion of following:

.1 Departmental Representative has inspected and approved installations.

.2 Departmental Representative has inspected and approved of construction below finish grade.

.3 Inspection, testing, approval, and recording location of underground utilities.

.4 Removal of concrete formwork.

.5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

.2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Place backfill material in uniform layers not exceeding 300 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.

.5 Backfilling around installations:

.1 Do not backfill around or over cast-in-place concrete within 24hours after placing of concrete.

.2 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.150 m.

.3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:

.1 Permit concrete to cure for minimum 14days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative

.6 Place unshrinkable fill in areas as indicated.

.7 Consolidate and level unshrinkable fill with internal vibrators.

.8 Install drainage system in backfill as indicated

3.11 RESTORATION

.1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.

.2 Replace topsoil as indicated.

.3 Reinstate lawns to elevation which existed before excavation.

.4 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.

.5 Clean and reinstate areas affected by Work as directed by Departmental Representative

.6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.

.7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION 31 23 33.01

Part 1 GENERAL

1.1 REFERENCES

.1 ASTM International

.1 ASTM C117-04, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C131-14, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft;) (600kN-m/m;).

.5 ASTM D1557-12e1, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft;) (2,700kN-m/m;).

.6 ASTM D1883-14, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

.7 ASTM D4318-10e1, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 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.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

Part 2 PRODUCTS

2.1 MATERIALS

.1 Granular base: material in accordance with the following requirements:

.1 Crushed stone or gravel.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.

.1 Gradation Method #1 to:

Sieve Designation	% Passing (1)	(2)	(3)
100 mm	-	-	-
75 mm	-	-	-
50 mm	100	-	-
37.5 mm	70-100	-	-
25 mm	-	100	-
19 mm	50-75	-	100
12.5 mm	-	65-100	70-100
9.5 mm	40-65	-	-
4.75 mm	30-50	35-60	40-70
2.00 mm	-	22-45	23-50
0.425 mm	10-30	10-25	7-25
0.180 mm	-	-	-
0.075 mm	3-8	3-8	3-8

.2 Material to level surface depressions to meet gradation (2) limits in accordance with Method #1.

.3 Liquid limit: to ASTM D4318, maximum 25

.4 Plasticity index: to ASTM D4318, maximum 6.

.5 Los Angeles degradation: to ASTM C131. 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 C136.

Passing		Retained on
50 mm	to	25 mm
25 mm	to	19.0 mm
19.0 mm	to	4.75 mm

.7 Soaked CBR: to ASTM D1883, minimum 100, when compacted to 100% of ASTM D1557.

Part 3 EXECUTION

3.1 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

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

3.2 PLACEMENT AND INSTALLATION

.1 Place granular base after sub-base and subgrade surface is inspected and approved 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 not less than 100% maximum dry density to ASTM D698 ASTM D1557.

.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.

3.3 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.

3.4 CLEANING

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 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 32 11 23

Part 1 GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)

.1 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.5-M91(March 1999), Low Flash Petroleum Spirits Thinner (Reaffirmation of December 1991).

.2 CAN/CGSB-1.74-2001, Alkyd Traffic Paint.

.3 Master Municipal Construction Documents Association (MMCD), Platinum Edition (2009).

1.3 SAMPLES

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

.2 Submit to Department Representative samples of material for sieve analysis at least 2 weeks before beginning Work.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Place materials defined as hazardous or toxic in designated containers.

.5 Divert unused aggregate materials from landfill to facility for reuse as approved by Department Representative.

.6 Dispose of unused paint and paint thinner materials at official hazardous material collections site as approved by Department Representative.

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

.8 Do not dispose of unused paint and paint thinner material into sewer system, into streams, lakes, onto ground or in other location where it will pose health environmental hazard.

.9 Divert unused asphalt from landfill to facility capable of recycling materials.

Part 2 PRODUCTS

2.1 MATERIALS

.1 Prime coat: N/A.

.2 Tack coat: CAN/CGSB – 16.2, Grade SS-1.

.3 Asphalt cement: CGSB – 16.3-M 90, Grade 80-100.

.4 Asphalt concrete bottom course: MMCD Lower Course #2

.5 Asphalt concrete top course: MMCD Upper Course #2

.6 Traffic paint: yellow and white to CAN/CGSB-1.74.

.7 Paint thinner: to CAN/CGSB-1.5.

Part 3 EXECUTION

3.1 FOUNDATIONS

.1 Foundations for roadways and parking lots comprise:

.1 250 mm compacted thickness of granular subbase.
.2 100 mm compacted thickness of granular base.

.2 Compaction: compact each lift of granular material to 100% maximum density to ASTM D698. Maximum lift thickness: 300 mm.

3.2 PAVEMENT THICKNESS

.1 Pavements for roadways and parking lots:

.1 Base course: 50 mm MMCD Lower Course #2.
.2 Wear course: 30 mm MMCD Upper Course #2.

3.3 PAVEMENT CONSTRUCTION

.1 Construction of asphalt concrete: MMCD.

.2 Surface preparation: MMCD.

.3 Application of tack coat: MMCD.

.4 Construction of asphalt concrete: MMCD.

3.4 TRAFFIC MARKINGS

.1 Paint parking space divisions and other pavement markings in accordance with manufacturer’s recommendations and as indicated.

.2 Use paint thinner in accordance with manufacturer's requirements.

END OF SECTION 32 12 16.01

Part 1 GENERAL

1.1 RELATED SECTIONS

.1 Section 02 81 01 - Hazardous Materials

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

.3 Section 03 20 00 - Concrete Reinforcing

.4 Section 31 05 16 - Aggregate Materials

.5 Section 31 23 33.01 – Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C117-13, Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.3 ASTM D260-86(2001), Standard Specification for Boiled Linseed Oil.

.4 ASTM D698-12ae2, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600 kN-m/m^3).

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-3.3-99(March 2004), Kerosene, Amend. No. 1, National Standard of Canada.

.2 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.3 Canadian Standards Association (CSA International)

.1 CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS in accordance with Section 01 35 33 Health and Safety Requirements

1.4 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 47 21 - Construction/Demolition Waste Management and Disposal.

Part 2 PRODUCTS

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.2 Reinforcing steel: in accordance with Section 03 20 00 - Concrete Reinforcing.

.3 Joint filler and Curing Compound: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.4 Granular base: material to the following requirements:

.1 Type 1, 2 or 3 fill.

.2 Crushed stone or gravel.

.3 Gradations: within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

.5 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water-soluble soap.

.6 Fill material: to the following requirements:

.1 Type 1, 2 or 3 fill.

.2 Crushed stone or gravel.

.3 Gradations: within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

.7 Boiled linseed oil: to ASTM D260.

.8 Kerosene: to CAN/CGSB-3.3.

Part 3 EXECUTION

3.1 GRADE PREPARATION

.1 Do grade preparation work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Construct embankments using excavated material free from organic matter or other objectionable materials.

.1 Dispose of surplus and unsuitable excavated material in approved location on site.

.3 Place fill in maximum 300mm layers and compact to at least 95% of maximum dry density to ASTM D698.

3.2 GRANULAR BASE

.1 Obtain Departmental Representative's approval of subgrade before placing granular base.

.2 Place granular base material to lines, widths, and depths as indicated.

.3 Compact granular base in maximum 300 mm layers to at least 95% of maximum density to ASTM D698.

3.3 CONCRETE

.1 Obtain Departmental Representative approval of granular base prior to placing concrete.

.2 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.3 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom in direction normal to centre line.

.4 Provide edging as indicated with 10 mm radius edging tool.

.5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to Departmental Representative can be demonstrated. Hand finish surfaces when directed by Departmental Representative.

3.4 TOLERANCES

.1 Finish surfaces to within 3 mm in 3m as measured with 3m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

.1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 3m.

.2 Install expansion joints at intervals of 9m.

.3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.6 ISOLATION JOINTS

.1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structure.

.2 Install joint filler in isolation joints in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.3 Seal isolation joints with sealant approved by Departmental Representative.

3.7 CURING

.1 Cure concrete by adding moisture continuously in accordance with CSA-A23.1/A23.2 to exposed finished surfaces for at least 1day after placing, or sealing moisture in by curing compound as directed by Departmental Representative.

.2 Where burlap is used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.

.3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.8 BACKFILL

.1 Allow concrete to cure for 7days prior to backfilling.

.2 Backfill to designated elevations with material as directed by Departmental Representative.

.1 Compact and shape to required contours as directed by Departmental Representative.

3.9 LINSEED OIL TREATMENT

.1 Apply two coats of linseed oil mixture uniformly to surfaces of curbs, walks and gutters, after concrete has cured for specified curing time and when surface of concrete is clean and dry.

.2 Linseed oil mixture to consist of 50% boiled linseed oil and 50% mineral spirits by volume.

.3 Apply treatment when air temperature above 10 degrees C.

.4 Apply first coat at 135mL/m^2.

.5 Apply second coat at 90mL/m^2 when first coat has dried.

3.10 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 32 16 15

Part 1 General

1.1 RELATED SECTIONS

.1 Section 03 20 00 – Concrete Reinforcing

.2 Section 31 23 33.01 - Excavating Trenching and Backfilling.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM A48/A48M-03(2012), Standard Specification for Gray Iron Castings.

.2 ASTM C117-13, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.

.3 ASTM C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates (Metric).

.4 ASTM C139-14, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.

.5 ASTM C478M-15a, Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric).

.6 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3)).

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 Canadian Standards Association (CSA International)

.1 CAN/CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CAN/CSA-A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.1 CSA-A3001-13, Cementitious Materials for Use in Concrete.

.2 CSA-A3002-13, Masonry and Mortar Cement.

.3 CAN/CSA-A165 Series-04 (R2014), CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2 and A165.3).

.4 CAN/CSA-G30.18-09 (R2014) Carbon Steel Bars for Concrete Reinforcement.

.5 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 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 two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 – Health and Safety Requirements.

.3 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.

.1 Submit manufacturer's test data and certification at least 2 weeks prior to beginning Work. Include manufacturer's drawings, information and shop drawings where pertinent.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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

1.4 QUALITY ASSURANCE

.1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Departmental Representative to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

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

Part 2 PRODUCTS

2.1 MATERIALS

.1 Cast-in-place concrete:

.1 In accordance with Section 03 30 00 - Cast-in-Place Concrete.

.2 Cement: to CAN/CSA-A3001, Type GU.

.3 Concrete mix design to produce 21 MPa minimum compressive strength at 28 days and containing 25 mm maximum size coarse aggregate, with water/cement ratio to CAN/CSA-A23.1.

.1 Air entrainment to CAN/CSA-A23.1, class C-3 exposure.

.4 Supplementary cementing materials: with minimum 20% Type F fly ash replacement, by mass of total cementitious materials to CAN/CSA A3001.

.5 Concrete reinforcement: in accordance with Section 03 20 00 - Concrete Reinforcing.

.2 Precast manhole units: to ASTM C478M, circular or oval.

.1 Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.

.2 Monolithic bases to be approved by Departmental Representative.

.3 Precast catch basin sections: to ASTM C139 ASTM C478M.

.4 Joints: made watertight using rubber rings, bituminous compound, epoxy resin cement.

.5 Mortar:

.1 Masonry Cement: to CAN/CSA-A3002.

.6 Ladder rungs: to CAN/CSA-G30.18, No.25M billet steel deformed bars, hot dipped galvanized to CAN/CSA-G164.

.1 Rungs to be safety pattern (drop step type).

.7 Adjusting rings: to ASTM C478M.

.8 Concrete Brick: to CAN3-A165 Series.

.9 Drop manhole pipe: same as sewer pipe.

.10 Galvanized iron sheet: approximately 2 mm thick.

.11 Steel gratings, I-beams and fasteners: as indicated.

.12 Frames, gratings, covers to dimensions as indicated and following requirements:

.1 Metal gratings and covers to bear evenly on frames.

.1 Frame with grating or cover to constitute one unit.

.2 Assemble and mark unit components before shipment.

.2 Gray iron castings: to ASTM A48/A48M, strength class 30B.

.3 Castings: coated with two applications of asphalt varnish.

.4 Manhole frames and covers: cover cast with perforations and complete with two 25 mm square lifting holes.

.5 Catch basin frames and covers: ASTM A48 and to withstand H20 loading.

.6 Size: 762 mm clear diameter.

.13 Granular bedding and backfill: in accordance with Section 31 23 33.01 Excavating, Trenching and Backfilling:

.14 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

Part 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 EXCAVATION AND BACKFILL

.1 Excavate and backfill in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling and as indicated.

.2 Obtain approval of Departmental Representative before installing, manholes or catch basins.

3.3 CONCRETE WORK

.1 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.2 Place concrete reinforcement in accordance with Section 03 20 00 - Concrete Reinforcing.

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

3.4 INSTALLATION

.1 Construct units in accordance with details indicated, plumb and true to alignment and grade.

.2 Complete units as pipe laying progresses.

.1 Maximum of three units behind point of pipe laying will be allowed.

.3 Dewater excavation to approval of Departmental Representative and remove soft and foreign material before placing concrete base.

.4 Cast bottom slabs directly on undisturbed ground.

.5 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% maximum density to ASTM D698.

.6 Precast units:

.1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.

.2 Make each successive joint watertight with rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.

.3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.

.4 Plug lifting holes with concrete plugs set in cement mortar or mastic compound.

.7 For sewers:

.1 Place stub outlets and bulkheads at elevations and in positions indicated.

.2 Bench to provide smooth U-shaped channel.

.1 Side height of channel to be 0.75 times full diameter of sewer.

.2 Slope adjacent floor at 1 in 20.

.3 Curve channels smoothly.

.4 Slope invert to establish sewer grade.

.8 Compact granular backfill to 95% maximum density to ASTM D698.

.9 Place unshrinkable backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.10 Installing units in existing systems:

.1 Where new unit is installed in existing run of pipe, ensure full support of existing pipe during installation, and carefully remove that portion of existing pipe to dimensions required and install new unit as specified.

.2 Make joints watertight between new unit and existing pipe.

.3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready for operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.

.11 Set frame and cover to required elevation on no more than three courses of brick.

.1 Make brick joints and join brick to frame with cement mortar.

.2 Parge and make smooth and watertight.

.12 Place frame and cover on top section to elevation as indicated.

.1 If adjustment required use concrete ring.

.13 Clean units of debris and foreign materials.

.1 Remove fins and sharp projections.

.2 Prevent debris from entering system.

3.5 ADJUSTING TOPS OF EXISTING UNITS

.1 Remove existing gratings, frames and store for re-use at locations designated by Departmental Representative.

.2 Sectional units:

.1 Raise or lower straight walled sectional units by adding or removing precast sections as required.

.2 Raise or lower tapered units by removing cone section, adding, removing, or substituting riser sections to obtain required elevation, then replace cone section.

.1 When amount of raise is less than 600 mm use standard manhole brick, moduloc or grade rings.

.3 Monolithic units:

.1 Raise monolithic units by roughening existing top to ensure proper bond and extend to required elevation with mortared brick course for 150 mm or less alteration.

.2 Lower monolithic units with straight wall by removing concrete to elevation indicated for rebuilding.

.3 When monolithic units with tapered upper section are lowered more than 150 mm, remove concrete for entire depth of taper plus as much straight wall as necessary, then rebuild upper section to required elevation with cast-in-place concrete.

.4 Install additional manhole ladder rungs in adjusted portion of units as required.

.5 Re-use existing gratings, frames.

.6 Re-set gratings and frames to required elevation on not more than three courses of brick.

.1 Make brick joints and join brick to frame with cement mortar, parge and trowel smooth.

.2 Re-set gratings and frames to required elevation on full bed of cement mortar, parge and trowel smooth.

3.6 SEALING OVER EXISTING UNITS

.1 Cut galvanized iron sheet to extend 50 mm beyond opening of existing manhole or catch basin grating.

.1 Center iron sheet over existing grating and spot or stitch weld to grating.

.2 Fill with cast-in-place concrete.

3.7 FIELD QUALITY CONTROL

.1 N/A

3.8 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 33 05 13

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 03 30 00 - Cast-in-Place Concrete

.3 Section 31 23 33 01 - Excavating Trenching and Backfilling

1.2 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 C111/A21.11- 07 , American National Standard for Rubber-Gasket Joints for Ductile-Iron and Fittings.

.5 ANSI/AWWA C110/A21.10- 08 , American National Standard for Ductile-Iron and Gray Iron Fittings for Water.

.6 ANSI/AWWA C153/A21.53- 11 , Standard for Ductile-Iron Compact Fittings.

.7 ANSI/AWWA C207- 07 , Standard for Steel Pipe Flanges for Waterworks Service, 4 Inch through 144 Inch (100 mm through 3,600 mm).

.8 ANSI/AWWA C500- 09 , Standard for Metal-Seated Gate Valves for Water Supply Service.

.9 ANSI/AWWA C504- 10 , Standard for Rubber-Seated Butterfly Valves.

.10 ANSI/AWWA C651- 05 , Standard for Disinfecting Water Mains.

.11 ANSI/AWWA C800- 05 , Standard for Underground Service Line Valves and Fittings.

.12 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.ASTM International

.2 CSA International

.1 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-B137.3- 09 , Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance 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 Store and protect water distribution piping from nicks, scratches, and blemishes .

.3 Replace defective or damaged materials with new.

1.4 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 a minimum of 5 working days in advance of interruption in service.

.4 Notify fire department of planned or accidental interruption of water supply to hydrants.

.5 Provide and post "Out of Service" sign on hydrant not in use.

.6 Advise local police department of anticipated interference with movement of traffic.

Part 2 Products

2.1 PIPE, JOINTS AND FITTINGS

.1 Polyvinyl chloride pressure pipe: to ANSI/AWWA C900, pressure class 150, DR 18, 1 MPa gasket bell end.

.1 CAN/CSA-B137.3, PVC series 160, 1.1 MPa elastomeric gasket [coupling.

.2 Cast iron fittings: to ANSI/AWWA C110/A21.10.

2.2 VALVES AND VALVE BOXES

.1 Valves to open clockwise.

.2 Gate valves: to ANSI/AWWA C500, standard iron body, with non-rising stems, suitable for 1 Pa.

.3 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 .

.4 Cast iron valve boxes: three piece sliding type adjustable over minimum of 450 mm.

.1 Base to be large round type with minimum diameter of 300 mm.

.2 Top of box to be marked "WATER"/"EAU".

2.3 SERVICE CONNECTIONS

.1 Copper tubing: to ASTM B88M type K, annealed.

.2 Copper tubing joints: compression type suitable for 1 MPa working pressure.

.3 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.

2.4 PIPE DISINFECTION

.1 Sodium to ANSI/AWWA B300 ANSI/AWWA B301, ANSI/AWWA B303 to disinfect water mains.

.2 Disinfect water mains in accordance with ANSI/AWWA C651.

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 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 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.

3.3 TRENCHING

.1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.4 PIPE INSTALLATION

.1 Join pipes in accordance with and manufacturer's recommendations.

.2 Bevel or taper ends of PVC pipe to match fittings.

.3 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends. 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 10mm in 3m.

.4 Face socket ends of pipe in direction of laying. For mains on grade of 2 % or greater, face socket ends up-grade.

.5 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.

.6 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.

.7 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.

.8 Align pipes before jointing.

.9 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.

.10 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.

.11 Complete each joint before laying next length of pipe. Minimize deflection after joint has been made.

.12 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.

.13 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes.

.14 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.

.15 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.

.16 Do not lay pipe on frozen bedding.

.17 Do hydrostatic and leakage test and have results approved by Departmental Representative.

.18 Backfill remainder of trench.

3.5 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.

.3 Install underground post-type indicator valves as indicated.

3.6 SERVICE CONNECTIONS

.1 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.

.2 Construct service connections at right angles to water main unless otherwise directed.

.3 Tappings on PVC pipe to be either PVC valve tees or bronze type service clamps, strap type with "O" ring seal cemented in place.

.4 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.

.5 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.

.6 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.

.7 Leave corporation stop valves fully open.

.8 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.

.9 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.

.10 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.

3.7 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.

.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.

3.8 PIPE ISULATION

.1 Insulate pipe in location as shown on design drawings

.2 Material:

.1 Rigid polyurethane foam, factory applied

.2 Thickness: 50.8 mm

.3 Density 35 to 48 kg/m3

.4 Closed cell content: 90%, minimum

.5 Thermal conductivity: 0.020 to 0.025 W/m degrees Celsius.

.6 Temperature range: -20C to 40C

.3 Jacketing to be 1.27mm thick polyethylene

3.9 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 3 working days 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.

.5 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.

.6 Open valves.

.7 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.

.8 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.

.9 Do not exceed allowable leakage of 1.25 L/mm of pipe/ 1000m length/ 24 hours, including lateral connections.

.10 Locate and repair defects if leakage is greater than amount specified.

.11 Repeat test until leakage is within specified allowance for full length of water main.

3.10 BACKFILL

.1 Place backfill material, above pipe surround, in uniform layers not exceeding 300mm 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 95% maximum density to ASTM D698.

.1 In other areas, compact to at least [90% corrected maximum dry density [[90 % maximum density to ASTM D698.

3.11 FLUSHING AND DISINFECTING

.1 Flushing and disinfecting operations:

.1 Notify Departmental Representative 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:

Pipe Size NPS	Flow (L/s) Minimum
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 introduce strong solution of chlorine as approved by into water main and ensure that it is distributed throughout entire system.

.7 Disinfect water mains to the requirements of local authority.

.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 Specialist 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.

END OF SECTION

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 31 05 16 - Aggregate Materials

.2 Section 03 30 00 - Cast-in-Place Concrete

.3 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 ASTM International

.1 ASTM C12-14, Standard Practice for Installing Vitrified Clay Pipe Lines.

.2 ASTM C14M-15a, Standard Specification for Concrete Sewer, Storm Drain and Culvert Pipe (Metric).

.3 ASTM C76M-15, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).

.4 ASTM C117-13, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.5 ASTM C136M-14, Standard Method for Sieve Analysis of Fine and Coarse Aggregates (Metric).

.6 ASTM C425-04(2013), Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

.7 ASTM C428-05(2011)e1, Standard Specification for Asbestos-Cement Nonpressure Sewer Pipe (Metric).

.8 ASTM C443M-11, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).

.9 ASTM C506M-14, Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe.

.10 ASTM C507M-15, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe (Metric).

.11 ASTM C663-98(2014), Standard Specification for Asbestos-Cement Storm Drain Pipe.

.12 ASTM C700-13, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

.13 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft;(600 kN-m/m;)).

.14 ASTM D1056-14, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

.15 ASTM D1869-15, Standard Specification for Rubber Rings for Fiber-Reingorced-Cement Pipe.

.16 ASTM D2680-01(2014), Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping

.17 ASTM D3034-15, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

.18 ASTM F667M-15, Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings (Metric).

.19 ASTM F794-03(2014), Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1-M88, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 CAN/CGSB-34.9-94, Asbestos-Cement Sewer Pipe.

.3 CSA International

.1 CAN/CSA-A3000-13, Cementitious Materials Compendium.

.2 CSA A257 Series-09(2010), Standards for Concrete Pipe and Manhole Sections.

.3 CAN/CSA-B1800-15, Thermoplastic Non-pressure Pipe Compendium - B1800 Series.

.4 CSA G401-14, Corrugated Steel Pipe Products.

1.3 SCHEDULING

.1 Schedule Work to minimize interruptions to existing services and to maintain existing flow during construction.

.2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

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 pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Shop drawings to indicate proposed method for installing carrier pipe for under crossings.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada.

.4 Certification to be marked on pipe.

.5 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance 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 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

Part 2 PRODUCTS

2.1 PLASTIC PIPE

.1 Type PSM Poly Vinyl Chloride (PVC): to ASTM D3034 CAN/CSA-B1800.

.1 Standard Dimensional Ratio (SDR): 28.

.2 Separate gasket and integral bell system.

.3 Nominal lengths: 4 m.

2.2 PIPE BEDDING AND SURROUND MATERIAL

.1 Granular material in accordance with Section 31 05 16 - Aggregate Materials.

.2 Concrete mixes and materials for bedding, cradles, encasement, supports: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

2.3 BACKFILL MATERIAL

.1 As indicated on design drawings and in accordance with Section 31 23 33.01 – Excavating, Trenching and Backfilling.

.2 Type 3 in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.3 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.4 JOINT MORTAR

.1 Portland cement: to CAN/CSA-A3000, normal type 10.

.2 Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additives.

2.5 GEOTEXTILE

.1 Geotextile: non-woven synthetic fibre fabric, supplied in rolls.

.1 Width: 3.81 m minimum.

.2 Length: 109.8 m minimum.

.2 Physical properties:

.1 Grab tensile strength and elongation: to [CAN/CGSB-148.1, No.7.3].

.1 Breaking force: minimum 40 N, wet condition.

.2 Elongation at future: 50

.3 Hydraulic properties:

.1 Apparent opening size (AOS): to ASTM D4751, 0.300 micrometres.

.2 Permitivity: to ASTM D4491, 2.0 pers.

.4 Factory seams: sewn in accordance with manufacturer's recommendations.

.5 Thread for sewn seams: equal or better resistance to chemical and biological degradation than geotextile.

.6

Part 3 EXECUTION

3.1 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 sediment and erosion control plan, specific to site, that complies with 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 to approval of Departmental Representative.

3.2 TRENCHING

.1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Protect trench from contents of sewer.

.3 Trench alignment and depth to approval of Departmental Representative prior to placing bedding material and pipe.

3.3 CONCRETE BEDDING AND ENCASEMENT

.1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete. 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 Backfill over concrete after 24 hours from placing.

3.4 GRANULAR BEDDING

.1 Place bedding in unfrozen condition.

.2 Place granular bedding material in uniform layers not exceeding 300 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 pipes.

.4 Shape transverse depressions as required to suit joints.

.5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.

.6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted bedding material.

3.5 INSTALLATION

.1 Lay and join pipes to: ASTM C12.

.2 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Departmental Representative.

.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 inverts smooth and free of sags or high points.

.1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.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 pipes 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 CAN/CSA-B1800.

.10 Joints:

.1 Concrete, clay and asbestos cement pipe:

.1 Install gaskets as recommended by manufacturer.

.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 other foreign material.

.5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace 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 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

.9 Mortared joints:

.1 Pipe exterior: for bell and spigot pipe, use mortar to seal outside of joints. Press and bed mortar into place.

.1 Allow mortar to set minimum of 1 hour before backfilling.

.11 When any stoppage of Work occurs, restrain pipes as directed by Departmental Representative to prevent "creep" during down time.

.12 Plug lifting holes with Departmental Representative approved prefabricated plugs, 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 and catch basins.

.1 Use shrinkage compensating grout when suitable gaskets are not available.

.15 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes.

.1 Joint to be structurally sound and watertight.

.16 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.6 PIPE SURROUND

.1 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.

.2 Hand place surround material in uniform layers not exceeding 300 mm compacted thickness as indicated.

.1 Do not dump material within 3 m of pipe.

.3 Place layers uniformly and simultaneously on each side of pipe.

.4 Compact each layer from pipe invert to mid height of pipe to at least 95% maximum density to ASTM D698.

.5 Compact each layer from mid height of pipe to underside of backfill to at least 90% maximum density to ASTM D698.

.6 When field test results are acceptable to Departmental Representative place surround material at pipe joints.

3.7 BACKFILL

.1 Place backfill material in unfrozen condition.

.2 Place backfill material, above pipe surround, in uniform layers not exceeding 300 mm compacted thickness up to grades as indicated.

.3 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D698. In other areas, compact backfill to at least 90% maximum density to ASTM D698.

.4 Place unshrinkable backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.8 FIELD TESTS AND INSPECTIONS

.1 Repair or replace pipe, pipe joint or bedding found defective.

.2 Remove foreign material from sewers and related appurtenances by flushing with water.

.3 Television and photographic inspections:

.1 Carry out inspection of installed sewers by television camera, photographic 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 Price and Payment Procedures in PART 1.

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.

END OF SECTION 33 41 00

1.0 GENERAL

1.1 RELATED SECTION
.1 Structural Steel for Buildings Section 05 12 23

1.2 WORK INCLUDED
.1 Supply and installation of top running, double girder, electronically operated CMAA Class "C" bridge cranes. Trolley and hoist electrical supply by festooned cable, bridge electrical supply from insulated runway conductor system (duct-o-bar)

1.3 REFERENCE
.1 Do bridge cranes to CSA B167 and CMAA Standards except where specified otherwise. Comply with the requirements of the industrial Health and Safety Regulations of Worker's Compensation Board of British Columbia.

1.4 SUBMITTALS
.1 Submit shop drawings in accordance with Section 01 30 00 – Submittal Procedures

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia, Canada. Submit Model Schedule B and C.

1.5 QUALITY ASSURANCE
.1 To reflect manufacturer's best standards of quality control and workmanship

1.6 ACCEPTANCE TESTS
.1 On completion of installation and following an inspection of the work for conformity to this specification, demonstrate to the Consultant by actual loaded operation of the hoist that it will accomplish the duties as specified herein for each item, including the correct functioning of all safety devices. In the event that the installation does not meet the Acceptance Tests, immediately make the necessary corrections, free of charge to the Owner, in order to meet the requirements of the specification. Supply all test loads required for the tests. The tests shall conform to CSA B167.

2.0 PRODUCTS

2.1 CRANE DETAILS

.1 Type of Crane: Wire rope hoist

.2 Crane Classification: Class "C", Indoor in accordance with CMAA

.3 Rate Loaded: 15 M ton

.4 Preferred Speeds with Rated Load:

.1 All movement operations (hoisting and travel) shall be two or variable speed as indicated and shall be equipped with fail safe brakes which are electrically operated and mechanically closed and shall be arranged by apply force evenly.

Brake shall not contain asbestos.

Specified speeds for hoisting and travel in Feet Per Minute (FPM)
Top Running Double Girder Bridge Crane
Main Hoist: 3.8m/min Stepless VFD or 3.35/0.3 (2 speed, up/down)
Trolley Traversing: 20-25 Stepless VFD
Bridge Travelling: 32-48.7m/min Stepless VFD

Trolley and bridge drives shall be designed so that acceleration and deceleration rates shall be constant and not measurably affected by variation of live load or location of load on bridge span and minimize swing.

.5 Dimensions shown are appropriate - Refer to drawings and confirm all dimensions on site with as built conditions:

Span: 20.9m (68.5ft)
Runway: 26.6m (87.4ft)
Maximum Lift: 15m (49ft)

.6 Controls: Pendant festooned cable push button control. Push buttons shall be guaranteed to prevent accidental actuation. Stop buttons shall be red. For two-speed operation partial depression shall activate the slower speed. Two speed push buttons shall have two “spring rates” to prevent accidental actuation of the faster speed. Crane shall be controlled remotely from the space. Provide spare battery for remote controller.

.7 Materials: Rolled steel sections, shapes, and rods to CAN/CSA-G40.21-300W, minimum yield strength 300 Mpa.

.8 Hoist: Hoist shall be complete with hoist rope guide designed to assure positive rope winding on drum and prevent overlap on groove

.9 Bridge End Trucks: Shall have double flanged wheels designed and fabricated to carry the wheel loads without undue wear. Co-ordinate wheel hardness with crane rail steel. End trucks shall be designed for easy wheel removal and exchange. End trucks shall be bolted to girder ends to form a rigid connection. Bolts in shear or welded connections are not permitted. End trucks shall be fitted with shock absorbing bumpers capable of decelerating and stopping crane within specified limits. Bridge drive shall be by separate motor at each end of truck.

.10 Lubrication: Cranes shall be fitted with all necessary lubrication fittings. Gear lubricant shall be synthetic, suitable for the life of the crane.

.11 Limit Switches: Provide adjustable control circuit limit switches for upper and lower limits of hoists. The operation of the upper limit (raising) switch shall not interfere with lowering function and lowering the block shall automatically reset the upper limit.

.12 Power Supply: Power Supply will be 575V/3/60Hz
.13. Grounding: Through rails or ground connector

2.2 ELECTRIFICATION

.1 Provide crane complete with all necessary controls, starters, limit switches and wiring required for proper operation of the crane. All motors shall have Class “F” Insulation and be thermally protected by heat sensors in the windings. Motors shall be sized/rated for the number of starts per hour expected and the duty cycle (on time vs. off time). Motor control shall be by means of magnetic contractors located in control enclosures. Select control enclosures for service application with minimum rating: watertight and dust resistant. Control power shall be isolated from main power supply by transformer and shall not exceed 120 Volts. Provide a disconnect switch on crane bridge with fuses. Provide over travel protection to reduce crane speed 1000mm before crane stops. All electrical components shall be CSA approved.

2.3 RUNWAY CONDUCTOR SYSTEM

.1 Runway conductors shall be insulated and properly supported and aligned horizontally and vertically with runway rail. Runway conductors shall be sufficient size to prevent excessive voltage drop or overloading when operated at rated load. Runway conductor system shall be arranged to prevent accidental contact with live parts. Power supply shall be at end of runway.

2.4 FINISHES

.1 Trolley, hoist and bridge assembly to be cleaned, prime painted and painted with high visibility machine enamel (manufacturers standard colour) Do not paint rails.

2.5 CAPACITY INDICATION

.1 Rated capacity of the crane shall be marked on the hook block and crane beam in accordance with WCB requirements.

2.6 HYDRA-SET

.1 A precise load positioner attachment that features very precise vertical lifting and lowering tolerances to 0.01” or 0.25mm. Hydra-Set eliminates oscillation produced by sudden starts and stops of crane cables, chains and slings. It also features a fail-safe load-docking system during power failure or sudden loss of pneumatics. 5 to 1 mechanical design safety factor with 4 methods of operation; manual, pneumatic, electro-hydraulic, and wireless remote up to 1000ft or 305 meters.

3.0 EXECUTION

3.1 EXAMINATION

.1 Before commencing work examine beams and tracks, clearances and other conditions that may affect the work. Report any problems that may hinder the effective installation of the cranes to the Consultant in writing. Commencement of work on site implies acceptance of existing work and conditions.

3.2 CLEAN UP

.1 Thoroughly clean mud, dirt and other discolourations or deleterious materials from all surfaces.

END OF SECTION 41 22 13.13

NRC HERZBERG ASTRONOMY & ASTROPHYSICS

ATP INTEGRATION FACILITY

VICTORIA, BRITISH COLUMBIA

Project No: R. 077596.001

APPENDIX 1

GEOTECHNICAL INVESTIGATION REPORT

5 September 2017

GEOTECHNICAL INVESTIGATION REPORT

Proposed ATP Integration Facility, Herzberg Institute of Astrophysics, 5071 West Saanich Road Victoria, BC

Submitted to:
Public Works and Government Services Canada
219-800 Burrard Street
Vancouver, BC
V6Z 0B9

Attention: Patrick Truong, PEng

REPORT

Report Number: 1314470497-013-R-Rev0

Distribution:

2 Copies - PWGSC

Golder Associates

Table of Contents

1.0 INTRODUCTION

This report provides the results of a geotechnical subsurface investigation carried out by Golder Associates Ltd. (Golder) for the site of the proposed new building for the NRC ATP Integration Facility at the Herzberg Institute of Astrophysics in Victoria, BC. The investigation was carried out for Public Works and Government Services Canada (PWGSC) according to the technical Terms of Reference (TOR) provided by PWGSC[1], Call up No. EZ899-160976/001/TPV and the Terms and Conditions of the Standing Offer Agreement No. EZ899-141238/001/TPV. This report should be read in conjunction with "*Important Information and Limitations of This Report*", which is included in Appendix A, following the text. The reader's attention is specifically drawn to this information for the proper use and interpretation of this report.

2.0 BACKGROUND

2.1 Site Description

The site under consideration is located within the National Research Council (NRC) Herzberg Institute of Astrophysics property located in Saanich, BC on Observatory Hill (Figure 1). The Site is located at civic address 5071 West Saanich Road, and is accessed via a paved road that leads to the observatory and associated facilities complex.

2.2 Proposed Development

Based on drawings provided to Golder, it is understood that a number of sites close to the current Site Services building have been considered for the new ATP integration facility. It is understood that the option referred to as Site 4 option H (Site 4H) is the preferred location at the present time. Site 4H is located southeast of the Site Services building on ground that slopes to the northeast. The southwest corner of the site is at approximately 197 m elevation and the north east corner is at approximately 190 m elevation.[2] The plan dimensions of the proposed building are 22.8 m wide by 29 m long.

2.3 Local Geological Conditions

The topography of the site is dominated by the feature referred to locally as Observatory Hill, which is a glacial feature developed as the result of deep erosion of bedrock, resulting in an elliptical shaped hill with more than 100 m of relief above the surrounding valley. The site of the proposed ATP facility is located near the edge of a narrow, bench-like feature with gentle slopes on the east side of the hill. Average slope gradients immediately downslope of the proposed building site are in the order of 25%. Slopes with similar gradients are present upslope of the proposed ATP Site. Bedrock outcrops are predominant on the hill slopes in the area of the Site. Figure 1 provides an overview of local bedrock outcrops that were mapped by Golder in the general area of the proposed footprint of Site 4H.

[1] PWGSC 2015, Terms of Reference, ATP/NSI Integration Facility, Victoria, B.C., Geotechnical Investigations and Laboratory Testing: Project # R.077596.001 (undated document)

[2] Elevations obtained from topographic contour information from Capital Regional District Regional Community Atlas

Available published bedrock geological mapping[3] indicates that the bedrock formation underlying the investigation area is Colquitz Gneiss, which is composed of generally hard, strong metamorphic rock referred to as quartz-feldspar gneiss. Published surficial geological mapping[4,5] indicates that the soil overlying the bedrock consists of thin (less than 1 m) colluvium, a type of locally derived soil resulting from the weathering of bedrock.

3.0 GEOTECHNICAL INVESTIGATION

A geotechnical subsurface investigation of the site was carried out on August 20, 2015. The investigation was conducted using sonic drilling methods to advance boreholes through the existing surficial soils, down to the surface of the underlying bedrock. Four boreholes were advanced using a Geoprobe 8140LS tracked sonic rig supplied and operated by Drillwell Enterprises Ltd. of Duncan B.C. The borehole investigation was conducted to assess existing soil conditions, groundwater seepage (if encountered), depth to bedrock, and to obtain disturbed soil samples for laboratory testing. The approximate locations of the boreholes as determined using a handheld GPS device are shown on Figure 1. Geotechnical summary logs of the soil and bedrock conditions encountered in the boreholes are provided in the Records of Boreholes, Appendix B.

The borehole investigation was conducted under the full time inspection of a member of Golder's geotechnical staff, who located the boreholes in the field, visually examined and logged the subsurface conditions encountered, and collected soil samples for visual examination and laboratory testing. During the investigation geotechnical staff also visually assessed the extent of the exposed bedrock outcrops and general bedrock strength characteristics. Locations of the observed bedrock outcrops are shown on Figure 1.

4.0 SUBSURFACE CONDITIONS

Depths within boreholes are referenced from the existing ground surface. Variations in the reported subsurface conditions should be expected throughout the area. Accordingly, caution should be used when extrapolating subsurface conditions between or beyond borehole locations.

The subsurface conditions encountered at the site have been generalized into the following units, in order of increasing depth below ground surface:

- Asphalt Pavement;
- Fill;
- Organic silt with sand and gravel; and
- Bedrock.

[3] Muller, J.E. 1983. Geology Victoria: Geological Survey of Canada, Map 1553A.

[4] Blythe,H.E. and Rutter, N.W., 1993. Surficial Geology of the Sidney Area: BC Geological Survey Branch, Open File 1993-24

[5] Monahan,P.A. and Levson,V.M., 2000. Quaternary Geological Map of Greater Victoria: BC Geological Survey Branch, Geoscience Map 2000-2

A discussion of geotechnical properties and detailed descriptions of the conditions encountered in the subsurface investigation are presented in the following sections.

Asphalt Pavement

All boreholes except SDH15-02 were drilled from paved areas. The asphalt pavement encountered in the boreholes ranged from 50 mm to 80 mm in thickness.

Fill

A unit of loose to compact fill, ranging from 0.4 to 3.1 m thick, was encountered in all four boreholes. This unit consisted of sand and gravel 0.4 to 0.5 m thick. In borehole SDH15-04, the sand and gravel layer was underlain by rock fill, approximately 2.7 m thick, consisting of boulders.

Silty Sand

Underlying the fill is a unit of non-cohesive organic silt with variable amounts of sand and gravel, ranging in thickness from 0.75 m to 1.75 m. The in-situ apparent density of the material in this unit ranged from loose to compact.

Bedrock

Bedrock was encountered in all four boreholes at depths ranging from 1.25 m to 4.82 m below ground surface (m bgs). The boreholes were advanced shallowly into the bedrock to confirm foundation conditions and extract samples for visual review of composition, weathering and structural features. Bedrock coring depths ranged from about 1.1 m to 2.6 m

Outcrops of bedrock were identified in the field and a sketch plan prepared showing their approximate locations (Figure 1). The rock was described as coarse grained, grey, quartz-feldspar-amphibole gneiss, slightly weathered, with a weak foliation resulting from mineral alignment. Planar joints were observed in several of the rock cores retrieved from the sonic drill. The joints were generally planar and rough with coatings of quartz, iron oxide and traces of clay. Based on visual observations and standard geotechnical field methods carried out in the course of outcrop mapping, the strength of the bedrock was estimated as R5[6] (very strong), which corresponds to an estimated unconfined compressive strength in the range 100 MPa to 250 MPa.

[6] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition: BiTech Publishers Ltd., Richmond, BC

Groundwater

Groundwater seepage was not observed in the boreholes. The fill layer in SDH15-02, SDH15-03 and SDH15-04 was reported as wet. These wet zones were likely due to local infiltration of precipitation and surface run off seepage at shallow depths in the permeable fills.

5.0 GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

5.1 General

This section of the report addresses the geotechnical design aspects of the project based on our interpretation of the geotechnical investigation results and project requirements. It is stressed that the information in this portion of the report is provided for the guidance of the designers and is intended for this project only. Contractors bidding on or undertaking the works should examine the factual information, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety and equipment capabilities.

5.2 Site Suitability

Based on our interpretation of the results of the site investigation, the geotechnical conditions at the site are considered generally suitable for the proposed development, subject to the site preparation and geotechnical design recommendations described below.

The key geotechnical aspects identified from the site investigation are as follows:

- the proposed building site comprises shallow and exposed bedrock with thin, natural soil (colluvium) cover and fill soils of variable thickness
- the site is located on sloping ground

In general, it is recommended that the entire building be constructed on bedrock to minimize the potential for differential settlements to occur as the result of foundations being constructed on combinations of bedrock and soil, or bedrock and structural fill. Of particular importance is to avoid or minimize construction of foundations that “straddle” rock/fill contacts.

5.3 Site Preparation Recommendations

5.3.1 Stripping

Site preparation should include removal of surficial soil, organic material, asphalt pavement and fill soils from the proposed development area. Excavation should extend beyond the perimeter of all buildings a horizontal distance at least equal to the depth of excavation below footings for foundations. Based on the results of the field investigation, sub-excavation depths are anticipated to be in the range of 0 to 5 m bgs, depending on the

final siting of the building. Local areas not investigated at the site may be underlain by thicker deposits of fill materials.

It is recommended that the exposed subgrade be inspected by experienced geotechnical personnel prior to bedrock excavation and placement of structural fill or footing form construction.

5.3.2 Rock Excavation

It is expected that excavation of bedrock will be required to achieve the desired building foundation elevations and final site grades. The amount of bedrock excavation required will depend on the final building envelope location and foundation elevation in relation to the existing topography. It may be possible to reduce the extent of bedrock excavation by adjusting the footprint of the building based on review of the detailed site survey and the location of bedrock within the proposed building envelope. Where possible, minor adjustments to the location of the proposed building may allow for a suitable cut and fill design and reduction in rock excavation requirements. The bedrock at the site is very strong (R5) and it is expected that drilling and blasting will be required for grading of the site. Excessive loosening or dislodging of the bedrock to be retained within the building footprint should be avoided. A blasting plan should be prepared by a qualified professional to achieve the required configuration of bedrock and to ensure that overbreak of bedrock resulting from blasting is controlled.

Should the geometry of the existing bedrock surface be uneven to the degree that an excessive amount of rock excavation is required, consideration could be given to the use of structural columns or short piles for foundation support as an alternative to thick grade fills.

5.3.3 Granular Fill

Granular materials to be placed in paved areas as a base course or as structural fill for foundations should generally consist of well-graded, 19 mm minus crushed gravel meeting the specifications for Granular Base in Section 31 05 17 of the Master Municipal Construction Documents (MMCD) Specifications.

Base course should be placed in horizontal lifts not exceeding 150 mm in loose thickness. Each lift should be uniformly compacted to at least 98 percent of the modified Proctor maximum dry density (MPMDD). Moisture conditioning, such as wetting or drying, may be required to achieve the specified compaction. Field density testing and visual review of base course placement by the geotechnical engineer are recommended.

5.3.4 Site Drainage

It is anticipated that localized zones of seepage or seasonal, shallow groundwater may be present in the rock throughout the site. During construction, provision should be made to intercept and direct groundwater or surface runoff away from work areas. Depending upon the magnitude and extent of near surface groundwater, it may be desirable or necessary to incorporate interceptor ditches and building drainage systems as part of the permanent drainage control measures.

Temporary and permanent cut slopes should be shaped and graded to direct water away from exposed subgrades, buildings, infrastructure and other areas that are sensitive to softening upon wetting or damage by flooding. If cut and fill slopes in any erodible soils will remain exposed during wet weather, the exposed slopes should be protected from precipitation with polyethylene sheeting and suitably secured over their entire surface to prevent ravelling and scouring or wind damage. Permanent slopes should be protected with surface coverage of concrete, asphalt, rip rap or vegetation, as appropriate.

The final design should include appropriate, permanent perimeter drains to collect groundwater and convey it away from foundations and the underside of floor slabs. A direct hydraulic connection should be provided between the granular base layer under floor slabs and perimeter drainage systems to allow drainage of groundwater from beneath slabs.

5.4 Pavement Recommendations

Golder understands that the site will have parking and access roads surrounding the building. In the absence of specific information on the road and parking locations and traffic volumes/loads the following is recommended:

- Asphalt Pavement: 50 mm thickness.
- Granular Base Course: 225 mm thickness of 19 mm minus crushed gravel, meeting the gradation specifications for Granular Base in Section 31 05 17 of the MMCD.
- Select Granular Sub-base (SGSB): 150 mm thickness over rock or rock fill, 300 mm thickness over clay or other materials. SGSB should meet the specification for Select Granular Sub-Base or Crushed Granular Sub-base in Section 31 05 17 of the MMCD.

Positive drainage is vital to the long-term performance of the roadway pavement. We recommend that the pavement be crowned and graded to provide adequate cross-fall sloping toward the outflow elements.

5.5 Shallow Foundations

5.5.1 General

A minimum of 150 mm thick granular structural fill is recommended to be placed over the bedrock prior to construction of the footings and slab. The base course should conform to the recommendations provided in Section 5.3.3.

Based on climate data for the Victoria Airport[7], a design freezing index of 162 degree-days below zero degrees Celsius is assumed for the Saanich area. This results in an estimated frost penetration depth of approximately 500 mm. We recommend that all exterior footings or footings in unheated areas be founded below this depth.

[7] http://climate.weather.gc.ca/

5.5.2 Strip and Pad Footings

Based on the preliminary building loads provided by CWMM Consulting Engineers on a drawing dated August 11 2015, the wall footing loads (Dead load plus Live load plus Snow load) will range from 8.6 kN/m to 59.8 kN/m. Assuming a footing width of 500 mm, the maximum bearing pressure will be in the order of 120 kPa. Assuming that footings for the main building will be constructed over rock, a minimum 150 mm thickness of structural fill over bedrock is considered acceptable. The following serviceability limit state (SLS) and ultimate limit state (ULS) bearing resistances can be used for design.

Table 1: Recommended Bearing Resistances

Foundation Condition	Bearing Resistance (kPa)	
	Serviceability Limit State (SLS)	Ultimate Limit State (ULS)*
Structural Fill over Rock	200	300

*Based on ultimate bearing resistance with a resistance modification factor of 0.5.

Provided that the base course materials are not loosened or disturbed after placement, it is anticipated that foundations at the site will be subject to total settlements of less than 25 mm and differential settlements of less than 1 mm vertical per 1 m horizontal. The minimum footing width should be selected in accordance with National Building Code requirements.

5.5.3 Resistance to Sliding, Uplift and Overturning Loads

Resistance to horizontal forces can be provided by friction between the soil or rock and the concrete foundation. An ultimate friction factor of 0.5 can be used to determine the resistance to sliding for concrete foundations cast on structural fill[8]. The recommended interface friction angle between cast-in-place concrete and the structural fill is 26 degrees. It is assumed that footings will be backfilled with suitably compacted base course as indicated above.

The ultimate uplift capacity of a spread footing is limited to the weight of the foundation plus the weight of any fill directly above the foundation. Golder recommends using an average unit weight of 21 kN/m^3 for base course and 24 kN/m^3 for concrete.

[8] Naval Facilities Engineering Command, “Foundations and Earth Structures, Design Manual 7.02, Chapter 3, Table 1”, September 1986.

The bearing capacity for eccentric loads, i.e., vertical loads (P) combined with moment (M) may be obtained considering the effective width of the footing (B'), which is equal to the width of the footing (B) minus two times the eccentricity (e), i.e., B'=B-2e, where e=M/P. The eccentric load should be kept within the central third of the footing in accordance with Canadian Foundation Engineering Manual[9] recommendations, which implies that e is equal to or less than B/6. The recommended design parameters provided are applicable to general design of conventional footings bearing on compact to very dense or very stiff to hard native soils or non-frost susceptible structural fill. Bearing resistance and settlement performance of a footing is also a function of footing geometry, embedment depth, and load combinations. Consequently, different bearing pressures under both an ultimate limit state and a serviceability limit state are possible. Golder should be provided with the opportunity to review the final foundation configurations and may provide revised parameters for specific footing configurations if deemed necessary.

5.6 Seismic Design Recommendations

Current seismic design loads, based on the 2010 National Building Code of Canada (NBCC), are based on ground motions corresponding to a design seismic event with a two percent probability of exceedance in 50 years (an average return period of 2,475 years). For a given site class, the effects of shaking level and period are incorporated via the acceleration (Fa) and velocity (Fv) based site coefficients defined in Tables 4.1.8.4B and C, respectively, of the 2010 NBCC.

The effects of local site conditions are assessed based on the characteristics of the soil and/or bedrock under a proposed structure. It is anticipated that the proposed structure will be founded entirely on bedrock or shallow granular fills over bedrock. Based on the anticipated geotechnical conditions at the site, the area of the proposed structure is classified as a Site Class A (hard rock) based on the criteria presented in Table 4.1.8.4.A, in Section 4.1.8.4 of the 2010 NBCC.

The earthquake provisions of the National Building Code and the BC Building Code are intended to reduce the risk of collapse of a structure due to an earthquake, but are not intended to ensure that no damage to the structure will occur.

[9] Canadian Geotechnical Society, "Canadian Foundation Engineering Manual, 4th Edition" 2006

5.6.1 Site-Specific Seismic Parameters for Foundation Design

A site-specific seismic hazard calculation was obtained from the Natural Resources Canada (NRC) for firm ground conditions in accordance with 2010 seismic hazard maps of Canada, and based on location of the site relative to inferred seismic sources and attenuation relationships[10]. The resulting peak horizontal ground acceleration (PGA) and the five percent damped spectral response acceleration (Sa) values at periods (T) of 0.2, 0.5, 1.0, and 2.0 seconds corresponding to the 2,475-year design earthquake are provided in Appendix C. These accelerations are applicable to Site Class A (hard rock) sites according to the 2010 NBCC and are used to linearly interpolate values for other site classes based on Tables 4.1.8.4B and C of the 2010 NBCC. Based on a site classification as Site Class A, and the seismic hazard calculation, the acceleration (F_a) and velocity (F_v) based site coefficients obtained from Tables 4.1.8.4B and C for are provided in Table 2 below:

Table 2: Values for Fa and Fv

Proposed Structure / Site Area	Site Class	Interpolated Fa Value	Interpolated Fv Value
ATP Integration Facility Building Structure	A	0.8	0.6

6.0 GEOTECHNICAL INSPECTION AND TESTING

The Geotechnical Engineer of Record should be given the opportunity to review the final plans and specifications to confirm that the geotechnical engineering recommendations provided herein are appropriately incorporated. Provisions should also be made for experienced geotechnical personnel to inspect and approve the exposed subgrade surfaces for foundation construction and/or structural fill placement. Further, we recommend conducting *in situ* field density testing of the structural fills to confirm that satisfactory compaction is being achieved.

[10] http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2010-eng.php, July 2013.

7.0 CLOSURE

We trust that the information contained in this report meets your current requirements. Please contact us if you require any further information.

GOLDER ASSOCIATES LTD.

Sarah Morse, PEng, PMP
Senior Geotechnical Engineer

Reviewed by:

Jeffrey Fillipone, PhD, PGeo
Principal, Senior Engineering Geologist

DRL/JAF/asd

\\golder.gds\gal\victoria\final\2013\1447\13-1447-0497 pwgsc wood creek quarry\1314470497-013-r-rev0\1314470497-013-r-rev0-6000-atp integration facility geotech investigation 5sep_17.docx

0 10 20
1:400 METRES

LEGEND

BEDROCK OUTCROP

BOREHOLE LOCATION

REFERENCES

2013 AERIAL PHOTO AND TOPOGRAPHIC CONTOURS OBTAINED FROM CAPITAL REGIONAL DISTRICT'S REGIONAL COMMUNITY ATLAS.

SITE 4 OPTION H BUILDING FOOTPRINT OBTAINED FROM CTA ARCHITECTS, FILE SOURCE: NRC_Site_Plan_Options_Sept_23.dwg

CLIENT
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-01
DESIGNED	H. WONG
PREPARED	J. FARAH
REVIEWED	D. LISTER
APPROVED	J. FILLIPONE

PROJECT
GEOTECHNICAL INVESTIGATION
NRC ATP INTEGRATION FACILITY
HERZBERG INSTITUTE OF ASTROPHYSICS, SAANICH, BC

TITLE
SITE PLAN

PROJECT NO.	PHASE	REV.	FIGURE
1314470497	6000	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

APPENDIX A

Important Information and Limitations of this Report

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Borehole Summary Logs

PROJECT No.: 13-1447-0497 / 6000

RECORD OF SONIC HOLE: SDH15-01

SHEET 1 OF 1

CLIENT: Public Works and Government Services Canada
PROJECT: Dominion Observatory
LOCATION: Central Saanich, B.C.
N: ~5374104 E: ~469311
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: August 20, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	ICE DESCRIPTION	GRADATION %: GRAVEL	SAND	FINES	SHEAR STRENGTH Cu, kPa / WATER CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface														
		ASPHALT.		0.05												
		FILL - **(SP)** gravelly SAND, trace silt; grey; non-cohesive, dry, compact.														
1	Track Mounted Sonic Drill / Sonic (Casing:152 mm.)	**(OL)** sandy ORGANIC SILT, trace gravel; brown, with wood debris; non-cohesive, dry, loose.		0.49				1								
		BEDROCK, medium to coarse grained; grey, quartz-feldspar-amphibole gneiss.		1.25	1	G		2								
2					2	G		3								
		End of Sonic Hole.		2.59												
3																
4																
5																
6																
7																
8																
9																
10																

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80
WATER CONTENT %: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40; field est. - ◎; lab - ○; ice est. - ⬠

DEPTH SCALE
1 : 50

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: DGM
CHECKED: DL

Golder Associates

PROJECT No.: 13-1447-0497 / 6000

RECORD OF SONIC HOLE: SDH15-02

SHEET 1 OF 1

CLIENT: Public Works and Government Services Canada
PROJECT: Dominion Observatory
LOCATION: Central Saanich, B.C.
N: ~5374134 E: ~469318
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: August 20, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	ICE DESCRIPTION	GRADATION %: GRAVEL	SAND	FINES	SHEAR STRENGTH Cu, kPa / WATER CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		0.00												
0	Track Mounted Sonic Drill (Casing:152 mm.)	FILL - **(OL)** sandy ORGANIC SILT; brown; non-cohesive, wet, loose.		0.15	1	G										
		FILL - **(SP)** silty gravelly SAND; grey; non-cohesive, dry, compact.		0.37												
1		**(OL)** ORGANIC SILT, some sand, some gravel; brown; non-cohesive, dry, loose.			2	G		1								
		(OL) ORGANIC SILT, some sand, trace gravel; brown; non-cohesive, dry, loose.		1.22	3	G		2								
		(GP) GRAVEL, some sand; grey; dry, compact.		1.43	4	G										
2		BEDROCK, medium to coarse grained; grey, quartz-feldspar-amphibole gneiss.		1.68				3								
					5	G										
3								4								
4					6	G										
		End of Sonic Hole.		4.27												
5																
6																
7																
8																
9																
10																

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80

WATER CONTENT %: Wp ⊢ W ⊣ Wl; NP - Non-Plastic; field est. - ◎; lab - ○; ice est. - ⬠; 10 20 30 40

SOIL CLASSIFICATION SYSTEM: GACS

DEPTH SCALE
1 : 50

LOGGED: DGM
CHECKED: DL

Golder Associates

PROJECT No.: 13-1447-0497 / 6000

RECORD OF SONIC HOLE: SDH15-03

SHEET 1 OF 1

CLIENT: Public Works and Government Services Canada
PROJECT: Dominion Observatory
LOCATION: Central Saanich, B.C.
N: ~5374141 E: ~469300
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: August 20, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	ICE DESCRIPTION	GRADATION %: GRAVEL	SAND	FINES	SHEAR STRENGTH Cu, kPa / WATER CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface														
	Track Mounted Sonic Drill / Sonic (Casing:152 mm;)	ASPHALT.		0.05												
		FILL - **(GP)** GRAVEL, some sand; grey-green; non-cohesive, wet, compact.			1	G										
				0.46	2	G		1								
1		**(OL)** sandy ORGANIC SILT; brown; non-cohesive, dry, loose.														
					3	G		2								
		BEDROCK, medium to coarse grained; grey, quartz-feldspar-amphibole gneiss.		1.68	4	G										
2								3								
					5	G										
		End of Sonic Hole.		2.74												
3																
4																
5																
6																
7																
8																
9																
10																

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80

WATER CONTENT %: Wp ⊢ W ⊣ Wl; NP - Non-Plastic; field est. - ◎; lab - ○; ice est. - ⬠; 10 20 30 40

SOIL CLASSIFICATION SYSTEM: GACS

DEPTH SCALE
1 : 50

LOGGED: DGM
CHECKED: DL

Golder Associates

PROJECT No.: 13-1447-0497 / 6000

RECORD OF SONIC HOLE: SDH15-04

SHEET 1 OF 1

CLIENT: Public Works and Government Services Canada
PROJECT: Dominion Observatory
LOCATION: Central Saanich, B.C.
N: ~5374138 E: ~469321
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: August 21, 2015
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 762mm

DEPTH SCALE METRES	DRILLING RIG	DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	ICE DESCRIPTION	GRADATION %: GRAVEL	SAND	FINES	SHEAR STRENGTH Cu, kPa / WATER CONTENT %	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
			Ground Surface														
0	Track Mounted Sonic Drill	Sonic (Casing:152 mm;)	ASPHALT.		0.08												
			FILL - **(GP-SP)** SAND and GRAVEL; grey, wet, compact.			1	G		1								
			ROCKFILL; with large diameter boulders.		0.46												
1																	
2									2								
3			**(OL)** gravelly ORGANIC SILT, some sand; dark brown; non-cohesive, wet, loose.		3.08												
			(ML) sandy SILT, some gravel; light brown; non-cohesive, dry, loose.		3.41				3								
4						2	G										
						3	G		4								
5			BEDROCK, medium to coarse grained; grey, quartz-feldspar-amphibole gneiss.		4.82	4	G		5								
6						5	G		6								
			End of Sonic Hole.		6.40												
7																	
8																	
9																	
10																	

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■; 20 40 60 80

WATER CONTENT %: Wp ⊖ W ⊖ Wl; NP - Non-Plastic; field est. - ◎; lab - ○; ice est. - ⬠; 10 20 30 40

SOIL CLASSIFICATION SYSTEM: GACS

DEPTH SCALE
1 : 50

LOGGED: DGM
CHECKED: DL

Golder Associates

National IM Server:GINT_GAL_NATIONALIM Unique Project ID: Output Form:BC_BOREHOLE (SONIC) (AUTO) rwiggins 9/24/15

APPENDIX C

Site Specific Seismic Hazard Calculation

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: , Golder Associates September 22, 2015

Site Coordinates: 48.5194 North 123.4154 West

User File Reference: Herzberg Institute of Astrophysics

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
1.194	0.802	0.373	0.185	0.596

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.*** Warning: You are in a region which considers the hazard from a deterministic Cascadia subduction event for the National Building Code. Values determined for high probabilities (0.01 per annum) in this region do not consider the hazard from this type of earthquake.

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.312	0.655	0.873
Sa(0.5)	0.202	0.434	0.582
Sa(1.0)	0.094	0.201	0.270
Sa(2.0)	0.043	0.094	0.130
PGA	0.160	0.329	0.437

References

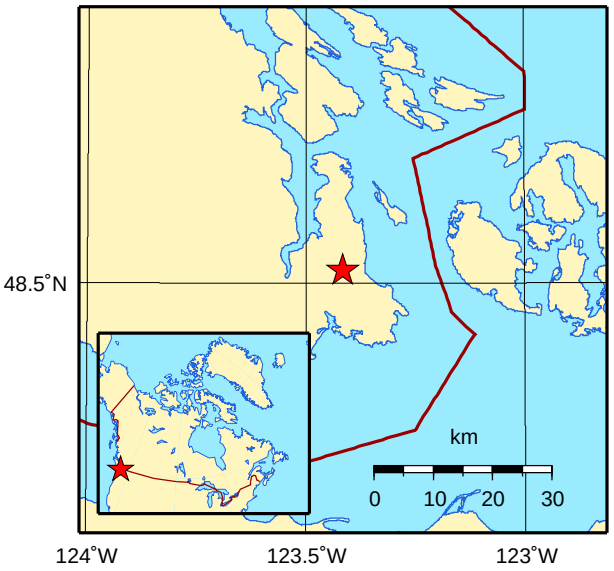
National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
2nd floor, 3795 Carey Road
Victoria, British Columbia, V8Z 6T8
Canada
T: +1 (250) 881 7372

Golder Associates

NRC HERZBERG ASTRONOMY & ASTROPHYSICS

ATP INTEGRATION FACILITY

VICTORIA, BRITISH COLUMBIA

Project No: R. 077596.001

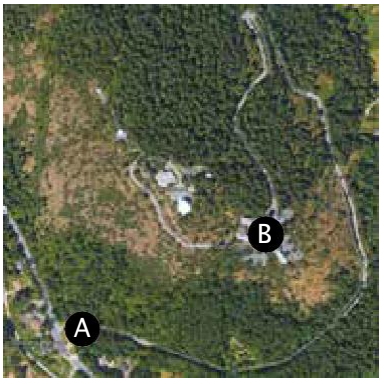
APPENDIX 2

EXTERIOR PHOTOS OF EXISTING SITE SERVICES BUILDING

APPENDIX 2: EXTERIOR PHOTOS OF EXISTING SITE SERVICES BUILDING

Date: Febuary 11, 2016

B: SITE PLAN



OVERVIEW OF SITE

A: ENTRANCE LOCATION

01

02

03

04

05

06

07

08

09

10

11

12

13

14

15

16

17

18

19

20

NRC HERZBERG ASTRONOMY & ASTROPHYSICS

ATP INTEGRATION FACILITY

VICTORIA, BRITISH COLUMBIA

Project No: R. 077596.001

APPENDIX 3

CERTIFICATE OF EXEMPTION CONTRACTOR

BRITISH COLUMBIA | Ministry of Finance

CERTIFICATE OF EXEMPTION CONTRACTOR

under the *Provincial Sales Tax Act*

Responsibilities for Sellers and Eligible Contractors:

Sellers – this certificate allows you to collect the information and declaration required under the *Provincial Sales Tax Act* (the Act) in order to provide a PST exemption to your customer.

If you do not receive a completed and signed certificate or the required information and declaration before the sale, you must charge and collect PST. Failure to do so may result in an assessment, penalty and interest.

Eligible Contractors – you are responsible for ensuring that you meet all the requirements for the exemption under the Act. If you complete the certificate but you do not qualify for the exemption, you are responsible for paying the PST.

General Instructions:

- Refer to **Page 2** for detailed instructions.

Freedom of Information and Protection of Privacy Act (FOIPPA)
The personal information on this form is collected for the purpose of administering the *Provincial Sales Tax Act* under the authority of both this Act and section 26 of the FOIPPA. Questions about the collection or use of this information can be directed to the Manager, Program Services, PO Box 9442 Stn Prov Govt, Victoria, BC V8W 9V4. (Telephone: toll-free at 1 877 388-4440)

PART A – CERTIFICATION OF ELIGIBLE PERSON (*see Page 2*)

NAME OF CORPORATION, ASSOCIATION, PARTNERS, INDIAN BAND OR INDIVIDUAL	MAILING ADDRESS (*including postal code*)
Public Works Gov. Canada	219 - 800 Burrard Street Vancouver, B.C. V6Z 0B9

I certify that I have entered into a contract with the eligible contractor named below for the supply and installation of affixed machinery or improvements to real property and if I were to purchase the tangible personal property identified below I would be exempt from PST because (*check (✓) one and complete the appropriate section*):

1. ☐ I am eligible for the **Production Machinery and Equipment** (PM&E) exemption under the Act.

2. ☐ I am a **status Indian** or authorized representative of an Indian band and the items being purchased would be exempt from PST under section 87 of the *Indian Act* (Canada). If you are representating an Indian band, attach written authorization from an official of the band that you are authorized to act on behalf of the Indian band.

	BAND NAME	STATUS CARD NUMBER
Indian and Indian Bands		
Indian Bands Only	NAME OF REPRESENTATIVE	

3. ☐ I am a **qualifying aquaculturist** under the Act. — AQUACULTURE LICENCE NUMBER

4. ☐ I am a **qualifying farmer** under the Act. — PROPERTY TAX FOLIO NUMBER / ADDRESS OF FARM

5. ☐ I am eligible for a PST exemption under the **Consular Tax Exemption Regulation**. — DIPLOMATIC / CONSULAR IDENTITY CARD NUMBER | EXPIRY DATE YYYY / MM / DD

I certify that the Government of Canada has entered into a contract with the eligible contractor named below for the supply and installation of affixed machinery or improvements to real property.

6. ☑ I am an **authorized representative of the Government of Canada**. — PST NUMBER: PST-1000-5001

By signing this form, I certify that the above information is correct.

FULL LEGAL NAME OF INDIVIDUAL SIGNING FORM	SIGNATURE	DATE SIGNED YYYY / MM / DD
Patrick Truong	X Patrick Truong	2015/12/15

PART B – CERTIFICATION OF ELIGIBLE CONTRACTOR (*see Page 2*)

FULL LEGAL NAME	MAILING ADDRESS (*including postal code*)

Description of all items of tangible personal property (goods) being purchased (*if you require more space, attach an additional document*):

I certify that the tangible personal property (TPP) identified above is being acquired to fulfill a contract for the supply and installation of affixed machinery or improvements to real property that meets the requirements of (*check (✓) one*):

7. ☐ **Customer is the eligible person identified in Part A:** the contract is with the eligible person identified in Part A, or — ELIGIBLE CONTRACTOR'S PST NUMBER

8. ☐ **Customer pays the PST:** you have a written agreement with your customer that they will pay PST on the TPP described above and the agreement sets out the purchase price of the TPP. You must be registered for PST before supplying this TPP to your customer. You may only use this certificate in advance of receiving your PST number.

By signing this form, I certify to the best of my knowledge that the above information and any attached information is correct. I acknowledge that if I make a false statement to avoid paying tax, the *Provincial Sales Tax Act* charges a fine of up to $10,000 and/or imprisonment up to two years, in addition to a penalty of 25% of the tax due and an assessment for the tax that should have been paid.

FULL LEGAL NAME OF INDIVIDUAL SIGNING FORM	SIGNATURE	DATE SIGNED YYYY / MM / DD
	X	

NRC HERZBERG ASTRONOMY & ASTROPHYSICS

ATP INTEGRATION FACILITY

VICTORIA, BRITISH COLUMBIA

Project No: R. 077596.001

APPENDIX 4

SARA PERMIT SARA-PYR-2016-0335

APPENDIX TO SARA PERMIT SARA-PYR-2016-0335
Potential incidental impacts to species at risk during construction of a new facility at the NRC Dominion Astrophysical Observatory in Saanich, B.C.

General Conditions

1. The permit is valid only for activities occurring in specified locations.
2. The holder and assistants agree to respect the terms and conditions as described below.
3. The permit becomes invalid if terms and conditions described above are not respected.
4. The issuance of this permit does not exempt the permit holder from compliance with relevant Canadian laws and regulations otherwise applicable.
5. The species authorized to be collected shall remain the sole property of the Federal Crown and shall not be traded, sold, or bartered.

Specific Terms and Conditions

1. Only qualified personnel, experienced in the identification and life cycle of the target Species at Risk and familiar with the specific locations, will monitor and oversee the timing of the activities.
2. Permit holder must supervise all assistants.
3. All activities carried out under the authority of this permit must be done in accordance with the methodology described in the permit application.
4. The permit (or a copy) must be carried by the applicant or a member of the field crew and be made available to a Wildlife Enforcement Officer upon request.
5. Species at Risk occurrence data must be reported to the Canadian Wildlife Service as part of the annual and final reports, as well as to the Province of British Columbia through the Conservation Data Centre or Species Inventory Database.
6. The permit holder must submit to the Canadian Wildlife Service a report detailing the observed impacts of activities hereby permitted within 30 days after December 31 of each year of permit and upon expiry of this permit, including (as applicable) the number of individuals possessed, collected, captured, harmed, harassed, taken, or killed, and the number and location of residences, and the total area and location of habitat impacted.
7. Machinery accessing the Project area must be cleaned of foreign soils before entering the Project area to reduce potential introduction of non-native species.
8. A qualified biologist(s) familiar with the Sharp-tailed Snake and Blue-grey Taildropper Slug must conduct a pre-clearing survey and a qualified biologist familiar with the Sharp-tailed Snake must be on site to work with the machine operator while the top substrate is removed. If an individual is located, it will be relocated by the biologist(s) to a suitable site nearby.
9. The construction limits must be physically delineated with fencing to avoid any impact to vegetation outside the impacted area.
10. Coarse woody debris removed during construction must be set aside and placed in adjacent forested area.
11. Sharp-tailed Snake habitat must be created along the foundation of the new building to compensate for any potential loss of snake habitat.
12. Any material containing invasive plant species is not to be stored at or near the project area and should be disposed of at an acceptable disposal facility off-site using appropriate BMPs.
13. Disturbed areas must be re-vegetated with native plant species appropriate for the site before the end of the construction year.
14. If a Sharp-tailed Snake aggregation or nest is found onsite during the clearing or construction phase, all work must stop immediately, and the Canadian Wildlife Service will be contacted for further instruction.

Signature of holder	Date	for the Minister	Date
	16 May 2016.		12 May 2016

Potential incidental impacts to species at risk during construction of a new facility at the NRC Dominion Astrophysical Observatory in Saanich, B.C.

Pacific and Yukon Region

Permit under section 73 of the *Species at Risk Act*		Permit No:	SARA-PYR-2016-0335
Species:	*This (these) species are regulated under the Species at Risk Act.* Blue-grey Taildropper Sharp-tailed Snake		
Purpose - section 73(2):	Affecting the species is incidental to the carrying out of the activity		
Description of activity:	The following species, listed on Schedule 1 of the Species at Risk Act (SARA), potentially use habitat that will be cleared for construction of a new facility at the NRC Dominion Astrophysical Observatory: Sharp-tailed Snake (Contia tenuis) and Blue-grey Taildropper Slug (Prophysaon coeruleum). At the time this permit was issued, none of these species had critical habitat finalized in a recovery strategy. This permit authorizes the National Research Council (NRC) Canada to undertake, with the participation of one or more qualified species experts, the clearing and construction of this facility in the designated project area, with specified avoidance and mitigation measures to minimize impacts to species at risk which may be incidentally impacted by this activity. Qualified species experts are authorized to handle and relocate Sharp-tailed Snake or Blue-grey Taildropper Slug should they be found on site during the clearing and construction phase. Methods to be followed are provided in the application documentation. The applicant will undertake a number of best management practices to avoid or minimize harm to SARA listed species, and any Sharp-tailed Snake habitat removed or disturbed will be restored to ensure no-net loss.		
Location(s):	*This (these) location(s) is (are) federal land(s) or identified in an Emergency Order.* 1. 5071 W Saanich Road, Victoria		
Province(s) or territory(ies):	British Columbia		
Valid from:	2016-05-16	Date of expiry:	2019-03-31

Permit Holder(s)

Name / E-mail	Organization	Address	Telephone / Fax
Morrick Vincent morrick.vincent@nrc-cnrc.gc.ca		5071 West Saanich Road Victoria, BC V9E 2E7	Phone: 250-363-0567

Assistant(s)

Christian Engelstoft, Clyde Donnelly, Matt Fairbarns, Michael Wallace

ANNEXE POUR LE PERMIS DE LA LEP SARA-PYR-2016-0335
Répercussions indirectes éventuelles sur les espèces en péril lors de la construction de nouvelles installations à l'Observatoire fédéral d'astrophysique du CNR, à Saanich, en C.-B.

Conditions Générales

1. Le permis n'est valide que pour les activités se déroulant aux endroits mentionnés.
2. Le détenteur et ses collaborateurs acceptent de respecter les modalités telles qu'elles sont décrites plus bas.
3. Le permis devient invalide si les modalités décrites plus haut ne sont pas respectées.
4. Même avec la délivrance du présent permis, le détenteur est tenu de se conformer aux lois et aux réglementations pertinentes normalement applicables.
5. Les espèces dont la collection est permise demeurent l'entière propriété de la Couronne fédérale, et leur échange, leur vente et leur troc sont interdits.

Termes et conditions spécifiques

1. Seulement du personnel qualifié et expérimenté, sur l'identification et le cycle de vie des espèces visées par la Loi sur les espèces en périls et connaissant précisément les lieux, superviseront les activités afin qu'elles aient lieu en temps opportun.
2. Le détenteur du permis doit superviser tous les assistants.
3. Toutes les activités réalisées en vertu de ce permis devront être menées conformément à la méthodologie décrite dans la demande de permis.
4. Le titulaire ou un membre de l'équipe de terrain doit toujours avoir le permis (ou une copie) en sa possession et le présenter à un agent d'application de la loi sur la faune sur demande.
5. Les données sur la présence d'espèces en péril doivent être déclarées au service canadien de la faune par le biais des rapports annuels et finaux, ainsi qu'au gouvernement de la Colombie-Britannique par l'entremise du Centre de données sur la conservation ou de la base de données de l'inventaire des espèces.
6. Le titulaire du permis doit faire parvenir au Service canadien de la faune un rapport détaillant les effets observés des activités autorisées par la présente dans les 30 jours suivant le 31 décembre de chaque année de validité du permis ainsi qu'à son échéance, lequel rapport doit comprendre le nombre d'individus en sa possession, collectionnés, capturés, blessés, harcelés, pris ou tués, le nombre et l'emplacement des résidences ainsi que la superficie et l'emplacement de l'habitat touché.
7. Toute machinerie accédant à la zone du projet doit être nettoyée pour éviter que des sols étrangers pénètrent dans la zone. Cela permettra de réduire l'introduction éventuelle d'espèces étrangères.
8. Un biologiste qualifié qui connaît la couleuvre à queue fine et la limace-prophyse bleu-gris doit réaliser un relevé préalable au défrichement. Un biologiste qualifié qui connaît la couleuvre à queue fine doit se trouver sur les lieux, et collaborera avec l'opérateur de la machinerie pendant l'enlèvement de la couche supérieure. Si un individu est localisé, il sera déplacé par le biologiste qui le placera dans un lieu adéquat à proximité.
9. La zone de construction doit être délimitée physiquement à l'aide de clôtures, afin d'empêcher tout dommage à la végétation se trouvant à l'extérieur de la zone désignée.
10. Tout débris ligneux grossier enlevé lors de la construction doit être placé dans le boisé adjacent.
11. Un habitat pour la couleuvre à queue fine doit être créé le long de la fondation du nouveau bâtiment afin de compenser la perte éventuelle de l'habitat.
12. Il ne faut pas stocker toute matière renfermant des espèces végétales envahissantes dans la zone désignée ou à proximité de celle-ci. Il faut l'éliminer dans des installations d'élimination acceptables à l'extérieur de la zone, conformément aux pratiques exemplaires de gestion appropriées.
13. Les zones perturbées doivent être revégétalisées à l'aide d'espèces végétales indigènes et appropriées pour le site avant la fin de l'année de construction.
14. Si on découvre une agrégation ou un nid de couleuvres à queue fine sur les lieux lors du défrichement ou de la construction, il faut cesser immédiatement tous les travaux, puis communiquer avec le Service canadien de la faune pour obtenir des directives.

Signature du détenteur	Date	Pour le ministre	Date
	16 May 2016.		16 mai 2016

Section des permis Service Canadien de la faune Delta, British Columbia Téléphone: (604) 940-4650 Télécopieur: (604) 946-7022 Courriel: sarapermitting.pyr@ec.gc.ca

Répercussions indirectes éventuelles sur les espèces en péril lors de la construction de nouvelles installations à l'Observatoire fédéral d'astrophysique du CNR, à Saanich, en C.-B.

Région du Pacifique et du Yukon

Permis en vertu de l'article 73 de la *Loi sur les espèces en péril*		Numéro du permis: SARA-PYR-2016-0335	
Espèces:	*Cette (Ces) espèce(s) est (sont) réglementée(s) en vertu de la Loi sur les espèces en péril.* Couleuvre à queue fine Limace-prophyse bleu-gris		
But - section 73(2):	Activité qui ne touche l'espèce que de façon incidente		
Description des activitées:	Les espèces suivantes, apparaissant à l'annexe 1 de la Loi sur les espèces en péril (LEP), utilisent possiblement l'habitat qui sera dégagé en vue de la construction de nouvelles installations à l'Observatoire fédéral d'astrophysique du CNR, soit la couleuvre à queue fine (Contia tenuis) et la limace-prophyse bleu-gris (Prophysaon coeruleum). Au moment de la délivrance du permis, aucune stratégie de rétablissement ne portait sur l'habitat essentiel de ces espèces. Ce permis autorise le Conseil national de recherches (CNR) à réaliser, avec la participation d'au moins un spécialiste qualifié des espèces, le défrichement et la construction de ces installations dans la zone désignée, lorsque des mesures d'évitement et d'atténuation précisées sont mises en place pour minimiser les répercussions sur les espèces en péril qui pourraient être touchées indirectement par cette activité. Des spécialistes qualifiés des espèces ont l'autorisation de manipuler et de réinstaller la couleuvre à queue fine ou la limace-prophyse bleu-gris si ces espèces se trouvent sur les lieux lors du défrichement et de la construction. Les méthodes à mettre en application se trouvent dans le document de la demande. Le demandeur adoptera un certain nombre de pratiques exemplaires de gestion, afin d'éviter de nuire aux espèces visées par la LEP ou de minimiser les torts à celles-ci. Tout habitat de la couleuvre à queue fine qui est supprimé ou perturbé doit être rétabli pour assurer qu'il n'y ait aucune perte nette.		
Endroit(s):	*Cet (Ces) endroit(s) est (sont) une (des) terre(s) fédérale(s) ou identifié(s) dans un décret d'urgence.* 1. 5071 W Saanich Road, Victoria		
Province(s) ou territoire(s):	Colombie-Britannique		
Valide à partir:	2016-05-16	Date d'échéance:	2019-03-31

Détenteur(s) du permis

Nom et courriel	Organisation	Adresse	Téléphone / Télécopieur
Morrick Vincent morrick.vincent@nrc-cnrc.gc.ca		5071 West Saanich Road Victoria, BC V9E 2E7	Téléphone : 250-363-0567

Assistant(es)(s)

Christian Engelstoft, Clyde Donnelly, Matt Fairbarns, Michael Wallace

NRC HERZBERG ASTRONOMY & ASTROPHYSICS

ATP INTEGRATION FACILITY

VICTORIA, BRITISH COLUMBIA

Project No: R. 077596.001

APPENDIX 5

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION REPORT

REPORT

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION REPORT

Proposed ATP Integration Facility, Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria BC

Submitted to:

Public Services and Procurement Canada
219-800 Burrard Street
Vancouver, BC
V6Z 0B9

Attention: George Strazicich, PEng

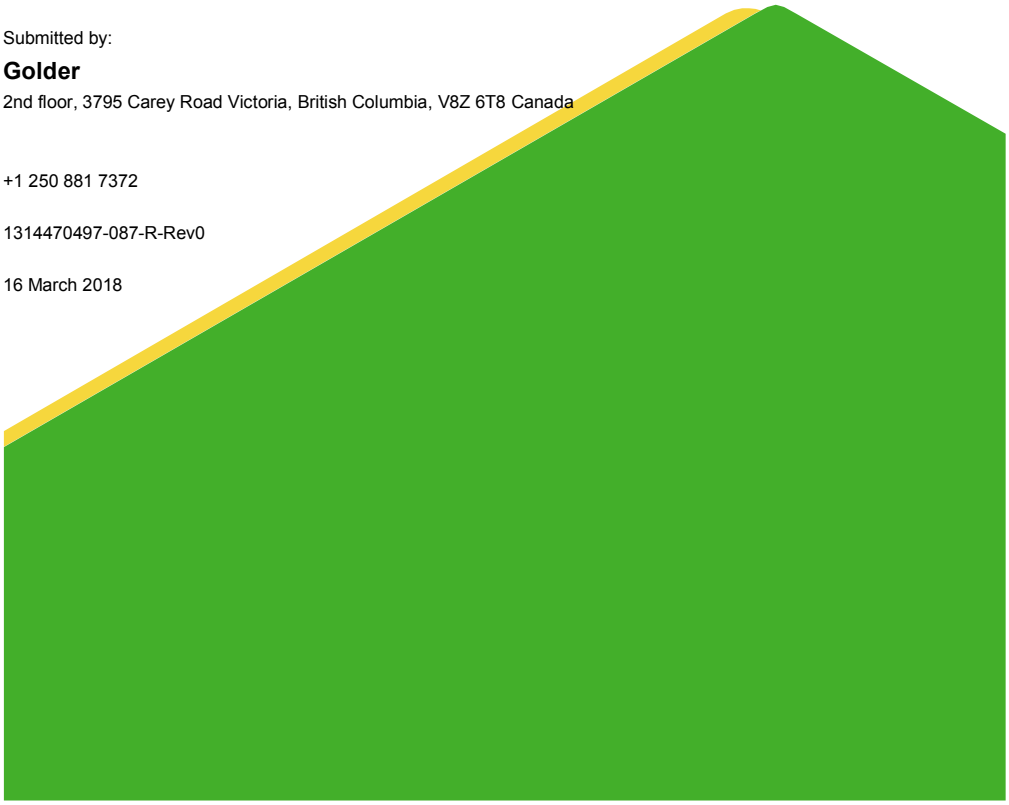
Submitted by:

Golder
2nd floor, 3795 Carey Road Victoria, British Columbia, V8Z 6T8 Canada

+1 250 881 7372

1314470497-087-R-Rev0

16 March 2018



Distribution List

2 Copies - PSPC

Table of Contents

1.0 INTRODUCTION

This report provides the results of the supplemental geotechnical subsurface investigation carried out by Golder Associates Ltd. (Golder) for the site of the proposed new building for the NRC ATP Integration Facility at the Herzberg Institute of Astrophysics in Victoria, BC (The Site). The investigation was carried out for Public Services and Procurement Canada (PSPC) according to the Terms of Reference (TOR) provided by PSPC[1], and the Terms and Conditions of Standing Offer Agreement No. EZ899-141238/001/TPV. This report provides geotechnical information and recommendations supplemental to that provided in Golder's previous investigation reports for the Site. It is recommended that this report be read in conjunction with the previous reports.[2,3] This report should also be read in conjunction with "*Important Information and Limitations of This Report*", which is included in Appendix A. The reader's attention is specifically drawn to this information for the proper use and interpretation of this report.

2.0 SITE AND PROPOSED DEVELOPMENT

The site of the proposed ATP integration facility is located within the National Research Council (NRC) Herzberg Institute of Astrophysics property at civic address 5071 West Saanich Road. The Site is accessed via a paved road that leads to the observatory and associated facilities complex.

Based on design drawings provided to Golder[4], it is understood that the Site for the proposed development is located directly south of the existing Site Services Building as shown on Figure 1. The ground surface within the footprint of the proposed development is sloped gently toward the northwest and generally consists of bedrock outcrops, tree stumps, and a portion of the existing asphalt pavement in those portions of the parking lot and road that lie within the footprint. The plan dimensions of the proposed building are 22.8 m wide by 29 m long, and will be founded on shallow strip and pad footings, with a 12 m by 10 m raft slab to be located within the south east area of the structure.

3.0 SITE TOPOGRAPHY AND GEOLOGY

The topography of the Site is dominated by an elliptical shaped hill referred to as Observatory Hill, which developed as a result of glacial erosion of bedrock, resulting in more than 100 m of relief above the surrounding terrain.

Published bedrock geological mapping[5] indicates that the bedrock underlying the Site consists of Colquitz Gneiss. The Colquitz Gneiss is a hard, strong, metamorphic rock composed predominantly of quartz-feldspar. Published surficial geological mapping[6,7] indicates that the soil overlying the bedrock consists of thin (less than 1 m) colluvium, a type of locally derived soil resulting from the weathering of bedrock.

---

[1] PWGSC. 2017. Terms of Reference, Geotechnical Engineering Services for ATP Integration Facility and Site Improvements NRC Herzberg Astronomy and Astrophysics Victoria, BC. Project # R.077596.001

[2] Golder Associates Ltd. 2017a. Geotechnical Investigation Report, Proposed ATP Integration Facility, Herzberg Institute of Astrophysics, 5071 West Saanich Road Victoria, BC: report dated 5 September 2017; Golder Ref. 1314470497-013-R-Rev0

[3] Golder Associates Ltd. 2017b. ATP Integration Facility - Geotechnical Investigation, Herzberg Institute of Astrophysics: report dated 19 December 2017; Golder Ref. 1314470497-084-TM-Rev0

[4] CWMM Consulting Engineers. 2017. "NRC Herzberg, Astronomy and Astrophysics, ATP Integration Facility" Drawings S101, S102, S103, S201 and S202, dated 11 December 2017.

[5] Muller JE. 1983. Geology Victoria: Geological Survey of Canada, Map 1553A.

[6] Blythe HE and Rutter NW. 1993. Surficial Geology of the Sidney Area: BC Geological Survey Branch, Open File 1993-24

4.0 GEOTECHNICAL SUBSURFACE INVESTIGATION

The supplemental geotechnical subsurface investigation of the site was carried out on 11 and 12 January 2018. The investigation was conducted using sonic drilling methods to advance boreholes through the existing surficial soils, and into the underlying bedrock. Three boreholes were advanced using a track mounted sonic drill rig supplied and operated by Drillwell Enterprises Ltd. of Duncan B.C. The borehole investigation was conducted to assess existing soil conditions, groundwater seepage (if encountered), depth to bedrock, and to obtain disturbed soil samples for laboratory testing. The approximate locations of the boreholes are shown on Figure 1. Detailed descriptions of the soil and bedrock conditions encountered in the boreholes are provided in the Record of Boreholes (Appendix C).

Prior to advancing the boreholes, Golder placed a BC One Call for the area and engaged a contract utility locator to conduct an on-site assessment of the proposed borehole locations for potential buried utilities and structures. The utility locator used ground penetrating radar (GPR) and electromagnetic (EM) methods in the assessment. No buried utilities or structures were identified near the borehole locations.

The borehole investigation was conducted under the full-time inspection of a member of Golder's geotechnical staff, who located the boreholes in the field, visually examined and logged the subsurface conditions encountered, and collected soil samples for visual examination and laboratory testing.

5.0 SUBSURFACE CONDITIONS

Depths within boreholes are referenced from the existing ground surface. Variations in the reported subsurface conditions should be expected throughout the area. Accordingly, caution should be used when extrapolating subsurface conditions between or beyond borehole locations.

The subsurface conditions encountered at the site have been generalized into the following geologic units, in order of increasing depth below ground surface (bgs):

- Fill or Topsoil
- Sandy clayey silt (encountered only at SDH18-03)
- Silty sand (encountered only at SDH18-03)
- Bedrock

A discussion of geotechnical properties and detailed descriptions of the conditions encountered in the subsurface investigation are presented in the following sections.

Fill or Topsoil

Fill was encountered at SDH18-01 and SDH18-03 from ground surface to depths ranging from 0.6 to 1.4 m. The fill consisted of sand and gravel with trace of non-plastic fines, and was described as brown to grey, non-cohesive, moist to wet, and compact.

[7] Monahan PA and Levson VM. 2000. Quaternary Geological Map of Greater Victoria: BC Geological Survey Branch, Geoscience Map 2000-2

Topsoil was encountered at SDH18-02 from ground surface to a depth of approximately 0.3 m. The topsoil consisted of organic silt with trace sand and gravel, and was described as dark brown, containing rootlets, cohesive, moist, with a water content generally less than the Plastic Limit, and soft.

Sandy clayey silt

Underlying the fill at SDH18-03 was a unit consisting of sandy clayey silt with trace of gravel, approximately 0.8 m in thickness. The sandy clayey silt was described as brown, cohesive, with a water content generally close to the Plastic Limit, and soft. This unit was only encountered at SDH18-03.

Silty Sand

Underlying the sandy clayey silt at SDH18-03 was a unit consisting of silty sand, approximately 0.15 m in thickness. The silty sand was described as brown, non-cohesive, and wet. This unit was only encountered at SDH18-03.

Bedrock

Bedrock was encountered in all three boreholes at depths ranging from 0.3 m to 1.5 m bgs. The boreholes were advanced into the bedrock to confirm foundation conditions and extract samples for visual review of composition, weathering and structural features. The boreholes were advanced approximately 1.4 m to 2.9 m into bedrock.

Table 1: Bedrock Characteristics

Borehole ID	Depth to Bedrock Surface (m bgs)	Penetration Depth into Bedrock (m)
SDH18-01	1.4	2.9
SDH18-02	0.3	2.4
SDH18-03	1.5	1.4

The bedrock encountered in the boreholes consisted of medium to coarse grained, grey, quartz-feldspar-amphibole gneiss, slightly weathered, with a weak foliation resulting from mineral alignment. Discontinuities consisting of natural joints were observed in several of the rock cores retrieved from the boreholes. The joints were generally planar and rough, with coatings of quartz, iron oxide and traces of clay. Based on visual observations and manual field assessment methods using a geological hammer, the strength of the bedrock was estimated as R5[8] (very strong), which corresponds to an estimated uniaxial compressive strength in the range 100 MPa to 250 MPa. No laboratory testing was carried out to confirm the strength of the bedrock.

Groundwater

Groundwater seepage was observed at approximately 1.5 m bgs in SDH18-01. Groundwater seepage was not observed at the other borehole locations, given that water was used during drilling of the other two boreholes.

[8] Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition: BiTech Publishers Ltd., Richmond, BC

6.0 SUPPLEMENTAL GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

6.1 General

This section of the report addresses the updated geotechnical design aspects of the project based on our interpretation of the geotechnical investigation results and project requirements. It is emphasized that the information in this portion of the report is provided for the guidance of the designers and is intended for this project only. Contractors bidding on or undertaking the construction works should examine the factual information, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety and equipment capabilities.

6.2 Site Preparation Recommendations

6.2.1 Stripping

All surficial materials and topsoil, organic materials including tree stumps and roots, asphalt pavement and fill soils should be completely removed, and the excavation carried down to bedrock within the footprint of the proposed development. Excavation should extend beyond the perimeter of all buildings a horizontal distance at least equal to the depth of excavation below the footings for the building foundation. Based on the results of the field investigation, depths of excavation to bedrock are anticipated to range from 0 m to 1.5 m bgs. It is possible that thicker deposits of fill may be present in areas of the Site where no subsurface investigation was completed.

It is recommended that the exposed subgrade be inspected by experienced geotechnical personnel prior to bedrock excavation and placement of structural fill or footing form construction.

6.2.2 Rock Excavation

It is expected that excavation of bedrock will be required to achieve the desired building foundation elevations and final site grades. The bedrock at the site is very strong (R5) and it is expected that drilling and blasting will be required for grading of the site. Excessive loosening or dislodging of the bedrock to be retained within the building footprint should be avoided. A blasting plan should be prepared by a qualified professional to achieve the required configuration of bedrock and to ensure that overbreak of bedrock resulting from blasting is controlled.

In areas of the building footprint where concrete foundations may be constructed across bedrock-fill contacts, it may be necessary to place and compact a layer of structural fill over the excavated rock to mitigate the potential for distress or cracking of concrete foundations associated with differential settlement over these contacts. Any areas where this situation is anticipated to occur should be reviewed by qualified geotechnical personnel and inspected prior to construction.

Excavated rock may be considered for re-use in construction as potential rock fill. It is recommended that Golder be given the opportunity to provide specific geotechnical comments on the use of this material for any applications being considered.

6.3 Structural Fill

Granular materials to be placed in paved areas as a base course or as structural fill for foundations should generally consist of well-graded, 19 mm minus crushed gravel meeting the specifications for Granular Base in Section 31 05 17 of the Master Municipal Construction Documents (MMCD) Specifications.

Structural fill material should be placed in horizontal lifts not exceeding 150 mm in loose thickness. Each lift should be uniformly compacted to at least 98 percent of the modified Proctor maximum dry density (MPMDD). Moisture conditioning, such as wetting or drying, may be required to achieve the specified compaction. Field density testing and visual review of base course placement by the geotechnical engineer are recommended.

6.4 Shallow Foundations

As discussed in Section 6.2.2, it is recommended that granular structural fill be placed over bedrock prior to construction of the concrete footings and slab. A minimum of 150 mm thickness of structural fill is recommended. The structural fill should conform to the recommendations provided in Section 5.3.3 of the previous geotechnical report by Golder (2017).

Based on the footing layout provided by CWMM Consulting Engineers on drawing S201, dated 14 March 2018, the proposed foundations comprise 2400 mm, 600 mm, and 500 mm wide strip footings and 600 mm by 600 mm pad footings. Based on the current building design details as presented on CWMM drawing S301 all footings for the proposed building will be constructed with a minimum 150 mm thickness, and recommended maximum 500 mm thickness of compacted structural fill over bedrock. The following serviceability limit state (SLS) and factored ultimate limit state (ULS) bearing resistances can be used for design.

Table 2: Recommended Bearing Resistances

Foundation Condition	Bearing Resistance (kPa)	
	Serviceability Limit State (SLS)	Ultimate Limit State (ULS)*
Structural Fill over Rock	200	300

*Based on ultimate bearing resistance with a resistance modification factor of 0.5.

Provided that the base course materials are not loosened or disturbed after placement, it is anticipated that foundations at the site will be subject to total settlements of less than 10 mm and differential settlements of less than 1 mm vertical per 1 m horizontal. The minimum footing width should be selected in accordance with National Building Code requirements.

6.5 Retaining Wall

A retaining wall is incorporated into the proposed south wall of the structure as shown on CWMM Drawing S301, dated 14 March 2018. Backfill placed adjacent to the retaining wall should be placed in accordance with the structural fill requirements in Section 6.3. Provided structural fill is placed as recommended, the assumed active earth coefficient (Ka) for the retaining wall is 0.28 It is recommended that the drainage for this wall be integrated into the structure perimeter drain system. No additional drainage requirements are anticipated to be required for the retaining wall.

6.6 Seismic Considerations

Current seismic design loads, based on the 2015 National Building Code of Canada (NBCC), are based on ground motions corresponding to a design seismic event with a two percent probability of exceedance in 50 years (an average return period of 2,475 years). The effects of local site conditions are assessed based on the characteristics of the soil and/or bedrock under a proposed structure. It is anticipated that the proposed structure will be founded entirely on bedrock or shallow granular fills over bedrock. Based on the anticipated geotechnical conditions at the site, the area of the proposed structure is classified as a Site Class A (hard rock) based on the criteria presented in Table 4.1.8.4.A, in Section 4.1.8.4 of the 2015 NBCC.

The earthquake provisions of the National Building Code and the BC Building Code are intended to reduce the risk of collapse of a structure due to an earthquake, but are not intended to ensure that no damage to the structure will occur.

A seismic hazard calculation for the site was obtained from the Natural Resources Canada (NRC) for firm ground conditions in accordance with 2015 seismic hazard maps of Canada, and based on location of the site relative to inferred seismic sources and attenuation relationships[9]. The resulting peak horizontal ground acceleration (PGA) and the five percent damped spectral response acceleration (Sa) values at periods (T) of 0.2, 0.5, 1.0, and 2.0 seconds corresponding to the 2,475-year design earthquake are provided in Appendix D.

7.0 GEOTECHNICAL INSPECTION AND TESTING

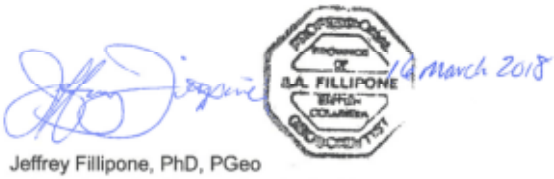
The Geotechnical Engineer of Record should be given the opportunity to review the final plans and specifications to confirm that the geotechnical engineering recommendations provided herein are appropriately incorporated. Provisions should also be made for experienced geotechnical personnel to inspect and approve the exposed subgrade surfaces for foundation construction and structural fill placement. Further, we recommend conducting in situ field density testing of the structural fills to confirm that satisfactory compaction is being achieved.

[9] http://www.earthquakescanada.nrcan.gc.ca/hazard/interpolator/index_2015-en.php

8.0 CLOSURE

We trust that the information contained in this report meets your current requirements. Please contact us if you require any further information.

Golder Associates Ltd.



Sarah Morse, PEng, PMP
Senior Geotechnical Engineer

Jeffrey Fillipone, PhD, PGeo
Principal, Senior Engineering Geologist

SM/JAF/nnv/lmk

\\golder.gds\gal\victoria\final\2013\1447\13-1447-0497 pwgsc wood creek quarry\1314470497-087-r-rev0\1314470497-087-r-rev0-atp integration geotech-16mar_18.docx

APPENDIX A

Important Information and Limitations of This Report

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Photographic Summary

Photo 1: Track mounted sonic rig and equipment set up at SDH18-01.

Photo 2: Example of a Standard Penetration Test split spoon sample at SDH18-01 from 0.0 m to 0.6 m.

Photo 3: Example of bedrock from a sonic core sample from 2.1 m to 2.7 m at SDH18-01. Bottom end of sample is shown on the right side.

Photo 4: Example of sonic core sample from 0.0 m to 0.6 m at SDH18-02. Bottom end of sample is shown on the left side.

Photo 5: Example of sonic core sample from 0.0 m to 1.4 m at SDH18-03. Bottom end of sample is shown on the left side.

Photo 6: Example of sonic core sample from 1.4 m to 1.7 m at SDH18-03. Bottom end of sample is shown on the left side.

\\golder.gds\gal\victoria\final\2013\1447\13-1447-0497 pwgsc wood creek quarry\1314470497-087-r-rev0\components\appendix b\appendix b - photo summary.docx

APPENDIX C

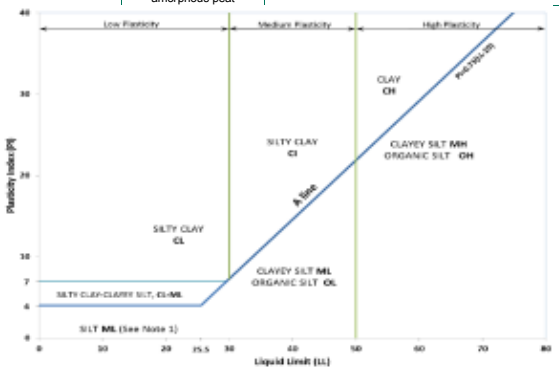
Record of Boreholes

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity			Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BORHEOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness terms are based on SPT-'N' ranges as provided in Terzaghi, Peck and Mesri (1996) and correspond to typical average N_{60} values. Many factors affect the recorded SPT-'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), groundwater conditions, and grainsize. As such, the recorded SPT-'N' value(s) should be considered only an approximate guide to the compactness term. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
u	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
φ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan\delta$
c′	effective cohesion
c_u, s_u	undrained shear strength ($\varphi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan\varphi'$

2 shear strength = (compressive strength)/2

PROJECT No.: 13-1447-0497 / 6100 / 6105

CLIENT: PSPC
PROJECT: ATP Integration Facility
LOCATION: Saanich, BC
N: ~5374099 E: ~469311
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

RECORD OF SONIC HOLE: SDH18-01

SHEET 1 OF 1
DATUM: Ground Surface

DRILLING DATE: January 11, 2018
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

INCLINATION: -90°

*SAMPLER HAMMER, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0	Tracked Sonic Rig / Sonic Drilling	Ground Surface															
		ASPHALT.															
		FILL - (SP) SAND and GRAVEL, trace non-plastic fines; grey; non-cohesive, moist to wet, compact.		0.05	1	SS	27	1									
1					2	SC											
					3	SS											
		BEDROCK. Quartz-feldspar-amphibole gneiss; grey, slightly weathered, oxidation within joints, foliation. - possible rock fill in upper portion.		1.37	4	SC		2									
2					5	SC		3									
3		- fractured/weathered zone from 3.35 m to 4.27 m depth.			6	SC		4									
4		End of Sonic Hole.		4.27													
5																	

DEPTH SCALE
1 : 25

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: RM
CHECKED: SM

PROJECT No.: 13-1447-0497 / 6100 / 6105

CLIENT: PSPC
PROJECT: ATP Integration Facility
LOCATION: Saanich, BC
N: ~5374102 E: ~469296
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

RECORD OF SONIC HOLE: SDH18-02

SHEET 1 OF 1
DATUM: Ground Surface

DRILLING DATE: January 12, 2018
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

INCLINATION: -90°

*SAMPLER HAMMER, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	SOIL CORE: RUN No.	RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002): GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa: nat V. + Q - ● / rem V. ⊕ U - ◐ / Pocket Pen ■ (20 40 60 80)	WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface																
0	Tracked Sonic Rig / Sonic Drilling	TOPSOIL - (OL) ORGANIC SILT, trace sand, trace gravel; dark brown, contains rootlets; cohesive, moist, w<PL, soft.		0.00	1 2	SS SC		1										
		BEDROCK. Quartz-feldspar-amphibole gneiss; grey, slightly weathered, oxidation within joints, foliation.		0.30	3	SC												
1					4	SC		2										
					5	SC		3										
2					6	SC		4										
		End of Sonic Hole.		2.74														
3																		
4																		
5																		

DEPTH SCALE
1 : 25

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: RM
CHECKED: SM

PROJECT No.: 13-1447-0497 / 6100 / 6105

CLIENT: PSPC
PROJECT: ATP Integration Facility
LOCATION: Saanich, BC
N: ~5374115 E: ~469286
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

RECORD OF SONIC HOLE: SDH18-03

SHEET 1 OF 1
DATUM: Ground Surface

DRILLING DATE: January 12, 2018
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

INCLINATION: -90°

*SAMPLER HAMMER, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	DRILLING RIG / DRILLING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	SOIL CORE RUN No.	SOIL CORE RECOVERY %	GRADATION % (CLAY PARTICLE SIZE <= 0.002) GRAVEL	SAND	FINES	SILT	CLAY	SHEAR STRENGTH Cu, kPa / WATER CONTENT PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface															
0	Tracked Sonic Rig / Sonic Drilling	FILL - (SP) SAND and GRAVEL, sub-rounded gravel, trace non-plastic fines; brown; non-cohesive, moist, compact.		0.00	1	SS	19	1									
1		(ML) sandy CLAYEY SILT, trace gravel; brown; cohesive, w~PL, soft.		0.61	2	SC											
		(SM) SILTY SAND; brown; non-cohesive, wet.		1.37	3	SC		2									
		BEDROCK. Quartz-feldspar-amphibole gneiss; grey, slightly weathered, oxidation within joints, foliation.		1.52	4	SC											
2					5	SC		3									
					6	SC		4									
3		End of Sonic Hole.		2.90													
4																	
5																	

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen ■; 20 40 60 80
WATER CONTENT PERCENT: Wp ⊢ W ⊣ Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE
1 : 25

* Note: Split-Spoon sampling and recorded blow counts were completed within a sonic cored borehole, a method which does not strictly comply with ASTM standards. Caution and judgment should therefore be exercised in the interpretation of the measured blow counts and their correlation with standard "N" values.

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: RM
CHECKED: SM

APPENDIX D

Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

March 14, 2018

Site: 48.5193 N, 123.4157 W User File Reference: 5071 West Saanich Rd. Victoria, BC

Requested by: , Golder Associates Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.705	1.076	**1.289**	1.292	**1.147**	**0.668**	**0.393**	**0.123**	**0.043**	**0.574**	**0.825**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.163	0.367	0.503
Sa(0.1)	0.251	0.566	0.777
Sa(0.2)	0.305	0.686	0.931
Sa(0.3)	0.301	0.685	0.933
Sa(0.5)	0.247	0.592	0.818
Sa(1.0)	0.117	0.310	0.451
Sa(2.0)	0.060	0.170	0.257
Sa(5.0)	0.012	0.038	0.071
Sa(10.0)	0.0040	0.012	0.024
PGA	0.132	0.304	0.415
PGV	0.148	0.392	0.565

References

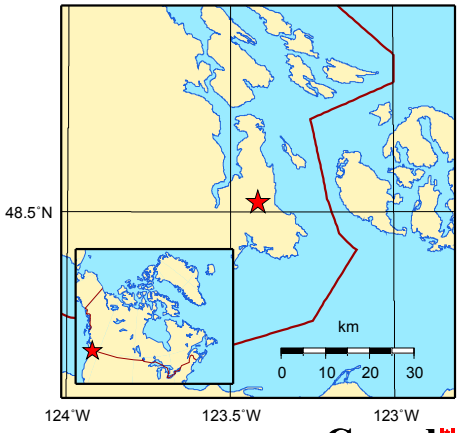
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Natural Resources Canada Ressources naturelles Canada

Canada

golder.com