Public Works and Government Services Canada

Requisition Number: EZ899-180611

SPECIFICATIONS for:

Environment Canada
2645 Dollarton Highway, North Vancouver, BC
Pacific Environmental Science Centre (PESC)
Fume Hood Recapitalization

Project Number: R.071030.001

APPROVED BY:

Regional Manager, AES — Date: June 12/2017

Construction Safety Coordinator — Date: 2017.06.13

TENDER:

Project Manager — Date: 2017.06.21

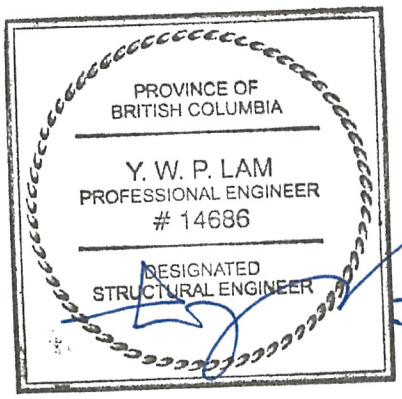
Project # R.071030.001
Pacific Environmental Science Centre (PESC)
Fume Hood Recapitalization
2645 Dollarton Highway
North Vancouver, B.C.

SEALS SHEET

Architect
Kasian Architecture Interior Design and Planning Ltd.

JUNE 15 2017

Structural Consultant
CWMM Consulting Engineers Ltd.



June 15, 2017

Mechanical Consultant
Integral Group Inc.

June 15/2017

Electrical Consultant
L. P. Gander & Associates Ltd.

June 19, 2017

Division 25 - Integrated Automation

Division 26 - Electrical

LIST OF DRAWINGS (bound separately)

Architectural Drawings

Structural Drawings

Mechanical Drawings

Electrical Drawings

END OF SECTION 00 01 10

PART 1 - 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 new Fume hood / ventilation upgrade pertaining to Block B of the Pacific Environment Science Centre. Construction of metal platform on the roof to support new mechanical equipment related to the mechanical upgrades. at Pacific Environmental Science Centre (PESC), 2645 Dollarton Highway, North Vancouver, B.C.

1.3 CONTRACT METHOD

1 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.

1.5 WORK SEQUENCE

.1 Construct work in stages to accommodate continued use of premises 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 Maintain fire access/control.

.4 Work to follow electrical and construction sequencing such that construction will not affect the continual operation of the facility.

.5 Project Phasing

.1 Phase 1:

.1 Establish temporary exhaust for fume hood FH-26. See drawing 1 / A-102. Refer to mechanical, structural and electrical for extent of work.

.2 Phase 2:

.1 Construction on main floor to be limited to rooms B112, B113, B114 and B115.

.2 All construction in noted rooms must be complete prior to moving to Phase 3.

.3 Client will continue to occupy rooms B116 and B117 during Phase 2.

.4 Allow one week between Phase 2 and Phase 3 for client relocation.

.5 Complete all work on mezzanine and roof levels.

.3 Phase 3:
.1 Construction on Main Floor to be limited to Rooms B116 and B117.

.2 Complete any remaining work on Mezzanine and roof levels.

.6 Construction duration shall be 20 weeks.

1.6 CONTRACTOR USE OF PREMISES

.1 Standard working hours to be 7:00 am to 5:00 pm Monday to Friday except holidays.

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

.3 Contractor shall provide one week advanced notice of after hour or weekend work and 48 hours notice in the event of cancellation of said work.

.4 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.

.5 At completion of operations the condition of existing work which is specified to remain must be equal to or better than that which existed before new work started.

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

.7 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

1.7 OWNER OCCUPANCY

.1 The existing building will remain in full use and occupancy throughout the duration of construction of the new Work.

.2 Provide and maintain continuation of fire protection in existing building.

.3 Maintain existing exits and ensure that proper and safe means of egress from all parts of existing building to open spaces are provided at all times to the approval of Departmental Representative. Mark, install exit lights, and illuminate temporary means of egress.

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

.5 Give Departmental Representative 48 hours notice of intention to commence Work in an occupied room or area of existing building.

1.8 OWNER AND CONTRACTOR RESPONSIBILITIES

.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 Designate Submittals and delivery date for major building components and equipment 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 (under their control).

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

.4 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including mechanical, plumbing, power and communication services. Adhere to approved schedule and provide notice to affected parties.

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

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

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

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

.9 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures. Maintain construction barriers as delineated in the drawings during the full duration of the contract.

END OF SECTION 01 11 00

PART 1 - GENERAL

1.1 CODES, BYLAWS, STANDARDS

.1 Perform work in accordance with the National Building Code of Canada (NBCC) 2010, National Energy Code of Canada for Buildings 2015 or BC Building Code which ever is more stringent, 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 the construction of fume hood / ventilation upgrade pertaining to Block B of the Pacific Environment Science Centre. Construction of metal platform on the roof to support new mechanical equipment related to the mechanical upgrades. as fully described in the Tender Documents.

1.3 CONTRACT DOCUMENTS

.1 The Contract documents, drawings and specifications are intended to complement each other.

.2 Drawings are, in general, diagrammatic and are intended to indicate the scope and general arrangement of the work.

1.4 HOURS OF WORK

.1 All work shall be executed during the normal operating hours of PESC: Monday through Friday – 07:00 AM to 05:00 PM, excluding statutory holidays.

.2 Notify Departmental Representative one week in advance of all after hours work, including weekends and holidays.

.3 All work conducted during and outside of normal operating hours will be subject to restrictions, including security arrangements.

1.5 WORK SCHEDULE

.1 Refer to Section 01 11 00 – Summary Of Work for Project Phasing.

.2 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 to approval of Departmental Representative. A copy of the updated schedule will be provided with the monthly progress payment.

1.6 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.

1.7 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.

1.8 REGULATORY REQUIREMENTS

.1 Building Permit

- .1 Obtain and pay for Building Permit, Occupancy Permit, Certificates, Licenses and other permits required by City of North Vancouver, provincial or federal authorities to complete the work.

.2 Provide inspection authorities with plans and information required for issue of acceptance certificates.

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

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

1.9 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 Pacific Environmental Science Centre 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.

1.10 EXAMINATION

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

1.11 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.

1.12 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 at least 48 hours prior to impending installation and obtain approval for actual location.

.4 Submit field drawings or shop drawings to indicate the relative position of various services and equipment when required by the Departmental Representative and/or as specified.

1.13 CUTTING AND PATCHING

.1 Cut existing surfaces as required to accommodate new work.

.2 Remove items so shown or specified.

.3 Do not cut, bore, or sleeve load-bearing members.

.4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.

.5 Fit work airtight to pipes, sleeves, ducts and conduits.

.6 Conceal pipes, ducts and wiring in raised floors (if any), wall and ceiling construction of finished areas except where indicated otherwise.

.7 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture.

.8 Making good is defined as matching construction and finishing materials and the adjacent surfaces such that there is no visible difference between existing and new surfaces when viewed from 1.5 metres in ambient light, and includes painting the whole surface to the next change in plane.

1.14 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.

1.15 ACCEPTANCE OF SUBTRADES

1 Each trade shall examine surfaces prepared by others and job conditions which may affect his work, and shall report defects to the General Contractor. Commencement of work shall imply acceptance of prepared work or substrate surfaces.

1.16 QUALITY OF WORK

.1 Ensure that quality workmanship is performed through use of skilled tradesmen, under supervision of qualified journeyman.

.2 The workmanship, erection methods and procedures to meet minimum standards set out in the National Building Code of Canada 2010, National Energy Code of Canada for Building, BC Building Code 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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 the services of testing agency or testing laboratory as specified, and where required for the following:
- .1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.
- .2 Inspection and testing performed exclusively for Contractor's convenience.
- .3 Testing, adjustment and balancing of mechanical and electrical equipment and systems.
  - .1 Mill tests and certificates of compliance.
  - .2 Tests specified in the contract documents to be carried out by Contractor which may be under the Departmental Representative's supervision.

.3 Within 15 working days after Contract award provide a list of proposed testing services or testing laboratories for Departmental Representative's approval.

.4 The Departmental Representative may require, and pay for, additional inspection and testing services not included in paragraph 1.20.2 above.

.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.

1.21 SECURITY CLEARANCES

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

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

.3 Contractor shall be fully responsible for securing the premises and its contents throughout construction period.

1.22 CLEANING

.1 Refer to Section 01 74 11 - Cleaning.

1.23 DUST CONTROL

.1 Provide temporary dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of work and public.

.2 Protect furnishings and equipment within work area with 0.102 mm thick polyethylene film during construction. Remove film during non- construction hours and leave premises in clean, unencumbered and safe manner for normal daytime function.

.3 Maintain and relocate protection until such work is complete.

1.24 ENVIRONMENTAL PROTECTION

.1 Prevent extraneous materials from contaminating air beyond construction area, by providing temporary enclosures during work.

.2 Do not dispose of waste or volatile materials into water courses, storm or sanitary sewers.

.3 Ensure proper disposal procedures in accordance with all applicable territorial regulations.

1.25 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.

1.26 BUILDING SMOKING ENVIRONMENT

.1 Smoking within the building area is not permitted.

1.27 SYSTEM OF MEASUREMENT

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

END OF SECTION 01 11 55

PART 1 - GENERAL

1.1 FACILITY OPERATIONS AND SECURITY PROCEDURES

.1 All construction staff shall become thoroughly familiar with and abide by all provisions and requirements of Pacific Environmental Science Centre, Safety and Security Procedures and Restrictions.

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

1.2 ACCESS AND EGRESS

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

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

1.3 EXISTING SERVICES SHUT DOWNS

.1 Notify Departmental Representative and utility companies of any intended interruption of services. Obtain applicable permission as required.

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 4 weeks of notice for necessary interruption of, mechanical or electrical service throughout course of work. Keep duration of interruptions minimum.
Carry out interruptions after normal working hours of occupants, preferably on weekends.

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

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

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

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

1.4 NOISE CONTROL

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

END OF SECTION 01 14 00

PART 1 – GENERAL

1.1 SECTION INCLUDES

.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.

1.2 DESCRIPTION

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

1.3 PRE-CONSTRUCTION MEETING

.1 Pre-construction Meeting:
- .1 Within 10 days after award of Contract, Departmental Representative will arrange pre-construction meeting.
- .2 Departmental Representative, Contractor and Owners representative.
- .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, PESC and consultants.
    - .2 Communication protocol for submittals.
    - .3 Start date on site.
    - .4 PESC 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.

1.4 PROJECT PLANNING

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

1.5 SCHEDULES

.1 Submit preliminary construction schedule to Departmental Representative 10 days after contract award and prepare for review 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.

1.6 CONSTRUCTION SITE MEETINGS

.1 During course of Work and prior to project completion, Departmental Representative will request Construction Site Meetings as required.

.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.

1.7 WALK THROUGH FIELD REVIEW BY DEPARTMENTAL REPRESENTATIVE

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

1.8 SUBMITTALS

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

.2 Process substitutions through Departmental Representative.

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

1.9 CLOSEOUT PROCEDURES

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

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

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

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

END OF SECTION 01 31 00

PART 1- 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: phasing and 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 Phasing Schedule and with prescribed milestones and time frame.

.3 Limit activity durations to maximum of approximately 15 working days, to allow for progress reporting.

.4 Ensure that it is understood that Award of Contract or time of beginning, phasing, 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 Phasing schedule.
- .2 Start and completion of all items of Work, their major components and interim milestones completion dates.
- .3 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.
- .4 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.
- .5 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.
- .6 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 Phasing
- .3 Shop Drawings, Samples and Approvals.
- .4 Permits.
- .5 Mobilization.
- .6 Mock-ups and Approvals.
- .7 Procurement.
- .8 Construction.
- .9 Installation.
- .10 Site Works.
- .11 Training.
- .12 Shutdowns for systems indicated in Section 01 14 00 1.5 Existing Services Shut Downs.
- .13 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

PART 1 - GENERAL

1.1 ADMINISTRATIVE

.1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are coordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

.11 Do not proceed with work until relevant submissions are reviewed by Departmental Representative.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 When specified in the Contract document, submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia of Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 10 days for Departmental Representative's review of each submission, unless noted otherwise.

.5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as Departmental Representative may require consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:
- .1 Date.
- .2 Project title and number.
- .3 Contractor's name and address.
- .4 Identification and quantity of each shop drawing, product data and sample.
- .5 Other pertinent data.

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

.9 After Departmental Representative's review, distribute copies.

.10 Submit electronic copy of shop drawings for each requirement requested in specification sections and as Departmental Representative may reasonably request.

.11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
- .2 Testing must have been within 3 years of date of contract award for project.

.13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
- .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
- .2 Certificates must be dated after award of project contract complete with project name.

.14 Submit electronic copies of manufacturer's instructions for requirements requested in specification Sections and as requested by Departmental Representative.
- .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Submit copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.18 Delete information not applicable to project.

.19 Supplement standard information to provide details applicable to project.

.20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, electronic copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.21 The review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general concept.
- .1 This review shall not mean that Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of Construction and Contract Documents.
- .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for 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

PART 1 - GENERAL

1.1 REFERENCE

.1 Government of Canada.
- .1 Canada Labour Code - Part II
- .2 Canada Occupational Health and Safety Regulations.

.2 National Building Code of Canada (NBC):
- .1 Part 8, Safety Measures at Construction and Demolition Sites.

.3 The Canadian Electric Code (as amended)

.4 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 CSA Z1006-10 Management of Work in Confined Spaces.
- .5 CSA Z462- Workplace Electrical Safety Standard

.5 National Fire Code of Canada 2010 (as amended)
- .1 Part 5 - Hazardous Processes and Operations and Division B as applicable and required.

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

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

1.2 WORKSAFE BC 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 WorkSafe BC coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

1.3 COMPLIANCE WITH REGULATIONS

.1 PSPC may terminate the Contract without liability to the Owner where the Contractor/subcontractor, in the opinion of the 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.

1.4 SUBMITTALS

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

.2 Submit the following:

.1 Site specific Health and Safety Plan.

.2 Copies of reports or directions issued by federal and provincial health and safety inspectors.

.3 Copies of incident and accident reports.

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

.5 Emergency procedures.

.3 The Departmental Representative will review the site-specific project Health and Safety Plan and emergency procedures, and provide comments within 5 days after receipt of the plan. Revise the plan as appropriate and resubmit to the Owner for review upon request.

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

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

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

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

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

1.5 RESPONSIBILITY

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

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

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

1.6 HEALTH AND SAFETY COORDINATOR

.1 The Health and Safety Coordinator:

.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, revising, daily enforcing, and monitoring the Site Specific Health and Safety Plan.

.3 Be on site during execution of work.

1.7 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 ersonnel, and temporary lighting as required.
.2 Secure site at night time as deemed necessary to protect site against entry.

1.8 REGULATORY REQUIREMENTS

.1 Comply with Owners Fire and Safety requirements, 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 Owner will advise on the course of action to be followed.

1.9 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:
.1 Multi-employer work site.
.2 Federal employees and general public.

1.10 UTILITY CLEARANCES

.1 The Contractor is solely responsible for all utility detection and clearances prior to starting the work

.2 The Contractor will not rely solely upon the Reference Drawings or other information provided for utility locations

1.11 REGULATORY REQUIREMENTS

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

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

1.12 WORK PERMITS

.1 Obtain speciality permit[s] related to project before start of work.

1.13 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.

1.14 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 proj ect.
.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 sub-contractors. Ensure that work/activities of sub-contractors 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 Owner.

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

1.15 EMERGENCY PROCEDURES

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

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

.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.

.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.

1.16 HAZARDOUS PRODUCTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labeling and provision of Material Safety Data Sheets (MSDS) acceptable to the Owner 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 013 30 00.
.2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when tenants have left the building.
.3 Provide adequate means of ventilation in accordance with Section 01 51 00.
.4 The contractor shall ensure that the product is applied as per manufacturers recommendations.
.5 The contractor shall ensure that only pre-approved products are brought onto the work site in an adequate quantity to complete the work.

1.17 ASBESTOS HAZARD

.1 Carry out any activities involving asbestos in accordance with applicable Provincial Regulations.

1.18 PCB REMOVALS

.1 Mercury-containing fluorescent tubes and ballasts which contain polychorinated biphenyls (PCBs) are classified as hazardous waste.

1.19 REMOVAL OF LEAD- CONTAINING PAINTS

.1 All paints containing TCLP lead concentrations above 5 ppm are classified as hazardous.

.2 Carry out demolition and/or remediation activities involving lead-containing paints in accordance with applicable Provincial Regulations.

1.20 ELECTRICAL SAFETY PROCEDURES

.1 Comply with authorities and ensure that, when installing new facilities, all electrical personnel are completely familiar with new electrical circuits and equipment and their operation.
  .1 Before undertaking any work, co-ordinate required energizing and de-energizing of new circuits with the 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.

1.21 ELECTRICAL LOCK-OUT

.1 Develop, implement and enforce use of established procedures to provide electrical lock-out 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 lock-out procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request/authorization form. Have the procedures available for review upon request by the Departmental Representative.

.3 Keep the documents and lock-out 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.

1.22 OVERLOADING

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

1.23 FALSEWORK

.1 Design and construct falsework in accordance with CSA S269.1.

1.24 SCAFFOLDING

.1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CAN/CSA-S269.2 - Access Scaffolding for Construction Purposes.

1.25 CONFINED SPACES

.1 Carry out work in confined spaces in compliance with provincial regulations.

1.26 POWDER-ACTUATED DEVICES

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

1.27 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.

1.28 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.

.3 Portable gas and diesel fuel tanks are not permitted on most federal work sites. Approval from the DR is required prior to any gas or diesel tank being brought onto the work site.

1.29 FIRE PROTECTION AND ALARM SYSTEMS

.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 fire fighting.

.3 Be responsible/liable for costs incurred from the fire department, the building owner and the tenants, resulting from false alarms.

1.30 UNFORSEEN 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.

1.31 POSTED DOCUMENTS

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

1.32 MEETINGS

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

1.33 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 Contractor/sub-contractors will be responsible for any costs arising from such a "stop work order".

END OF SECTION 01 35 29.06

PART 1 - GENERAL

1.1 INSPECTION

.1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.

.2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work

.3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.

.4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

1.2 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Contractor for 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 replacement's 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 the Contractor will furnish paper copies of reports on site to allow for work to proceed in a timely manner.

.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, 25, 26, 27 and 28 for definitive requirements.

END OF SECTION 01 45 00

PART 1 - GENERAL

1.1 ACCESS AND DELIVERY

.1 Contractor is required to use only the designated entrance to access the work site, for deliveries to site, and as the exit for offsite disposal.
- .1 Maintain for duration of contract.
- .2 Make good damage resulting from Contractor's use.
- .3 Maintain road cleanliness utilizing mechanical means from project site to main entrance on a daily basis.

1.2 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.

1.3 POWER

.1 Connect to existing power supply approved by Departmental Representative's and Owner in accordance with Canadian Electrical Code.

1.4 WATER SUPPLY

.1 Departmental Representative will provide continuous supply of potable water for construction use.
- .1 .

1.5 SCAFFOLDING

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

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

1.6 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.

1.7 HOARDING

.1 Prior to all demolition and construction, install plywood hoarding or protective barrier as detailed. Maintain in safe and clean condition throughout duration of project. Submit hoarding plan to Departmental Representative for approval.

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

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

1.8 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.

1.9 REMOVAL OF TEMPORARY FACILITIES

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

1.10 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.

1.11 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

PART 1 - GENERAL

1.1 PRODUCTS/MATERIAL AND EQUIPMENT

.1 Use NEW products/material and equipment unless otherwise specified. The term "products" is referred to throughout the specifications.

.2 Use products of one manufacturer for material and equipment of the same type or classification unless otherwise specified.

.3 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

.4 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer's instructions. Departmental Representative will designate which document is to be followed.

.5 Provide metal fastenings and accessories in the same texture, colour and finish as base metal in which they occur.
- .1 Prevent electrolytic action between dissimilar metals.
- .2 Use non-corrosive fasteners, anchors and spacers for securing exterior work.
- .3 Fastenings which cause spalling or cracking are not acceptable.
  - .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .4 Use heavy hexagon heads, semi-finished unless otherwise specified.
- .5 Bolts may not project more than one diameter beyond nuts.
- .6 Types of washers as follows:
  - .1 Plain type washers: use on equipment and sheet metal.
  - .2 Soft gasket lock type washers: use where vibrations occur.
  - .3 Resilient washers: use with stainless steel.
- .7 Deliver, store and maintain packaged material and equipment with manufacturer's seals and labels intact.
- .8 Prevent damage, adulteration and soiling of products during delivery, handling and storage. Immediately remove rejected products from site.
- .9 Store products in accordance with suppliers' instructions.
- .10 Touch up damaged factory finished surfaces to Departmental Representative's satisfaction.
  - .1 Use primer or enamel to match original.
  - .2 Do not paint over nameplates.

1.2 QUALITY OF PRODUCTS

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

.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 Departmental Representative

.4 Should any dispute arise as to quality or fitness of products, the decision rests strictly with the Departmental Representative based upon the requirements of the Contract documents.

.5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.

.6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 AVAILABILITY OF PRODUCTS

.1 Immediately upon signing the Contract, review product delivery requirements and anticipate foreseeable supply delays for any items.

.2 If delays in supply of products are foreseeable, notify Departmental Representative of such in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of the work.

.3 In event of failure to notify Departmental Representative at the start of work and should it subsequently appear that the work may be delayed for such reason, the Departmental Representative reserves the right to substitute more readily available products of similar character, at no increase in either the Contract price or the Contract time.

1.4 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the specifications, install or erect products in accordance with the manufacturer's instructions.
- .1 Do not rely on labels or enclosures provided with products.
- .2 Obtain written instructions directly from the manufacturer.

.2 Notify Departmental Representative in writing of conflicts between the specifications and the manufacturer's instructions so that the Departmental Representative may establish the course of action.

.3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Departmental Representative to require removal and reinstallation at no increase in either the Contract price or the Contract time.

1.5 CONTRACTOR'S OPTIONS FOR SELECTION OF PRODUCTS FOR TENDERING

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

.2 Products specified under "Acceptable Products": select any one of the indicated manufacturers, or any other manufacturer meeting or exceeding the Prescriptive specifications and indicated Products.

.3 Products specified by performance and referenced standard: select any product meeting or exceeding the referenced standard.

.4 Products specified to meet particular design requirements or to match existing materials: use only material specified Approved Product. Alternative products may be considered provided full technical data is received in writing by Departmental Representative in accordance with "Special Instructions to Tenderers".

.5 When products are specified by a referenced standard or by or Performance specifications, upon request of Departmental Representative obtain from manufacturer an independent laboratory report showing that the product meets or exceeds the specified requirements.

1.6 SUBSTITUTION AFTER CONTRACT AWARD

.1 No substitutions are permitted without prior written approval of the Departmental Representative.

.2 Proposals for substitution may only be submitted after Contract award. Such request must include statements of respective costs of items originally specified and the proposed substitution.

.3 Proposals will be considered by the Departmental Representative if:

.1 Products selected by tenderer from those specified are not available;

.2 Delivery date of products selected from those specified would unduly delay completion of Contract, or;

.3 Alternative product to that specified, which is brought to the attention of and considered by Departmental Representative as equivalent to the product specified, and will result in a credit to the Contract amount.

.4 Should the proposed substitution be accepted either in part or in whole, assume full responsibility and costs when substitution affects other work on the project. Pay for design or drawing changes required as result of substitution.

.5 Amounts of all credits arising from approval of the substitutions will be determined by the Departmental Representative and the Contract price will be reduced accordingly.

END OF SECTION 01 61 00

PART 1 - GENERAL

1.1 RELATED WORK

.1 Summary of Work: Section 01 11 00

.2 General Instructions: Section 01 11 55

.3 Demolition for Minor Works Section 02 41 99

1.2 DEFINITIONS

.1 Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

.2 Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.3 QUALITY ASSURANCE

.1 Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

.2 Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operating elements include the following:
- .1 Primary operational systems and equipment.
- .2 Air or smoke barriers.
- .3 Fire-suppression systems.
- .4 Mechanical systems piping and ducts.
- .5 Control systems.
- .6 Communication systems.
- .7 Conveying systems.
- .8 Electrical wiring systems.

.3 Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
- .1 Water, moisture, or vapour barriers.
- .2 Roofing membranes and flashings.
- .3 Metal Roofing
- .4 Equipment supports.

.4 Piping, ductwork, vessels, and equipment.

.5 Noise and vibration-control elements and systems.

.6 Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Departmental Representative's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

.7 Cutting and Patching Conference: Before proceeding, meet at Project site with Departmental Representative and parties involved in cutting and patching, including mechanical and electrical trades. Review are as of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.4 WARRANTY

.1 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.5 SUBMITTALS

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

.2 Informational Submittals: Provide the following submittals during the course of the work:

.1 Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

.1 Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.

.2 Changes to Existing Construction:

.1 Describe anticipated results.

.2 Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.

.3 Products: List products to be used and firms or entities that will perform the Work.

.4 Dates: Indicate when cutting and patching will be performed.

.5 Utilities:

.1 List utilities that cutting and patching procedures will disturb or affect.

.2 List utilities that will be relocated and those that will be temporarily out of service.

.3 Indicate how long service will be disrupted.

.6 Structural Elements: Submit details and engineering calculations showing integration of reinforcement with original structure to the Departmental Representative prior to making cuts or modifications where cutting and patching involve adding reinforcement to structural elements.

.7 Departmental Representative's Acceptance:

.1 Obtain acceptance of cutting and patching proposal before cutting and patching.

.2 Review and acceptance of cutting and patching proposal does not waive right to later require removal and replacement of unsatisfactory work.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Comply with requirements specified in other Sections of the Project Manual.

.2 Existing Materials: Use materials identical to existing materials and historic elements. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible:

.1 If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials to the approval of the Departmental Representative.

PART 3 - GENERAL

3.1 EXAMINATION

.1 Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed:
- .1 Provide investigative methods that use non-ionizing radiation or other approved method to determine locations of existing services and reinforcing in existing concrete slabs and walls before cutting and renovations.
- .2 Advise Departmental Representative of findings before proceeding with the Work and revise penetration locations as required and directed by Departmental Representative.
- .3 Verify compatibility with and suitability of substrates, including compatibility with historic elements, existing finishes or primers before patching.
- .4 Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

.1 Provide temporary support of Work to be cut in accordance with Section 01 51 00 -Temporary Utilities.

.2 Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

.3 Adjoining Areas: Avoid interference with operations of existing facility and use of adjoining areas or interruption of free passage to adjoining areas.

3.3 PERFORMANCE

.1 Employ skilled workers to perform cutting and patching.
- .1 Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

.2 Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, using methods least likely to damage elements retained or adjoining construction.
- .1 In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
- .2 Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
- .3 Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond core drill.
- .4 Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
- .5 Proceed with patching after construction operations requiring cutting are complete.

.3 Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications:

- .1 Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- .2 Exposed Finishes: Restore exposed finishes and extend on to adjoining construction using techniques that completely hide patching and refinishing work.
- .3 Floors and Walls:
  - .1 Provide an even surface of uniform finish, colour, texture, and appearance.
  - .2 Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform colour and appearance.
  - .3 Apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing the patch where patching occurs in a painted surface; provide additional coats until patch blends with adjacent surfaces.
- .4 Ceilings: Patch, repair existing ceilings as necessary to provide an even plane surface of uniform appearance.
- .5 Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

END OF SECTION 01 73 29

PART 1 - 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 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.12 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.13 Remove dirt and other disfiguration from exterior surfaces.

.14 Clean and sweep gutters.

.15 Sweep and wash clean paved areas.

.16 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

.17 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

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

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Waste goals.

.2 Waste management plan.

.3 Waste management plan implementation.

.4 Disposal of waste.

1.2 DEFINITIONS

.1 Clean Waste: Untreated and unpainted; not contaminated with oils, solvents, sealants or similar materials.

.2 Construction and Demolition Waste: Solid wastes typically including but not limited to, building materials, packaging, trash, debris, and rubble resulting from construction, re-modelling, repair and demolition operations.

.3 Hazardous: Exhibiting the characteristics of hazardous substances including, but not limited to, ignitability, corrosiveness, toxicity or reactivity.

.4 Non-hazardous: Exhibiting none of the characteristics of hazardous substances, including, but not limited to, ignitability, corrosiveness, toxicity, or reactivity.

.5 Non-toxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

.6 Recyclable: The ability of a product or material to be recovered at the end of its life cycle and re-manufactured into a new product for reuse by others.

.7 Recycle: To remove a waste material from the Project site to another site for re-manufacture into a new product for reuse by others.

.8 Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

.9 Return: To give back reusable items or unused products to vendors for credit.

.10 Reuse: To reuse a construction waste material in some manner on the Project site.

.11 Salvage: To remove a waste material from the Project site to another site for resale or reuse by others.

.12 Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

.13 Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

.14 Toxic: Poisonous to humans either immediately or after a long period of exposure.

.15 Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

.16 Volatile Organic Compounds (VOC): Chemical compounds common in and emitted by many building products over time through outgassing:

.1 Solvents in paints and other coatings,

.2 Wood preservatives; strippers and household cleaners,

.3 Adhesives in particle board, fibreboard, and some plywood; and foam insulation,

.4 When released, VOC's can contribute to the formation of smog and can cause respiratory tract problems, headaches, eye irritations, nausea, damage kidneys, and central nervous system, and possibly cancer.

.17 Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.3 WASTE MANAGEMENT GOALS

.1 Owner has established that this Project shall generate the least amount of waste possible that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors shall be employed. The owners goal is to divert 75% of waste materials from the landfill.

.2 Owner recognizes that waste in any project is inevitable, but indicates that as much of waste materials as economically feasible shall be reused, salvaged, or recycled.

.3 Waste disposal in landfills shall be minimized.

1.4 MATERIAL SOURCE SEPARATION PLAN

.1 Before project start-up, prepare Materials Source Separation Program. Provide separate containers for re-usable and/or recyclable materials of following:

.1 Construction waste: including but not limited to following types.

.1 Uncontaminated packaging (wood, metal banding, cardboard, paper, plastic wrappings, polystyrene).

.2 Wood pallets (recycle or return to shipper).

.3 Batt insulation.

.4 Metals (pipe, conduit, ducting, wiring, miscellaneous cuttings)

.5 Wood (uncontaminated).

.6 Gypsum board (uncontaminated).

.7 Paint, solvent, oil.

.8 Other materials as indicated in technical sections.

.2 Administration/worker waste (uncontaminated): including but not limited to following types.

.1 Paper, cardboard.

.2 Plastic containers and lids marked types 1 through 6.

.3 Glass and aluminum drink containers (recycle or return to vendor).

.2 Implement MSSP for waste generated on project in compliance with approved methods and as approved by Departmental Representative.

.3 Locate containers in locations, to facilitate deposit of materials without hindering daily operations and as directed by Departmental Representative.

.4 Locate separated materials in areas which minimize material damage.

1.5 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 becomes Contractor's property.

.3 All materials for recycling must be source separated into separate bins to be accepted by the local processing authority.

.4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.

.5 Protect surface drainage, storm sewers, sanitary sewers, and utility services from damage and blockage.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

Part 3 EXECUTION

3.1 PREPARATION

.1 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

3.2 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises.

3.3 WASTE MANAGEMENT IMPLEMENTATION

.1 Manager: Contractor to designate an on-site party responsible for instructing workers and overseeing the results of the Waste Management Plan the Project.

.2 Instruction: Contractor shall provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.

.3 Separation facilities: Contractor shall lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.

.4 Hazardous wastes: Hazardous wastes shall be separated, stored, and disposed of according to local regulations.

3.4 DISPOSAL OF WASTE

.1 Burying of rubbish and waste materials is prohibited.

.2 Disposal of waste into waterways, storm, or sanitary sewers is prohibited.

3.5 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.

END OF SECTION 01 74 19

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

.1 Section 01 78 00 - Closeout Submittals.

1.3 INSPECTION AND DECLARATION

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
- .1 Notify Departmental Representative in writing 3 weeks prior to the satisfactory completion site visit of the Contractor's Inspection to allow Departmental Representative to schedule relevant authorities.
- .2 Attend 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 values 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

PART 1 - GENERAL

1.1 SUBMISSION

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

.2 Copy of operating and maintenance manual will be returned after Substantial Completion Inspection, with Departmental Representative's comments.

.3 Revise content of documents as required prior to formal 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 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.

.11 Certificate of Completion.

1.2 INTERACTIVE OPERATING AND MAINTENANCE MANUAL SYSTEM

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

.2 System Description and Requirements
- .1 All as constructed drawings and operation and maintenance (O&M) manuals listed under the Scope of Work shall be converted, where necessary, into Portable Data File (PDF) format for viewing using the Adobe Acrobat Reader.
- .2 Documentation storage and retrieval system shall be structured based on a database framework with direct links to the appropriate PDF files. Documents retrieval and viewing shall be executed through a menu driven approach.

.3 Program shall be capable of storing separately and independently data of multiple buildings and shall be expandable for addition of new buildings and systems.

.4 Data of each building shall be accessible by the input of either the building name or building number as defined by the Departmental Representative.

.5 O&M data and as constructed drawings shall be classified by their corresponding disciplines, including:
- .1 Architectural
- .2 Mechanical
- .3 Electrical
- .4 Data & Communication
- .5 BSCS
- .6 Under each discipline, data shall be grouped into the following four major categories:
  - .1 Basic Documents
    - .1 'Basic Documents' shall, according to the type of services or disciplines, include the full contents of each hard copy of the O&M manuals with the addition of Miscellaneous Maintenance Reports and Records, or as defined by the user. In general the following shall be included unless specifically excluded by the Departmental Representative:
      - .1 Introduction
      - .2 Consultant/Contractor/Suppliers List
      - .3 System Description
      - .4 Maintenance and Lubrication Schedules
      - .5 Testing and Commissioning (T&C) Reports
      - .6 Misc. Reports
      - .7 Specifications
      - .8 Equipment and/or point schedules as identified in the hard copy documents
      - .9 Others as stipulated by the Departmental Representative
    - .2 All Basic Documents PDF files shall be enhanced with appropriate bookmarks to facilitate searching of information within the document or linking to other relevant documents for references.
  - .2 'As-Constructed' Drawings
    - .1 'As-Constructed' drawings shall be converted from the original electronic files, such as CAD, into PDF format. If only the hard copies of the 'as constructed' drawings are available, they shall be scanned and saved in PDF format. PDF files of the 'As-Constructed' drawings shall be enhanced with the following bookmarks to zoom into legible views on the computer screen as a minimum:
      - .1 Drawing Number and Title
      - .2 Drawing Notes
      - .3 Major Equipment Locations
      - .4 Cross-links to other related drawings
      - .5 Revisions
  - .3 System Data
    - .1 Building systems shall be identified by their services, disciplines, function, nature and specific scope. System data shall be classified into the following categories:
      - .1 System Description
      - .2 Schematic (where applicable)
      - .3 Equipment List
    - .2 Provide hot key buttons, where applicable, for direct access to drawings/data referenced on the schematics. The same shall be applied to listed equipment for direct links to the corresponding equipment data.
  - .4 Equipment Data
    - .1 Equipment data shall be classified into the following categories:
      - .1 Equipment submittals

.3 T&C Report
.4 Maintenance Data
.5 Maintenance Records
.6 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.

1.3 FORMAT HARD COPY MANUALS

.1 Organize data in the form of an instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.

.4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: Manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.9 Provide 1:1 scaled CAD files in .dwg format on CD.

1.4 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.

1.5 '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.

1.6 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, provided by Departmental Representative.

.2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

.

.4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
- .1 Measured depths of elements of foundation in relation to finish first floor datum.
- .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
- .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
- .4 Field changes of dimension and detail.
- .5 Changes made by change orders.
- .6 Details not on original Contract Drawings.
- .7 References to related shop drawings and modifications.

.5 Specifications: legibly mark each item to record actual construction, including:
- .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
- .2 Changes made by Addenda and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.7 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .1 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .2 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
  - .3 Description of plumbing specialties and accessories, giving manufacturer's name, type, model, year, capacity. List of recommended spare parts.
- .3 Performance data to include:
  - .1 Equipment performance verification test results.
  - .2 Special performance data as specified.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 00 – Commissioning Plan.

.15 Additional requirements: As specified in individual specification sections.

1.8 MATERIALS AND FINISHES

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

1.9 SPARE PARTS

.1 Provide spare parts, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.10 MAINTENANCE MATERIALS

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in the Operating and Maintenance Manuals.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.11 SPECIAL TOOLS

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.12 STORAGE, HANDLING AND PROTECTION

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.13 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

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.

.2 Owner: 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 23 08 00 Commissioning of Mechanical Systems.

.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.

1.2 ACTION AND INFORMATIONAL 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

Part 1 General

1.1 Section Includes

.1 Commissioning Requirements

.2 This section of the specifications does not prevent systems other than those described herein from being tested, verified, or commissioned as per other sections of the specifications.

.3 **Refer to the Commissioning Plan Section 01 91 00.01 attached to and forming part of the Division 1 – General Requirements for the Project.** The Commissioning Plan has been written by the Commissioning Authority, **KD Engineering Co.**, and describes the commissioning process and documentation requirements for this Project.

1.2 Related Sections

.1 Division 01, Section 01 91 00.01 – Commissioning Plan

.2 Division 01, Section 01 79 00 – Demonstration and Training

.3 Division 23, Section 23 05 00 – Common Work Results for HVAC

.4 Division 23, Section 23 08 00 – Commissioning of Mechanical Systems

.5 Division 23, Section 23 08 00.01 – Commissioning System Testing

.6 Division 23, Section 23 05 93 – Testing, Adjusting and Balancing

.7 Division 23, Section 23 31 10 – Cleaning of Mechanical Duct Systems

.8 Division 23, Section 23 34 00 – HVAC Fans

.9 Division 23, Section 23 36 00 – Air Terminal Units

.10 Division 23, Section 23 38 16 13 – Fume Hoods

.11 Division 25, Section 25 05 01– EMCS: General Requirements

.12 Division 25, Section 25 30 11 – EMCS: Building Controllers

.13 Division 25, Section 25 30 12 – EMCS: Field Control Devices

.14 Division 26, Section 26 05 00- Common Work Results-For Electrical

1.3 Definitions

.1 Commissioning is a methodical, team-based process. Each member of the commissioning team must fulfill his or her commissioning functions, as described in the Commissioning Plan in order for this process to be successful. The Commissioning Team is responsible for accomplishing the commissioning process activities and is to provide leadership in identifying and resolving all commissioning process issues.

.2 “The commissioning process is a quality assurance method adopted by an Owner to consistently achieve successful construction projects. It is not an additional layer of construction or project management – it is the Owner’s means of verifying that the planning, design, construction and operational processes are achieving their goals, and ensures the delivery of a well-performing building with high quality and asset value.

.3 "The intent of the commissioning process is "To verify that the project's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents.

.4 It is of primary concern that all "Commissioned Systems" in the project perform in accordance with the contract documents, the design intent and the Owner's Project Requirements. The process of assuring that such performance is achieved is referred to as "commissioning."

1.4 References

.1 PWGSC Commissioning Manual (CP.1)

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 The Commissioning Process

.1 Begins at project inception.

.2 Has ongoing verification of achievement of the owner's project requirements.

.3 Requires integration of contractor-completed commissioning process activities into the construction documents.

.4 Aids in the coordination of static and dynamic testing that acceptance is based on.

.5 Verifies staff training.

.6 Is completed with warranty verifications and lessons-learned documentation and implementation.

3.2 Commissioned Systems

.1 The following systems shall be commissioned for this Project:

.1 Mechanical Systems:

.1 New centralized (Strobic) fume hood exhaust system for Block B

.2 Verification of approximately 7 fume hood cabinets

.3 Re-balancing of VAV and Air Handling units supplying make-up air to reworked fume hood system

.2 Electrical Systems:

.1 Associated electrical systems required for mechanical systems listed above

.3 Building Automation System (Energy Management & Control Systems)

3.3 Commissioning Team

.1 All commissioning team members are to refer to and perform tasks assigned to them listed in the Commissioning Plan.

.2 For this Project, the commissioning team will be comprised of, but not necessarily limited to, the following parties:

.1 Owner
.2 Owner's Representative
.3 Building Operation & Maintenance
.4 Commissioning Authority (overseeing, multiple discipline role)
.5 Design Consultant -Architectural
.6 Design Consultant – Electrical
.7 Design Consultant – Mechanical
.8 General Contractor
.9 Subcontractor – Electrical
.10 Subcontractor – Mechanical
.11 Subcontractor – Controls
.12 Subcontractor – Balancing
.13 Commissioning Agent – Electrical
.14 Commissioning Agent – Mechanical

.3 Commissioning requires cooperation and direct involvement by all Commissioning Team members throughout the construction and warranty processes. Commissioning Team member roles and responsibilities are listed within the Commissioning Plan.

3.4 Commissioning Plan

.1 **Refer to the Commissioning Plan Section 01 91 00.01 attached to and forming part of the Division 1 – General Requirements for the Project.** The Commissioning Plan has been written by the Owner`s Commissioning Authority, **KD Engineering Co.**, and describes the commissioning process and documentation requirements for this Project.

.2 The Commissioning Plan will be revised and re-issued over the course of the Project several times so that it is as accurate and as useful a document as is possible.

.3 The Commissioning Plan includes the following elements:

.1 Brief overview of the commissioning process.
.2 A list of all systems and assemblies included in the Commissioning Authority's scope of work.
.3 Identification of Commissioning Team and its responsibilities.
.4 Description of the management, communication and reporting of the commissioning process.
.5 Overview of the commissioning process activities for the pre-design, design, construction, and occupancy and operations phases, including the following:
.1 Development of the owner's project requirements (pre-design phase).
.2 Review of the basis of design (design phase).

.3 Review of the schematic design (design phase).
.4 Review of the construction documents (design phase).
.5 Review of submittals (construction phase).
.6 Construction phase verification (construction phase).
.7 Functional performance test development (construction phase).
.8 Functional performance test implementation (construction phase).
.9 Warranty review (occupancy and operations phase).

.6 A list of the expected work products.

.7 A list of key commissioning process milestones.

3.5 Commissioning Responsibilities

.1 The Commissioning Plan describes the expected contributions from the various commissioning team members as well as the expected commissioning work products.

.2 The Commissioning Authority provides the services in support of the commissioning requirements and for the overall commissioning of the project. The Commissioning Authority shall provide technical comments or advice to the Project team as the design documentation advances and shall assemble a Commissioning Plan to be followed by the commissioning team such that the project can be properly commissioned. By following the Commissioning Plan, the commissioning team can assure that the "commissioned systems" properly function in accordance with the owner's requirements and the consultant's design intent.

.3 It is important to note the clear distinction between the Commissioning Authority and the Commissioning Agents (mechanical & electrical). The Commissioning Authority is responsible for overseeing the overall multi-discipline commissioning process while the Commissioning Agents perform and document the testing of the various mechanical and electrical "commissioned systems".

.4 "The Commissioning Authority serves as an objective advocate for the Owner, plans and directs the commissioning process, and presents final recommendations to the Owner regarding the performance of commissioned systems and assemblies. The Commissioning Authority introduces standards and strategies early in the planning process and then verifies implementation of the commissioning process activities by clearly specifying the requirements in construction documents.

.5 Per the Commissioning Plan, the Contractor's commissioning process responsibilities shall include, but shall not necessarily be limited to, the following:

.1 Commissioning team involvement.
.2 Submittal review procedures.
.3 Operations and maintenance documentation requirements.
.4 Training plan development.
.5 Construction verification procedures.
.6 Start-up plan development and implementation.
.7 Functional performance testing.
.8 Milestones.
.9 Training.

.10 Warranty review site visit.

3.6 Commissioning Documentation

.1 All commissioning-related documentation shall to be copied to the Commissioning Authority in a timely manner. All commissioning issues shall be brought to the attention of the Commissioning Authority in a timely manner. All commissioning team members shall create or shall assist in the creation of all commissioning and commissioning-related documentation as indicated in the Commissioning Plan.

END OF SECTION

PESC- Fume Hood Recapitalization

Commissioning Plan

KD ENGINEERING co.

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Table of Contents

1.0 Introduction to Commissioning Plan (CP)

The Commissioning Plan (CP) describes the commissioning process and documentation requirements for this project so that all commissioning team members (especially those being contracted) fully understand the required commissioning process and documentation requirements for this project.

It is noted that this CP has been written by the Commissioning Authority (CA). The CA has an overseeing, multi-disciplinary role (oversees the work of the Mechanical and Electrical Commissioning Agents and/or contractors of specific disciplines.).

The commissioning process described by this commissioning plan was written with reference to the following documentation:

- a brief overview of the commissioning process
- a list of all systems and assemblies included in the Commissioning Authority's scope of work
- identification of Commissioning Team and its responsibilities
- description of the management, communication and reporting of the commissioning process
- overview of the commissioning process activities for this project includes construction, and Occupancy and operations phases, including:
    - review of submittals (construction phase)
    - construction phase verification (construction phase)
    - functional performance test development (construction phase)
    - functional performance test implementation (construction phase), and
- a list of the expected work products
- a list of key commissioning process milestones

Note that this commissioning plan may be revised and re-issued over the course of the project several times so that it is as accurate and as useful as is possible.

The commissioning process responsibilities must be integrated in the construction contract documents and must clearly describe the {following} components:

- commissioning team involvement
- submittal review procedures
- operations and maintenance documentation requirements
- training plan development
- construction verification procedures
- start-up plan development and implementation
- functional performance testing
- milestones
- training
- warranty review site visit"

Because this Commissioning Plan is included in the specifications, the above components have been clearly described to the contractors.

2.0) Brief Overview of the Project and the Commissioning Process

2.1 Project Overview

It is understood that the project is the Environment Canada Pacific Environmental Science Centre (PESC)-Fume Hood Recapitalization which is located at 2645 Dollarton Avenue in North Vancouver, BC. It is a single storey (plus mezzanine mechanical rooms) laboratory building constructed in 1994 with the gross floor area of 4,680 m^2. It is generally separated into five (5) main inter-connected buildings; Blocks A, B, C, D and E. Block A is mostly an administrative building, while Blocks B, C, D and E contain laboratories for scientific research. The table below provides a simplistic outline of mechanical systems in Block B related to this project:

Major Air Handling Equipment	Fume Hoods	Exhaust Fans	Split A/C Units
AHU-5	FH-26E (Rm B117)	PDEF-1	IAC-1 (indoor unit)
	FH-27E (Rm B116)	EF-B1	CU-1 (outdoor unit)
	FH-28E (Rm B116)		
	FH-29E (Rm B115)		
	FH-30E (Rm B115)		
	FH-31E (Rm B114)		
	FH-32E (Rm B113)		

We understand that the scope of work involves the elimination of the individual fume hood exhaust stacks on the roof of Block B and individual fume hood exhaust fans in the mezzanine. They will be replaced with multiple manifolded exhausts connected to “Strobic Air” fan units on the roof. We also understand that there will be an upgrade to the other HVAC systems serving Block B.

We also understand that the services of a qualified Commissioning Authority are required to oversee the commissioning process on the project as per the PWGSC Terms of Reference. KD Engineering intends to follow the process outlined in the Commissioning specification sections noted in Section 01 91 00 - Commissioning.

We also understand that the following organizations who will be involved in the commissioning process:

- Environment Canada-PESC
- Public Works and Government Services
- Lab Consultant –PWGSC SOA Architect
- Kasian Architecture Interior Design and Planning Ltd.
- JM Bean & Co. Ltd / Integral Group
- L.P Gander & Associates Ltd.
- General Contractor -TBD
- Mechanical Contractor -TBD
- Electrical Contractor -TBD
- Mechanical Commissioning Agent –TBD
- Electrical Commissioning Agent - TBD
- Controls Contractor -TBD

2.2 Commissioning Defined (for this project)

The commissioning process is a quality assurance method adopted by an owner to consistently achieve successful construction projects. It is not an additional layer of construction or project management – it is the owner’s means of verifying that the planning, design, construction and operational processes are achieving their goals, and ensures the delivery of a well-performing building (or renovated portion of a building) with high quality and asset value.

The commissioning process involves the owner, users, occupants, operations and maintenance staff, design professionals and contractors.

The commissioning process:

- Begins at project inception
- has ongoing verification of achievement of the owner's project requirements
- requires integration of contractor-completed commissioning process activities into the construction documents
- aids in the coordination of static and dynamic testing that acceptance is based on
- verifies staff training, and
- completes with warranty verifications

The Commissioning Authority serves as an objective advocate for the owner, plans and directs the commissioning process, and presents final recommendations to the owner regarding the performance of commissioned systems and assemblies. The Commissioning Authority introduces standards and strategies early in the planning process and then verifies implementation of the commissioning process activities by clearly specifying the requirements in construction documents.

It is noted that the Commissioning Authority (CA) leads the commissioning team but that the commissioning work is divided among the commissioning team members. It is important that this delineation of work be kept in mind throughout the project.

Please refer to Appendix C (Commissioning Services of this Project) of this plan for the commissioning requirements. Appendix C also describes the expected contributions from the various commissioning team members.

The building industry has come to understand that building commissioning is an essential and cost-effective process which serves to ensure that the building operates as designed and that the building is designed according to the owner's requirements. The successful completion of the commissioning process together with other sustainable building design and construction practices result in more than just ensuring that designed resource savings are actualized. When a building performs properly, as is verified through the commissioning process, there is lasting value to the owners/occupants through the realization of a comfortable and enjoyable space in which to live, work and play.

Also, a project that is properly commissioned, by assuring that the owner's requirements are achieved, ensures long term prestige to all those who were involved with the project.

2.3 The Commissioning Authority

The Commissioning Authority (CA) leads the commissioning team but that the commissioning work is divided among the commissioning team members. In this plan we have made every effort to highlight the distinction between the various roles of the commissioning team members.

The Commissioning Authority (CA) provides the services in support of the commissioning requirements of and for the overall commissioning of the project. The CA is to provide technical comments or advice to the Project team as the design documentation advances and is to assemble a Commissioning Plan (CP) to be followed by the commissioning team such that the project can be properly commissioned. By following the Commissioning Plan (CP), the commissioning team can assure that the "commissioned systems" properly function in accordance with the owner's requirements and the consultant's design intent.

The CA is to report to the Owner or to parties as designated by the Owner during the course of performing the services. Generally, documentation produced by the Commissioning Authority is sent to the entire commissioning team.

It is important to note the clear distinction between the Commissioning Authority and the Commissioning Agents (Mechanical & Electrical). The Commissioning Authority is responsible for overseeing the overall multi-discipline commissioning process while the Commissioning Agents perform and document the testing of the various

mechanical and associated electrical “commissioned systems”.

3.0) Commissioning Scope of Work

This section is intended to describe both the systems to be commissioned as well as the specific tasks to be carried out as per this plan.

3.1) Commissioned Systems

The following is a list of the systems to be commissioned by the Commissioning Team for this project.

Mechanical Systems:
1. New centralized (Strobic) fume hood exhaust system for Block B
2. Verification of approximately 7 fume hood cabinets
3. Re-balancing of VAV and Air Handling units supplying make-up air to reworked fume hood system.
4. Associated electrical systems
5. Building Automation System (Energy Management & Control Systems)

To be clear, the following lists the systems not referenced by as requiring commissioning and therefore are not addressed in the commissioning process (or this plan):

- Telecommunications
- Wireless Communications
- Audio/Visual Systems
- Fire Alarm System
- Fire Sprinkler Systems
- Building Envelope
- Site Services

3.2) Overview of the Commissioning Tasks and Expected Commissioning Work Products

Please refer to Appendix C (Commissioning Services of this Project) of this plan for the commissioning requirements. Appendix C also describes the expected contributions from the various commissioning team members as per as well as the expected commissioning results and documentations.

It is noted that the Commissioning Authority is not responsible for design, construction, construction scheduling, cost estimating, or construction management, but may assist with problem solving or resolving non-conformance issues or deficiencies. A clear distinction is made between the role of the Commissioning Authority and that of the contracted commissioning agents. Appendix C of this Commissioning Plan highlights the distinction between the roles of the commissioning team members with special emphasis on what the Commissioning Authority does and does not do.

4.0) Identification of the Commissioning Team and its Responsibilities

Commissioning is a methodical, team-based process. Each member of the commissioning team must fulfill his or her commissioning functions, as described herein, in order for this process to be successful.

The Commissioning Team is responsible for accomplishing the commissioning process activities and provides leadership for identifying and resolving all commissioning process issues. For this project the commissioning team will be comprised of the parties as shown in Appendix A, at a minimum (team to evolve as the project progresses – also during the construction phase the contracted team members will be added such as the mechanical and electrical contractors and the mechanical and electrical commissioning agents).

5.0) Management, Communication and Reporting of the Commissioning Process

KD Engineering has been tasked with the role of Commissioning Authority for this project and will oversee the commissioning teams for this project. The commissioning team will expand to include tendered commissioning team members such as the mechanical and electrical contractors and the mechanical and electrical commissioning agents.

The post-tender commissioning team is comprised of the Owner Personnel, Design Consultants and Contractors/Suppliers as will be listed in a revised Commissioning Plan Appendix A (to be issued post-tender).

All commissioning-related documentation is to be copied to the Commissioning Authority. All commissioning issues are to be brought to the attention of the Commissioning Authority in a timely manner. All commissioning team members are to assist in the creation of all commissioning and commissioning-related documentation (the creation of these documents is by various members of the commissioning team as specified).

From our experience in performing commissioning consultant services, we would like to highlight the following specific issues of particular importance, which must be kept in mind throughout the project such that the commissioning goals are achieved. These are:

- Good Communication

It is especially important that the Commissioning Authority is kept abreast of all information as it becomes available throughout the design process.

- Design Documentation

Also, it is important that commissioning is treated as an important part of the overall design process and that the various design briefs are created and passed on to the Commissioning Authority.

- Sufficient Time Allowance

To properly perform the various commissioning tasks, sufficient time needs to be allowed for especially during the final phases of construction. Also, time allowances are the most important prior to tender for such tasks as the design review.

- Clarity of Design Ownership

It is important to maintain clear ownership of design with the design consultants (not the commissioning consultant).

- Clarity of Commissioning in the General Contract

It is very important that all contracted parties understand their role in the team process of commissioning. Failure of any team member to fulfill their role can result in a failure of the commissioning process as a whole.

6.0) List of Key Commissioning Process Milestones

Appendix B lists the key commissioning process milestones in a table organized by commissioning/project phase. This table shows the various commissioning steps, its expected completion date and the commissioning team members involve with each step.

7.0) Summary (of this Commissioning Plan)

Together with other referenced documentation, this commissioning plan is intended to describe the commissioning process, procedures and documentation for this project. It is intended that this commissioning plan be modified as is required throughout the project such that it maintains a highly useful function as the prime source for understanding the commissioning process.

8.0) Appendix A - Identification of the Commissioning Team and its Roles and Responsibilities

Commissioning is a methodical, team-based process. Each member of the commissioning team must fulfill the following listed commissioning-related responsibilities in order for the commissioning process to be successful.

Identification of the Commissioning Team:

Commissioning Team Member	Abbr.	Person	Organization/Company
1. Owner Personnel			
1.1 Owner	O	Nik Fehr	Environment Canada
1.2 Owner's Representative	OR	Patrick Truong Tony Esposito Kai Mark	PWGSC Project Manager PWGSC Design Manager PWGSC Mechanical Engineer
1.3 Building Operation & Maintenance	BOM	TBD	PESC
2. Key Commissioning Personnel			
2.1 Commissioning Authority	CA	Ed Joson	KD Engineering Co.
2.2 Commissioning Agent - Mechanical	CAg-M	TBD	TBD
2.2 Commissioning Agent - Electrical	CAg-E	TBD	TBD
3. Design Consultants			
3.1 Design Consultant – Architectural	DC-A	Dragana Perusinovic	Kasian
3.2 Design Consultant – Mechanical	DC-M	TBD	JM Bean & Co Ltd.
3.3 Design Consultant – Electrical	DC-E	TBD	L.P. Gander & Associates Ltd.
4. Contractors/Suppliers			
4.1 Contractor - General	C-G	TBD	TBD
4.2 Subcontractor - Mechanical	C-M	TBD	TBD
4.3 Subcontractor - Electrical	C-E	TBD	TBD
4.4 Subcontractor – Controls	C-C	TBD	TBD
4.5 Subcontractor - Balancing	C-B	TBD	TBD

The roles and responsibilities of the commissioning team members:

0. All Commissioning Team Members

All Commissioning Team Members to perform the following tasks:

- Perform tasks and submit documentation as outlined in this Commissioning Plan.
- Provide any required documentation promptly.
- Attend commissioning meetings (as required).
- Attend commissioning testing/verification sessions (as required).
- Identify and announce any commissioning-related issues discovered by your own forces in a timely manner.
- Be responsible for accomplishing your own commissioning process activities and assist in identifying and resolving all commissioning-related issues.
- Provide accurate information as requested such that a realistic commissioning schedule can be developed.
- Provide schedule-tracking information including reasons for any foreseen delays.
- Direct own forces such the commissioning schedule can be maintained.
- Cooperate with other commissioning team members to further the commissioning process and to complete the project as efficiently as possible.
- Minimize construction delays due to the process of initiating, pricing and approving any changes in the contract (i.e. site instructions, change orders, and addenda).
- Be available during the warranty period to address any commissioning-related issues.

1. Owner Personnel

All Owner Personnel to perform the following tasks:

- (see also “All Commissioning Team Members” section above).
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Advise Commissioning Authority of any changes in building occupancy and/or usage.
- Operate “commissioned systems” after project “hand-over”.
- Assign a staff member to be responsible for detailed EMCS system knowledge and operation.

1.1 Owner’s Representative

Owner’s Representative to perform the following listed tasks in addition to the tasks listed under “Owner Personnel” above:

- (see also “Owner Personnel” section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Assign a staff member to be responsible for overall project knowledge, communications and decision-making.
- Assign a staff member to be responsible for detailed EMCS system knowledge and operation.

- Organize owner's own forces to be demonstrated to and trained.
- Sign-off the "Demonstration to the Owner".
- Operate "commissioned systems" after project "hand-over".

1.2 Building Operation & Maintenance (BOM) Representative

BOM's Representative to perform the following listed tasks in addition to the tasks listed under "Owner Personnel" above:

- (see also "Owner Personnel" section above).
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Assign a staff member to be responsible for overall project knowledge, communications and decision-making.
- Assign a staff member to be responsible for detailed EMCS system knowledge and operation.
- Organize BOM personnel to be demonstrated to and trained.
- Sign-off the "Demonstration to the Owner".
- Operate "commissioned systems" after project "hand-over".

2. Key Commissioning Personnel

All Key Commissioning Personnel to perform the following tasks:

- (see also "All Commissioning Team Members" section above)

2.1 Commissioning Authority

Commissioning Authority to perform the following listed tasks in addition to the tasks listed under "Key Commissioning Personnel" above:

- (see also "Key Commissioning Personnel" section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Oversee the commissioning process.
- Function to coordinate commissioning throughout the construction and warranty periods of the project.
- Accomplish Commissioning tasks (as per the Commissioning Plan).

2.2 Mechanical Commissioning Agent

Mechanical Commissioning Agent to perform the following listed tasks in addition to the tasks listed under "Key Commissioning Personnel" above:

- (see also "Key Commissioning Personnel" section above).
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Should follow Mechanical Specifications with reference to Section 23 08 00 – Commissioning.
- Develop detailed pre-startup, startup, and functional verification forms specifically developed for each of the mechanical "commissioned systems" and equipment installed on the project (to the approval of the Mechanical Consultant and the Commissioning Authority).
- Hold and minute Design Intent Meeting with consultant and appropriate other parties to review "commissioned systems" to be installed such that design intent is understood and

supported in the installed systems and such that the commissioning agent knows what is to be commissioned.

- Ensure entire mechanical commissioning process of the “commissioned systems” is documented with copies sent to the Commissioning Authority.
- Assist the mechanical contractor in mechanical contractor’s overall responsibility of commissioning the mechanical “commissioned systems”.
- Advise mechanical contractor of mechanical “commissioned systems” commissioning issues and their resolution as they occur.
- Derive the mechanical commissioning schedule as part of the overall project construction schedule and monitor for accuracy.
- Hold mechanical commissioning meetings for the “commissioned systems”, and generate and distribute minutes.
- Conduct and document mechanical “commissioned systems” functional verifications to the satisfaction of the Commissioning Authority.
- Ensure that any documentation by others related to the mechanical “commissioned systems” is obtained (copy to the Commissioning Authority).
- Coordinate and attend demonstration of mechanical “commissioned systems” to the CA, the engineer and the owner.
- Issue mechanical commissioning report.
- Provide information for the operation & maintenance manual as required.

2.3 Electrical Commissioning Agent

Electrical Commissioning Agent to perform the following listed tasks in addition to the tasks listed under “Key Commissioning Personnel” above:

- (see also “Key Commissioning Personnel” section above).
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- To follow the testing and commissioning requirements (to be provided by electrical consultant) pertaining to the electrical equipment associated with the upgraded mechanical systems.
- Develop detailed functional verification forms specifically developed for each of the electrical “commissioned systems” and equipment installed on the project (to the approval of the Electrical Consultant and the Commissioning Authority).
- Hold and minute Design Intent Meeting with consultant and appropriate other parties to review “commissioned systems” to be installed such that design intent is understood and supported in the installed systems and such that the commissioning agent knows what is to be commissioned.
- Conduct and document electrical “commissioned systems” functional verifications to the satisfaction of the Commissioning Authority.
- Ensure entire electrical commissioning process of the “commissioned systems” is documented with copies sent to the Commissioning Authority.
- Derive the electrical commissioning schedule as part of the overall project construction schedule and monitor for accuracy.
- Hold electrical commissioning meetings for the “commissioned systems”, as is required, and generate and distribute minutes.
- Conduct and document electrical “commissioned systems” verifications.

- Ensure that any documentation by others related to the electrical “commissioned systems” is obtained (copy to the Commissioning Authority).
- Coordinate and attend demonstration of electrical “commissioned systems” to the CA, the engineer and the owner.
- Issue electrical commissioning report.
- Provide information for the operation & maintenance manual as required.

3.0 Design Consultants

All Design Consultants to perform the following tasks:

- (see also “All Commissioning Team Members” section above)
- Provide design intent and basis of design documentation such as design narratives to the Commissioning Authority.
- Specify the creation of an adequate operating and maintenance manual for the “commissioned systems” (mechanical and electrical).
- Take part in design intent review process with appropriate contractor and commissioning agent.
- Produce and clarify, as is necessary, contract documents (drawings and specifications) as required with regards to Commissioning requirements.
- Conduct periodic inspections of work in progress to ensure that all systems and equipment of “commissioned systems” are installed according to specifications.
- Provide exclusive review of “commissioned systems” from project beginning to startup (static completion review).
- Provide additional review of “commissioned systems” from startup to full functionality.
- Ensure tests associated with static completion have been performed and documented.
- Regardless of the commissioning process, retain ultimate responsibility for evaluation and inspections of the “commissioned systems” as well as the adequacy of these systems to meet the owner’s requirements, the design intent and all applicable codes.
- Provide information for the operation & maintenance manual as required.

3.1 Architect

Architect to perform the following listed tasks in addition to the tasks listed under “Design Consultants” above:

- (see also “Design Consultants” section above).
- Oversee and administer contracts.
- Be aware of the state of the commissioning process and provide direction as is required to ensure process remains active.
- Direct other consultants as is required.
- Include Commissioning Plan in contract documents and include language in the specifications supporting the Commissioning Plan.

3.2 Mechanical Consultant

Mechanical Consultant to perform the following listed tasks in addition to the tasks listed under “Design Consultants” above:

- (see also “Design Consultants” section above).

- Sign-off the "Demonstration to the Consultant".
- Specify commissioning tasks as outlined in the Commissioning Plan to be performed by the mechanical contractor with the assistance of the mechanical commissioning agent.
- Review balancing as is required – especially after balancing report has been issued.

3.3 Electrical Consultant

Electrical Consultant to perform the following listed tasks in addition to the tasks listed under "Design Consultants" above:

- (see also "Design Consultants" section above)
- Sign-off the "Demonstration to the Consultant".
- Specify commissioning tasks as outlined in the Commissioning Plan to be performed by the electrical contractor (aka the electrical commissioning agent).
- Provide design light intensity levels and required reading locations to the electrical contractor so the electrical contractor can take measurements and compare them to design.

4.0 Contractors/Suppliers

All Contractor/Suppliers to perform the following tasks:

- (see also "All Commissioning Team Members" section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Ensure agreed to commissioning schedule is maintained (commissioning schedule forms part of the overall project construction schedule).
- Include cost for commissioning requirements (as per the commissioning plan) in the contract price.
- Perform corrective work for issues identified through the commissioning process as required in a timely manner.
- Sub-contractors and suppliers for the "commissioned systems" to cooperation and participate in the commissioning process as is required.
- Major equipment manufacturers/suppliers to participate in appropriate testing and training activities.
- Installing trade to assist the appropriate commissioning agent (mechanical, electrical) in all verifications and functional performance checks by completing all appropriate checklists and forward these checklists to the appropriate commissioning agent for review. Address any issues that may be indicated on the checklists. Address any concerns the appropriate commissioning agent may have with the checklists.
- Gather and assemble operation and maintenance data on all equipment of the "commissioned systems" and provide to the appropriate commissioning agent (mechanical, electrical). Also provide same to the Commissioning Authority. Include all review stamps and cover letters/sheets with this documentation.
- Provide a minimum of 5 working days notice prior to testing or startup events to the appropriate Commissioning Agent and the Commissioning Authority.
- Participate in and schedule vendors and sub-contractors of the "commissioned systems" within your scope to participate in any training sessions for these systems.
- Provide information for the operation & maintenance manual as required.

4.1 General Contractor

General Contractor to perform the following listed tasks in addition to the tasks listed under "Contractors/Suppliers" above:

- (see also "Contractors/Suppliers" section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Oversee completion of contract.
- Direct all contracted trades.
- Incorporate an agreed-to commissioning schedule (by commissioning agents) into an agreed-to overall project construction schedule and ensure that this overall project schedule is maintained.
- Ensure prerequisite work allowing testing of "commissioned systems" is scheduled and completed such that testing of "commissioned systems" can occur as scheduled.
- Ensure cooperation of all sub-contractors and suppliers with each other and all commissioning team members such that the commissioning process can be efficiently and effectively carried out.

4.2 Mechanical Contractor

Mechanical Contractor to perform the following listed tasks in addition to the tasks listed under "Contractors/Suppliers" above:

- (see also "Contractors/Suppliers" section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Keep mechanical commissioning agent fully informed on all aspects of the project (change orders, supplier delays, scheduling problems, system/equipment operational problems etc.).
- Provide copies of the approved equipment shop drawing to mechanical commissioning agent.
- Provide complete schedule to mechanical commissioning agent for individual equipment installation, hydrostatic pressure test, hydronic flushing & chemical treatment, and start-up.
- Sign-off equipment checklist and check-out verification sheets related to mechanical installation provided by commissioning agent.
- Provide copies of individual equipment start-up reports to the mechanical commissioning agent.
- Perform mechanical equipment startups (with suppliers as required).
- Participate in and schedule vendors and sub-contractors of the "commissioned systems" within your scope to participate in any commissioning meeting, and training sessions for the commissioned systems.
- Operate mechanical equipment during tests and as is necessary (for balancing for example) until hand-over.
- Act on issues identified through the commissioning process which are related to the "commissioned systems" installed by your forces or sub-trades.
- Organize, hold and document the mechanical demonstration to the mechanical consultant to the owner.
- Provide equipment related information to the Commissioning Authority for insertion into the "Systems Manual".

- Participate in the post warranty review “Review Building Operations after Substantial Completion”.
- Provide Operation & Maintenance Manual.

4.3 Electrical Contractor

Electrical Contractor to perform the following listed tasks in addition to the tasks listed under “Contractors/Suppliers” above:

- (see also “Contractors/Suppliers” section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Designate an Electrical Commissioning Agent to coordinate and facilitate the electrical commissioning process as directed by the Commissioning Authority.
- Perform electrical equipment startups related to the “commissioned systems” (with suppliers as required).
- Sign-off equipment checklist and check-out verification sheets related to electrical installation for all mechanical equipment. The equipment checklist and check-out sheets will be compiled in a commissioning binder provided by the mechanical commissioning agent.
- Operate electrical equipment during tests and as is necessary until hand-over.
- Act on issues identified through the commissioning process which are related to the “commissioned systems” installed by your forces or sub-trades.
- Organize, hold and document the electrical demonstration to the mechanical consultant and to the owner.
- Provide final complete electrical commissioning report to the Commissioning Authority.
- Provide equipment related information to the Commissioning Authority for insertion into the “Systems Manual”.
- Participate in the post warranty review “Review Building Operations after Substantial Completion”.
- Provide Operation & Maintenance Manual.

4.4 Controls Contractor

Controls Contractor to perform the following listed tasks in addition to the tasks listed under “Contractors/Suppliers” above:

- (see also “Contractors/Suppliers” section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Coordinate the engineer's approval of a detailed sequence of operation.
- Provide copies of the approved controls shop drawings to the Mechanical Commissioning Agent & Commissioning Authority.
- Perform own controls testing & commissioning.
- Sign-off equipment checklist and check-out verification sheets related to controls installation provided by mechanical commissioning agent.
- Submit completed controls end to end check sheets to commissioning agent prior to functional verification of each mechanical/HVAC controls equipment.

- Provide schedule of individual equipment functional verification to the mechanical commissioning agent.
- Show mechanical commissioning agent control system in sufficient detail (including necessary simulations) to allow mechanical commissioning agent and CA to perform necessary functional verification checks.
- Attend the demonstration to the consultant and the demonstration to the owner.
- Setup and monitor trendlogs in order to prove satisfactory system functionality.
- Provide mechanical commissioning agent sufficient trendlogs (in chart and text format) such that mechanical commissioning agent and CA can verify proper system operation.
- Provide information for the operation & maintenance manual as required.

4.5 Balancing Contractor

Balancing Contractor to perform the following listed tasks in addition to the tasks listed under "Contractors/Suppliers" above:

- (see also "Contractors/Suppliers" section above)
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Report commissioning-related balancing issues as they are encountered to the Mechanical Commissioning Agent and the Commissioning Authority.
- Produce an independent balancing report to the approval of the mechanical engineer.

4.6 Other Contractors & Suppliers

All other contractors and suppliers involved with the "commissioned systems" are to perform the following listed tasks in addition to the tasks listed under "Contractors/Suppliers" above:

- (see also "Contractors/Suppliers" section above).
- Adhere to the Roles & Responsibilities of the commissioning team members listed under the Commissioning Plan (CP) provided by the Commissioning Authority (CA).
- Provide information for the Operation & Maintenance Manual.

9.0) Appendix B - List of Key Commissioning Process Milestones

Commissioning is a methodical, team-based process. Each step of the commissioning process must be completed progressively in order for the commissioning process to be successful. This appendix lists the four basic phases of the project and the commissioning steps within each of those phases.

Commissioning Phase	Date	Parties Involved	Completed
Construction Phase			
Review of Contractor Submittals	TBD	CA, DC's	
Verification Form Creation	TBD	CAg's	
Pre-Startup Verifications	TBD	C's, CAg's	
Startup Verifications	TBD	C's, CAg's	
Testing & Balancing	TBD	C-B	
Functional Verifications	TBD	CAg's, C's	

Develop an O & M Manual	TBD	CAg's, C's	
Submit Mechanical Commissioning Report	TBD	CAg-M	
Submit Electrical Commissioning Report	TBD	CAg-E	
Submit Overall Commissioning Report	TBD	CA	
Occupancy and Operations Phase			
Orientation/Training Plan Creations	TBD	CA, CAg's, C's	
Orientation/Training Conducted-Mechanical & Electrical System	TBD	C's, CAg's	
Near Warranty-End Review	TBD	CA, CAg's, C's	

10.0) Appendix C - Commissioning Services for this Project

This appendix describes the required commissioning tasks and written commissioning results and documentations for this project. This appendix to the commissioning plan highlights the distinction between the roles of the commissioning team members with special emphasis on what the Commissioning Authority does verses what the other Commissioning Team members do.

This appendix also lists the timing, and any required work products of the various commissioning tasks.

The following tables lists the commissioning team member abbreviations and other abbreviations used in this appendix.

Commissioning Team Members

Abbreviation	Description
O	Owner
OR	Owner's Representative
BOM	Building Operation & Maintenance
CA (or CxA)	Commissioning Authority (overseeing, multiple discipline role)
DC-A	Design Consultant – Architectural
DC-E	Design Consultant – Electrical
DC-M	Design Consultant – Mechanical
DC's	All (related) Design Consultants
C-G	Contractor – General
C-E	Subcontractor – Electrical
C-M	Subcontractor – Mechanical
C-C	Subcontractor – Controls
C-B	Subcontractor – Balancing
C's	All (related) Contractors
CAg-M	Commissioning Agent – Mechanical
CAg-E	Commissioning Agent – Electrical
CAg's	All (related) Commissioning Agents

This appendix describes the required commissioning tasks and written commissioning work products for this project. These tasks are organized according to the five (5) requirements of Building Systems Commissioning.

As a quick summary, these requirements are as:

Project Phase	**Commissioning Tasks (Steps 1-6)**
Equipment procurement, Equipment installation	**Step 1 – Review Contractor Submittals Applicable to the Systems Being Commissioned** **Step #1 "The CA for the purposes of this plan should review contractor submittals applicable to the systems being commissioned for compliance with the owner's project requirements and basis of design."**
Functional testing, test and balance, performance testing acceptance	**Step 2 – Verify Installation and Performance of Commissioned Systems** **Step #2 "Verify the installation and performance of the systems to be commissioned." Deficiency list will be provided if necessary.**
Building Management (Operation & Maintenance) Manual	**Step 3 – Develop Building Management (Operation & Maintenance) Manual for Commissioned Systems** **Step #3 "Develop a Building Management Manual that gives future operating staff the information needed to understand and optimally operate the commissioned systems."**
O&M training	**Step 4 – Verify that Requirements for Training are Completed** **Step #4 "Verify that the requirements for training operating personnel and building occupants have been completed."**
Substantial completion	**Step 5 – Complete a Summary Commissioning Report** **Step #5 "Complete a summary commissioning report."**
Warranty period	**Step 6 – Follow-up Visits during the Warranty Period** **Step #6 "Follow-up visits during the warranty period."**

Step 1 – Review Contractor Submittals Applicable to the Systems Being Commissioned

Step #1 "The (CxA (CA for the purposes of this plan)) should review contractor submittals applicable to the systems being commissioned for compliance with the owner's project requirements and basis of design. This review must be concurrent with the architect's or engineer's reviews and submitted to the design team and the owner.

Task No.	Task Description	Task by	Timing	Others involved	Notes
1	Review normal contractor submittals for systems being commissioned for compliance with commissioning needs.	CA	Construction Phase	DC-A, DC-M, DC-E, O, G-C	▪ G-C to forward copy of submittals (a.k.a. shop drawings) to the CA at the same time that the consultant review takes place
2	Verify mechanical operation and maintenance documentation.	CA, DC-M	Construction Phase	C-M	▪ CA reviews O&M documentation prior to review by DC-M. ▪ DC-M to include CA comments in DC-M review. ▪ C-M to revise documentation as is necessary and re-submit.
3	Verify electrical operation and maintenance documentation.	CA, DC-E	Construction Phase	C-E	▪ CA reviews O&M documentation prior to review by DC-E. ▪ DC-E to include CA comments in DC-E review. ▪ C-E to revise documentation as is necessary and re-submit.

Step 2 – Verify Installation and Performance of Commissioned Systems

Step #2 "Verify the installation and performance of the systems to be commissioned.

Task No.	Task Description	Task by	Timing	Others involved	Notes
1	Verify and document proper operation of mechanical systems (installation, start-up and initial checkout, and functional performance).	DC-M, CAg-M	Construction Phase	CA, C-M	▪ DC-M to specify work by CAg-M. ▪ CAg-M to notify CA in advance of work. ▪ CAg-M to perform work. ▪ CAg-M to provide completed checklists to CA. ▪ CA to oversee verification (using sampling). ▪ C-M to install systems and facilitate testing by CAg-M.
2	Verify and document proper operation of electrical systems (installation, start-up and initial checkout, and functional performance).	DC-E, CAg-E	Construction Phase	CA, C-E	▪ DC-E to specify work by CAg-E. ▪ CAg-E to notify CA in advance of work. ▪ CAg-E to perform work. ▪ CAg-E to provide completed checklists to CA. ▪ CA to oversee verification (using sampling). ▪ C-E to install systems and facilitate testing by CAg-E.

Step 2 – Verify Installation and Performance of Commissioned Systems

Step #2 "Verify the installation and performance of the systems to be commissioned.

Task No.	Task Description	Task by	Timing	Others involved	Notes
3	Conduct CA commissioning meetings and record and distribute meeting minutes.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-M, DC-E, O	▪ CA to conduct regular commissioning meeting and distribute meeting minutes.
1	Perform site visits, as necessary, to observe component and system installations.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to conduct site visits to witness system installation.
2	Attend selected jobsite meetings to obtain information on construction progress.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to attend selected job meetings to obtain information on construction progress as required.
3	Direct the commissioning activities.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to witness commissioning activities randomly.
4	Ensure construction checklists are being completed for commissioned equipment.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to review commissioning checklist submitted by all Commissioning Agents.
5	Ensure the commissioning activities are being scheduled into the master schedule.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to review and verify commissioning schedule submitted by all Commissioning Agents.
6	Review and revise, as necessary, the Commissioning Plan (CP), developed earlier, to reflect current project realities.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to review and revise CP as required.
7	Assist in resolving any discrepancies discovered through the commissioning process.	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to assist Commissioning Agents in resolving any discrepancies in the commissioning process..
8	Meet all review, documentation, planning and implementation requirements provide a completed submission	CA	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ CA to review documentations submitted by all commissioning Agents.

Step 3 – Develop Operating & Maintenance (O & M) Manual for Commissioned Systems

Step #3 "Develop operating & maintenance manual as per specification section 01 78 00.

Task No.	Task Description	Task by	Timing	Others involved	Notes
1	Provide the owner with an operating & maintenance (O & M) manual that contains the information as per specification section 01 78 00 –Closeout Submittals.	C-G, C-M, C-E	Construction Phase Occupancy & Operations Phase	CA, CAg-M, CAg-E, C-G, DC-A, DC-M, DC-E, O	▪ Consultants to specify work required to be performed by contractors such that this manual can be created. ▪ Contractors to provide information and documentation as required (refer to Specification section 01 78 00) for inclusion in this manual.

Step 4 – Verify that Requirements for Demonstration/Training Agenda

Step #4 "Verify that the requirements for training operating personnel and building occupants have been completed

Task No.	Task Description	Task by	Timing	Others involved	Notes
1	Provide and execute training plan (schedules, agendas, minutes, sign-off letters etc.) as per specification section 01 79 00-Demonstration and Training.	CAg-M, CAg-E, C-G, C-M, C-E,	Construction Phase	CAg-M, CAg-E, C-G, C-M, C-E, DC-A, DC-M, DC-E, O	▪ DC's to specify work by CAg's and Contractors. ▪ Contractors and CAg's to prepare training plans for commissioned systems (refer to specification section 01 79 00). ▪ CAg's to notify CA in advance of work. ▪ Contractors & CAg's to perform work. ▪ CA to oversee training by reviewing training completion report by contractors.

Step 5 – Complete a Summary Commissioning Report

Step #5 "Complete a summary commissioning report"

Task No.	Task Description	Task by	Timing	Others involved	Notes
1	Complete a mechanical commissioning report.	CAg-M	Construction Phase	CA, C-M, DC-M	▪ CA to review, CAg to revise as required. ▪ Contractors to address any construction-related items such that a final commissioning report can be compiled.

Step 5 – Complete a Summary Commissioning Report

Step #5 "Complete a summary commissioning report"

Task No.	Task Description	Task by	Timing	Others involved	Notes
2	Complete an electrical commissioning report.	CAg-E	Construction Phase	CA, C-E, DC-E	▪ CA to review, CAg to revise as required. ▪ Contractors to address any construction-related items such that a final commissioning report can be compiled.
3	Complete a Commissioning Report.	CA	Construction Phase Occupancy & Operations Phase	DC-A, DC-M, DC-E, O	▪ Design Consultants to review and address any remaining design-related items such that a final commissioning report can be compiled. ▪ Design Consultants to provide information as is required to the Commissioning Authority for this report. ▪ CAg's to provide own commissioning reports for inclusion in Final Commissioning Report.

Step 6 – Complete a Final Commissioning Report at the end of Warranty Period

Step #6 "Complete a final commissioning report at the end of warranty period"

Task No.	Task Description	Task By	Timing	Others involved	Notes
1	Perform near-end warranty review. CA meets with Owner and Commissioning team, prior to the expiration of the warranty, to discuss the operation of the building and assembles a written plan to address any operational deficiencies.	CA	Warranty Phase	DC-A, DC-M, DC-E, O, OR, BOM	▪ Design Consultants to respond to design related issues as identified by the CA in the near-end warranty review. ▪ Contractors to perform near-end warranty review as directed by CA. ▪ CAg's to perform near-end warranty review as directed by CA.

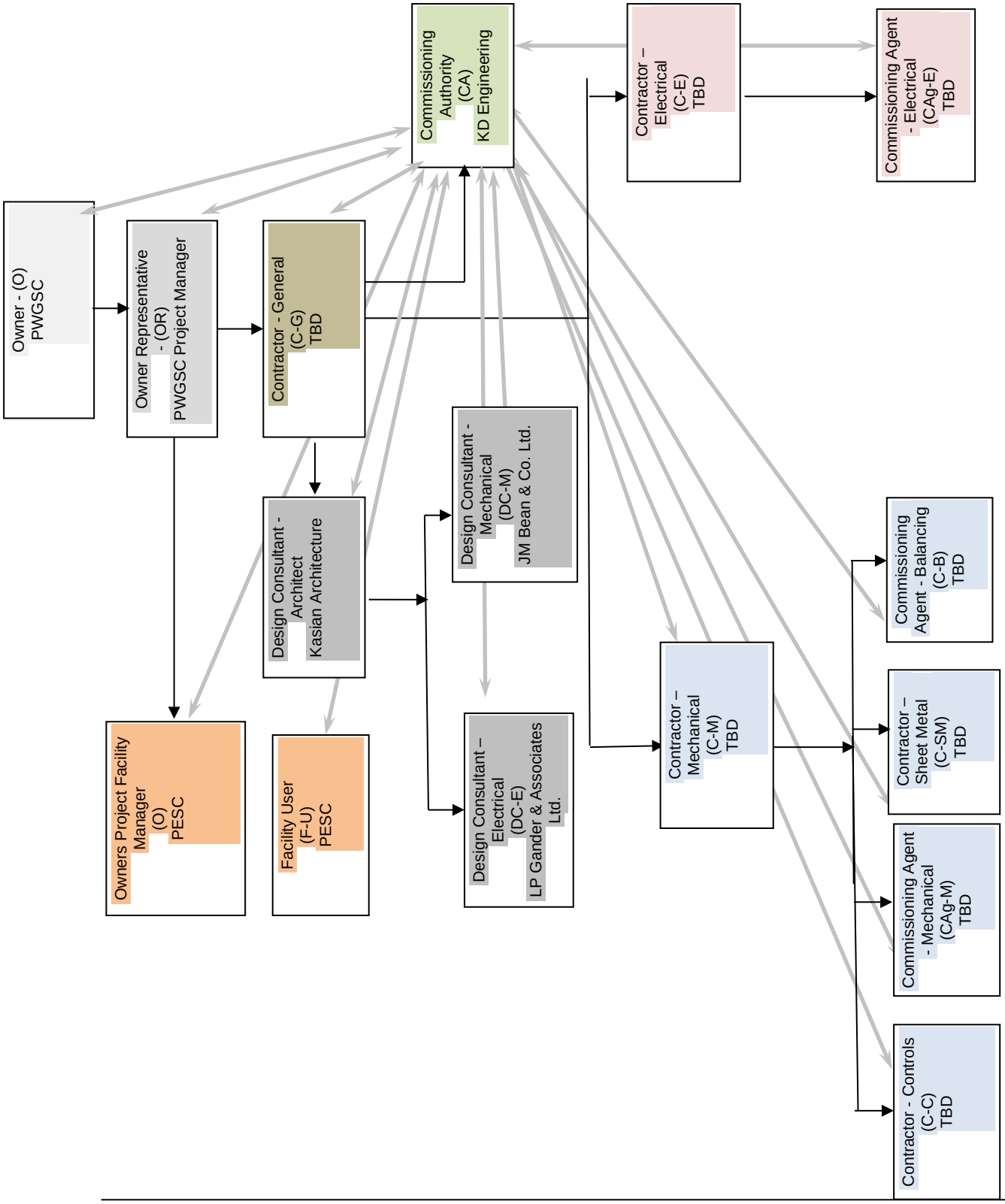
Step 6 – Complete a Final Commissioning Report at the end of Warranty Period

Step #6 "Complete a final commissioning report at the end of warranty period"

Task No.	Task Description	Task By	Timing	Others involved	Notes
2	Update the Final Commissioning Report to include post warranty review information and any updated commissioning test forms.	CA	Warranty Phase	DC-A, DC-M, DC-E, O, OR, BOM	▪ Design Consultants to respond to design related issues as identified by the CA in the near-end warranty review. ▪ Contractors to address any construction-related warranty items such that a final commissioning report can be compiled. ▪ CAg's to update own commissioning reports for inclusion in Final Commissioning Report at the end of Warranty Period.

11.0) Appendix D - Organizational Chart

In the following chart of parties most-related to commissioning, the black arrows generally represent contractual relationships while the grey arrows represent primary working relationship with the Commissioning Authority.



Part 1 GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA S350-(R2003)], Code of Practice for Safety in Demolition of Structures.

1.2 SUBMITTALS

.1 Submit shop drawings in accordance with Sections [01 33 00 - Submittal Procedures.

.2 Before proceeding with demolition of load bearing walls or of other walls and where required by authority having jurisdiction submit for review by Departmental Representative drawings prepared by qualified professional engineer registered or licensed in the Province of British Columbia, showing proposed method.

.3 Prior to beginning of Work on site submit detailed Waste Management Plan in accordance with Sections [01 74 19 - Construction/Demolition Waste Management and Disposal and indicate:

.1 Descriptions of and anticipated quantities in percentages of materials to be salvaged reused, recycled and landfilled.

.2 Schedule of selective demolition.

.3 Number and location of dumpsters.

.4 Anticipated frequency of tippage.

.5 Name and address of [haulers] [waste facilities] [waste receiving organizations].

1.3 WASTE MANAGEMENT AND DISPOSAL

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

1.4 SITE CONDITIONS

.1 Review "Designated Substance Report" and take precautions to protect environment.

.2 Should material resembling spray or trowel-applied asbestos or other designated substance [listed as hazardous be encountered, stop work, take preventative measures, and notify [Departmental Representative immediately.

.1 Do not proceed until written instructions have been received from [Departmental Representative.

.3 Notify [Departmental Representative before disrupting [building access or services.

Part 2 PRODUCTS

2.1 NOT USED

.1 Not used.

Part 3 EXECUTION

3.1 PREPARATION

.1 Inspect [building] with [Departmental Representative and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

.2 Notify and obtain approval of utility companies before starting demolition.

3.2 PROTECTION

.1 Prevent movement, settlement, or damage to adjacent [structures,] [utilities,] [and parts of building] to remain in place. Provide bracing and shoring required.

.2 Keep noise, dust, and inconvenience to occupants to minimum.

.3 Protect building systems, services and equipment.

.4 Provide temporary dust screens, covers, railings, supports and other protection as required.

.5 Do Work in accordance with Section [01 35 29.06 - Health and Safety Requirements.

3.3 SALVAGE

.1 Refer to demolition drawings and specifications for items to be salvaged for reuse.

.2 Remove items to be reused, store as directed by [Departmental Representative, and re-install under appropriate section of specification].

3.4 SITE REMOVALS

.1 Remove items as indicated.

3.5 DEMOLITION

.1 Remove parts of existing [building] to permit new construction. [Sort materials into appropriate piles for [reuse] [and] [recycling.

.2 Trim edges of partially demolished building elements to tolerances as defined by [Departmental Representative to suit future use.

3.6 DISPOSAL

.1 Dispose of removed materials, [to appropriate recycling facilities] [reuse facilities] except where specified otherwise, in accordance with authority having jurisdiction.

END OF SECTION 02 41 99

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 35 29.06 – Health and Safety Requirements

.3 Section 01 74 19 – Construction/Demolition Waste Management Disposal

.4 Section 01 74 11 – Cleaning

1.2 REFERENCES

.1 Reports:

.1 "Project-Specific Hazardous Building Materials Assessment – Site Review Report – Pacific Environmental Science Center, North Vancouver British Columbia", prepared by Stantec Consulting Inc., dated May 16, 2017 (further referred to herein as the Assessment Report) – attached in the Appendix of the Project Specifications.

.2 Definitions:

.1 Dangerous Goods: product, substance, or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.

.2 Hazardous Material: product, substance, or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.

.3 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

.4 Hazardous Building Material: component of a building or structure that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when altered, disturbed or removed during maintenance, renovation or demolition.

.3 Reference Standards:

.1 Canadian Environmental Protection Act,1999 (CEPA 1999)

.1 Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149).

.2 Department of Justice Canada

.1 Transportation of Dangerous Goods Act, 1992 (TDG Act) [1992], (c. 34).

.2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286).

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 National Research Council Canada Institute for Research in Construction (NRC-IRC)

.1 National Fire Code of Canada (2010).

.5 WorkSafe BC

.1 British Columbia's Occupational Health and Safety Regulation (BC Reg. 296/97, including amendments to date of work)

.2 "Safe Work Practices for Handling Asbestos" (2012)

.3 "Lead-Containing Paints and Coatings; Preventing Exposure in the Construction Industry" (2011)

.4 "Safe Work Practices for Handling Lead" (2017)

.6 British Columbia Hazardous Waste Regulation (BC Reg. 63/88)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data for hazardous materials to be used by the Contractor to complete the Work:

.1 Submit manufacturer's instructions, printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements to Departmental Representative for each hazardous material required prior to bringing hazardous material on site.

.3 Submit hazardous materials management plan to Departmental Representative that identifies hazardous materials, usage, location, personal protective equipment requirements, and disposal arrangements.

.4 Construction/Demolition Waste Management:

.1 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating percentage of construction/demolition wastes were recycled or salvaged

.5 Low-Emitting Materials: submit listing of adhesives and sealants used in building, comply with VOC and chemical component limits or restrictions requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle hazardous materials to be used by the Contractor to complete the Work in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver hazardous materials to be used by the Contractor to site in original factory packaging, labelled with manufacturer's name and address.

.3 Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations, and applicable provincial regulations.

.4 Storage and Handling Requirements:

.1 Co-ordinate storage of hazardous materials to be used by the Contractor to complete the Work with Departmental Representative and abide by internal requirements for labelling and storage of materials and wastes.

.2 Store and handle hazardous materials and wastes in accordance with applicable federal and provincial laws, regulations, codes, and guidelines.

.3 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada requirements.

.4 Keep no more than 45 litres of flammable and combustible liquids such as gasoline, kerosene and naphtha for ready use.

.1 Store flammable and combustible liquids in approved safety cans bearing the Underwriters' Laboratory of Canada or Factory Mutual seal of approval.

.2 Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires the written approval of the Departmental Representative.

.5 Transfer of flammable and combustible liquids is prohibited within buildings.

.6 Transfer flammable and combustible liquids away from open flames or heat-producing devices.

.7 Solvents or cleaning agents must be non-flammable or have flash point above 38 degrees C.

.8 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.

.9 Observe smoking regulations, smoking is prohibited in areas where hazardous materials are stored, used, or handled.

.10 Storage requirements for quantities of hazardous materials and wastes in excess of 5 kg for solids, and 5 litres for liquids:

.1 Store hazardous materials and wastes in closed and sealed containers.

.2 Label containers of hazardous materials and wastes in accordance with WHMIS.

.3 Store hazardous materials and wastes in containers compatible with that material or waste.

.4 Segregate incompatible materials and wastes.

.5 Ensure that different hazardous materials or hazardous wastes are stored in separate containers.

.6 Store hazardous materials and wastes in secure storage area with controlled access.

.7 Maintain clear egress from storage area.

.8 Store hazardous materials and wastes in location that will prevent them from spilling into environment.

.9 Have appropriate emergency spill response equipment available near storage area, including personal protective equipment.

.10 Maintain inventory of hazardous materials and wastes, including product name, quantity, and date when storage began.

.11 When hazardous waste is generated on site:

.1 Co-ordinate transportation and disposal with Departmental Representative.

.2 Comply with applicable federal, provincial and municipal laws and regulations for generators of hazardous waste.

.3 Use licensed carrier authorized by provincial authorities to accept subject material.

.4 Before shipping material obtain written notice from intended hazardous waste treatment or disposal facility it will accept material and it is licensed to accept this material.

.5 Label containers with legible, visible safety marks as prescribed by federal and provincial regulations.

.6 Only trained personnel handle, offer for transport, or transport dangerous goods.

.7 Provide photocopy of shipping documents and waste manifests to Departmental Representative.

.8 Track receipt of completed manifest from consignee after shipping dangerous goods. Provide photocopy of completed manifest to Departmental Representative.

.9 Report discharge, emission, or escape of hazardous materials immediately to Departmental Representative and appropriate provincial authority. Take reasonable measures to control release.

.12 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.

.13 Report spills or accidents immediately to Departmental Representative. Submit a written spill report to Departmental Representative within 24 hours of incident.

.5 Include provisions for Work of this Section in Waste Reduction Workplan as outlined in Section 01 74 19 – Construction/Demolition Waste Management and Disposal.

Part 2 PRODUCTS

2.1 MATERIALS

.1 Description:

.1 Bring on site only quantities hazardous material required to perform Work.

.2 Maintain MSDS in proximity to where materials are being used. Communicate this location to personnel who may have contact with hazardous materials.

Part 3 EXECUTION

3.1 HAZARDOUS MATERIALS ABATEMENT

.1 Scope of Abatement Activities.

.1 Abatement shall be conducted to handle, alter, remove and/or dispose of hazardous building materials as identified in the Assessment Report in accordance with applicable regulations, guidelines, standards and/or best practices for such work, where such identified hazardous building materials will be impacted (handled, altered, damaged, removed) by the Work.

.2 Contractor is responsible for reviewing plans, specifications and reports such that they understand the locations and amounts of hazardous materials that will be impacted by the Work of this contract, and such that appropriate plans and budgets can be included in their overall bids.

.3 The listing below is a summary of the identified hazardous building material categories and associated removal and disposal regulations, guidelines and/or standards.

.1 Asbestos-Containing Materials (ACMs)

.1 Removal, alteration and/or disposal of ACMs is not anticipated to be required during the Work.

.2 If encountered during renovation activities, any suspected ACMs not accessible during the preparation of the Assessment Report should be considered as asbestos-containing and handled as such, unless proven otherwise, through analytical testing.

.2 Lead and Lead-Containing Paints (LCPs)

.1 Refer to the Assessment Report for identities and locations of lead-containing materials (including LCPs) that may require disturbance during the Work.

.2 Actions that will disturb lead-containing materials (including paints and materials coated with LCPs) are to be conducted in accordance with the requirements of the current versions of the following WorkSafe BC publications:

.1 "Lead-Containing Paint and Coatings: Preventing Exposure in the Construction Industry"

.2 "Safe Work Practices for Handling Lead"

.3 Actions that will disturb lead-containing materials (including paints and materials coated with LCPs) are to be conducted so as to keep airborne exposure to lead dust to less than the 8-hour Occupational Exposure Limit (OEL) for lead of 0.05 milligram per cubic metre (mg/m^3).

.4 Although LCPs and items coated with LCPs will be disturbed and/or removed for disposal during the Work, unless deemed necessary through risk assessment or cost analysis conducted by the Contractor, comprehensive removal of LCPs from items or surfaces is not expected to be required during the Work.

.1 Refer to the provisions of the 2012 WorkSafe BC publication "Lead-Containing Paint and Coatings: Preventing Exposure in the Construction Industry" and/or the 2017 WorkSafeBC Publication "Safe Work Practices for Handling Lead" for removal of LCPs from surfaces before any welding and torch-cutting, should the Contractor plan to use such methods to complete the Work.

.1 Contractor will be responsible for verification testing of surfaces where LCPs have been removed. Confirmation of acceptable results is to be provided to the Departmental Representative for review before proceeding with any welding or torch-cutting on surfaces where LCPs were present.

.5 Waste transportation to be conducted in accordance with BC Reg. 63/88 and the Federal Transportation of Dangerous Goods Regulation.

.6 Waste disposal to be conducted in accordance with BC Reg. 63/88.

.3 Polychlorinated Biphenyls (PCBs)

.1 Removal, alteration and/or disposal of PCB-containing equipment is not anticipated to be required during the Work.

.4 Mould

.1 Removal, alteration and/or disposal of mould-impacted materials is not anticipated to be required during the Work.

.5 Mercury

.1 Removal, alteration and/or disposal of mercury-containing equipment is not anticipated to be required during the Work.

.6 Ozone-Depleting Substances (ODSs)

.1 Removal, alteration and/or disposal of refrigeration or air conditioning equipment with ODS refrigerants is not anticipated to be required during the Work.

.7 Silica

.1 When silica-containing materials are to be disturbed and/or removed (e.g., coring through concrete slabs, demolition of masonry or concrete units), ensure dust control measures are employed such that airborne silica dust concentrations do not exceed the exposure limit as stipulated by BC Reg. 296/97 (Cristobalite and Quartz – each 0.025 mg/m^3). This would include, but not be limited to, the following:

.1 Providing workers with respiratory protection

.2 Wetting the surface of the materials, use of water or dust suppressing agents to prevent dust emissions

.3 Providing workers with facilities to properly wash prior to exiting the work area.

3.2 CLEANING

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

.1 Dispose of hazardous waste materials in accordance with applicable federal and provincial acts, regulations, and guidelines.

.2 Recycle hazardous wastes for which there is approved, cost effective recycling process available.

.3 Send hazardous wastes to authorized hazardous waste disposal or treatment facilities.

.4 Burning, diluting, or mixing hazardous wastes for purpose of disposal is prohibited.

.5 Disposal of hazardous materials in waterways, storm or sanitary sewers, or in municipal solid waste landfills is prohibited.

.6 Dispose of hazardous wastes in timely fashion in accordance with applicable federal and provincial regulations.

.7 Minimize generation of hazardous waste to maximum extent practicable. Take necessary precautions to avoid mixing clean and contaminated wastes.

.8 Identify and evaluate recycling and reclamation options as alternatives to land disposal, such as:

.1 Hazardous wastes recycled in manner constituting disposal.

.2 Hazardous waste burned for energy recovery.

.3 Lead-acid battery recycling.

.4 Hazardous wastes with economically recoverable precious metals.

END OF SECTION 02 81 01

Part 1 GENERAL

1.1 RELATED SECTIONS

.1 Submittal Procedures — Section 01 33 00

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)

- .1 ASTM A 36/A 36M-12, Specification for Structural Steel.
- .2 ASTM A307-12, Specification for Carbon Steel Bolts and Studs, 60,000psi Tensile.
- .3 ASTM A325-10e1, Specification for Structural Bolts, Steel, Heat Treated,120/105 ksi Minimum Tensile Strength.
- .4 ASTM A 325M-13, Specification for High-Strength Bolts for Structural Steel Joints.

.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-G40.20-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel.
- .2 CAN/CSA-G40.21-04 (R2009), 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 W47.1-03 (R2009), 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 REQUIREMENTS

.1 All structural steel connections shall be designed by the contractor for forces, moments and shears resulting from the specified load and self weight of the supporting elements and all forces as shown on the drawings, unless noted otherwise. All main connection bolts shall be minimum M20. Use minimum two bolts per connection. All welds shall have 6mm leg minimum.

.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 Provide splices as indicated on drawings. Unless noted otherwise, all continuous elements called up on the drawings shall be provided with full strength splice either by full strength groove weld or by full strength splice plates on each end of the connection elements.

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. Shop drawings for anchor bolt layout and embedded plate layout shall also be submitted for review.

.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 No fabrication or work shall be commenced until the review and approval of the shop drawings. The contractor shall assume full responsibility for any fabrication and work done prior to review and approval of the shop drawings.

.4 Contractor shall co-ordinate and verify all dimension and locations prior to production of the drawing.

.5 All fabricator designed assemblies, components and connections, and drawings to be stamped and signed by qualified professional engineer licensed in the British Columbia, Canada.

.6 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 Consultant 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 – Construction/Demolition Waste Management and Disposal.

Part 2 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 A 325

.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/m2.

2.2 FABRICATION

.1 Fabricate structural steel in accordance with CAN/CSA-S16 and in accordance with reviewed shop drawings.

.2 Welding shall be performed by certified welders. Fabrication shops shall be approved by the Canadian welding bureau to CSA-W47.1 (Division 1 or 2). Certification shall be supplied to the Departmental Representative upon request.

.3 Unless noted otherwise, install all rolled steel sections with mill camber upwards.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

.5 All areas of galvanized parts shall be grounded off prior to welding. Part 2 coats minimum of zinc rich primer read mix to CAN/CGSB-1.181 after welding.

2.3 SHOP PAINTING

.1 Clean, prepare surfaces and shop 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.

Part 3 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 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.

.5 Install and torque all bolts and drilled anchors in accordance with manufacturer’s specifications and procedures.

.6 Any misfit or misalignment must be reported to the Departmental Representative. The contractor shall provide proposed remedial measures to the Departmental Representative for review and approval. Any remedial work on connections must be reviewed and/or redesigned by the connection engineer. Costs of remedial work are at the expense of the contractor.

.7 Do not notch or cut openings in any of the framing members and connection without prior approval from the Departmental Representative.

.8 Provide temporary bracing to structure for stability and safety as required until the completion of the steel structure.

3.5 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.

.4 Welding inspector shall be certified to CSA W178.2 Level 2 or Level 3.

.5 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by Departmental Representative.

.6 Submit test reports to Departmental Representative within 1 week of completion of inspection.

.7 Costs of tests shall be borne by the Contractor.

3.6 FIELD PAINTING

.1 Touch up damaged surfaces and surfaces without shop coat with primer to SSPC-SP-6 except as specified otherwise. Apply in accordance with CAN/CGSB 85.10.

END OF SECTION 05 12 23

PART 1 - GENERAL

1.1 REFERENCE STANDARD

.1 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
.1 Architectural Woodwork Standards.

.2 American National Standards Institute (ANSI)
.1 ANSI A208.2, Medium Density Fiberboard (MDF) for Interior Applications.

.3 National Electrical Manufacturers Association (NEMA)
.1 ANSI/NEMA LD-3-05, High-Pressure Decorative Laminates (HPDL).

1.2 QUALITY ASSURANCE

.1 Do cabinet and casework in accordance with Architectural Woodwork Standards (AWS) of the Architectural Woodwork Institute (AWI), Woodwork Institute (WI) and Architectural Woodwork Manufacturers Association of Canada (AWMAC).

1.3 SUBMITTALS

.1 Samples
.1 Submit samples of cabinet hardware and plastic laminate.
.2 Approved samples will become standard for cabinets and casework installed on site and may form part of Work.

.2 Shop Drawings
.1 Submit shop drawings, indicate locations of all service outlets in casework; typical and special installation conditions; all connections, attachments, anchorage and locations of exposed fastenings.

1.4 COOPERATION

.1 Cooperate with other trades and do all cutting, trimming etc in order to accommodate the work of others.

.2 Coordinate and sequence installation with Mechanical and Electrical for plumbing and electrical work.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal packaging material in appropriate on-site bins for recycling.

.3 Dispose of unused finish and adhesive materials at hazardous material collections site.

.4 Do not dispose of unused finish and adhesive materials into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Plywood core: to CSA O153 S2S, Grade Popular Plywood, 19 mm thick.

.2 High Pressure Decorative Laminate (HPDL): to CAN3-A172 or National Electric Manufacturers Association (NEMA)LD 3; of grades, types and thicknesses listed below.

.1 (HGS) Horizontal General Purpose Standard Grade and Chemical Resistant: 1.22 mm in thickness. Flame retardant where required to CAN/ULC S-102 shall have a Flame Spread Classification UL/ULC Class I or A .

.2 (HGP) Horizontal General Purpose Postformable Grade: 1.07 mm in thickness.

.3 (VGS) Vertical General Purpose Standard Grade: be 0.71 mm in thickness.

.4 (CLS) Cabinet Liner Standard Grade: 0.51 mm in thickness.

.5 (BK) Backing Sheet 0.51 mm in thickness. Backing sheets shall be provided for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate

.3 Adhesive for Bonding Plastic Laminate: Waterbase contact cement. Toxicity/IEQ: Comply with applicable regulations regarding toxic and hazardous materials, GS-36 for Commercial Adhesive, South Coast Air Quality Management District Rule 1168.

.4 Joint adhesives: types recommended by solid polymer material manufacturer.

.5 Sealant: CGSB 19-GP-22M silicone.

2.2 CASEWORK

.1 Casework: (HPDL)

.1 AWS quality grade: Custom.

.2 Construction: Flush Overlay in accordance with AWS Section 10, and as detailed.

.3 Core: veneer core plywood, S2S, Grade Popular Plywood, 19 mm thick.

.4 Exposed parts:

.1 Countertops: (HGS) Horizontal General purpose Standard Grade.

.2 Vertical surfaces: Vertical General Purpose Standard (VGS) Grade.

.5 Semi-exposed parts:
.1 Face veneer: Cabinet Liner Standard (CLS) Grade.

.6 Concealed surfaces:
.1 Backing Sheet (BK) Grade.

2.3 CASEWORK DOORS AND DRAWERS

.1 AWS quality grade: Custom.

.2 Construction (HPDL): to match casework with box style drawers with flush overlay applied fronts in accordance with AWS Section 10.

.1 Applied fronts: Vertical General Purpose Standard (VGS) Grade on minimum 19 mm MDF in accordance with AWS Section 4.

.2 Sides, backs, fronts: Cabinet Liner Standard (CLS) Grade HPDL on minimum 12 mm thick veneer core plywood

.3 Bottoms: Cabinet Liner Standard (CLS) Grade HPDL on minimum 6 mm thick veneer core plywood.

2.4 EDGE BANDING

.1 Plastic laminate where indicated.

2.5 EDGE BANDING COUNTERTOPS

.1 Plastic laminate where indicated.

2.6 CASEWORK HARDWARE

.1 Cabinet door hinges:, 170 degree swing opening, all metal, full and half overlay 4 way adjustment, spring loaded for closure, two per door.

.2 Cabinet door, drawer pulls: D pulls, nominal 191 mm,. Richelieu BP8160160195 stainless steel.

.3 Magnetic catches.

.4 Drawer slides: Drawer slides: side-mounted, full-extension, self-closing, epoxy-coated steel drawer slides, load rated 68 kg.

.5 Adjustable shelf hardware: wood shelves, urface mounted standards.

2.7 SEALANTS

.1 Silicone, one part, containing anti-fungicide properties. Colours: to match plastic laminate or clear.

.2 CAN/CGSB 19.17, acrylic emulsion base.

2.8 FABRICATION

.1 Fabricate to AWMAC Custom Grade requirements and arrangements indicated.

.2 Shop install cabinet hardware for doors, shelves and drawers.

.3 Surface mount shelf standards, unless noted otherwise. Notch shelves to fit around surface mounted shelf standards, for seismic restraint of shelving.

.4 Make all cabinet shelving adjustable, unless noted otherwise.

.5 Provide cut-outs for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.6 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

.7 Shop finish casework ready for installation. Limit on site finishing to touch-up and to site fabricated/fitted items where shop finishing impractical.

.8 Install cabinet glazing. Provide glass for shelves and sliding doors.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install casework in accordance with Architectural Woodwork Standards.

.2 Apply small bead of silicone sealant at junction of laminated plastic counter and backsplash and between backsplash and adjacent wall finish.

.3 Apply a small bead of acrylic sealant around the perimeter of the casework and adjacent wall finish.

END OF SECTION 06 40 00

PART 1 - GENERAL

1.1 RELATED WORK

.1	Summary of Work:	Section 01 11 00
.2	General Instructions:	Section 01 11 55
.3	Work Restrictions:	Section 01 14 00
.4	Cutting Patching:	Section 01 73 29
.5	Demolition for Minor Works:	Section 02 41 99
.6	HVAC:	Division 23

1.2 REFERENCE STANDARDS

.1 Guarantee Standards of Roofing Contractors Association of British Columbia (RCABC) RGC Roofing Practices Manual.

.2 CAN/ULC-S107M Standard Method of Fire Test of Roof Coverings.

.3 CGSB 37-GP-56M Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing

.4 WorkSafe BC, Industrial Health and Safety Regulations.

.5 B.C. Waste Management Act and Special Waste Regulation.

1.3 WORK INCLUDED

.1 The work consists of, but is not necessarily limited to:
- .1 Protection of existing building and finishes, roof top equipment.
- .2 Patching, repairing and making good mermbrane and metal roofing, insulation and flashing.
- .3 Co-ordination of the installation of fume hood installations, by others.

.2 From the date that work commences until completion and acceptance of work, assume full responsibility for maintaining the roof watertight. All new roofing is to be sealed and watertight at the end of each workday.

.3 Do not overload any portion of the building, either by the use of equipment, storage of debris or storage of materials.

1.4 QUALITY ASSURANCE

.1 Workmanship Standards: Conform to the latest Guarantee Standards of the Roofing Contractors Association of British Columbia (RGC) as published in the RCABC Roofing Practices Manual.

.2 Contractor must be a member in good standing with the Roofing Contractors Association of British Columbia.

1.5 SUBMITTALS

.1 Submit to the Departmental Representative for verification, prior to installation, full product identification of coated roofing sheets and metal roofing and associated components intended for use in roof installation.

.2 Provide one set of any required Material Safety Data Sheets (MSDS) prior to commencement of work, for review and posting on job site.

1.6 SPECIAL SITE INSTRUCTIONS

.1 Interior protection for work in accordance with applicable Division 01 sections

.2 Minimize disruptions to regular building activities. Arrange special access and times to project site with Departmental Representative.

.3 Coordinate work with Phasing requirements.

.4 All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents shall be protected against all risks.

.5 The Contractor shall follow all safety regulations as required by WorkSafe BC, Occupational Health and Safety Act and any other applicable authority having jurisdiction.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Site storage is limited. Location of storage to be coordinated with Departmental Representative.

.2 All materials shall be delivered and stored in their original packaging bearing the manufacturers label, grade and product weight, including all other related standards, specifications, and the like.

.3 All materials shall be adequately protected from inclement weather conditions and stored in a dry, well ventilated and weather protected location.

.4 Only materials to be installed on the same day shall be removed from the protected location to the work site.

.5 All materials in a rolled configuration shall be stored on end, elevated off the ground on a pallet or skid, to protect the bottom surface from foreign debris and moisture.

.6 When possible, the Contractor shall restrict stock piling of material in one location on the roof surface to prevent exceeding the specified deck live load capacity.

.7 Handle and store products in a manner to prevent damage and deterioration.

.8 Remove and replace damaged products at own expense and to the satisfaction of the .9.

1.8 WARRANTY

.1 Contractor shall supply a one (1) year Warranty for workmanship. In the event any work related to roofing, flashing, or metal roofing is found to be within the Contractor warranty term, defective or otherwise not in accordance with the Contract Documents, the Contractor shall repair that defect at no cost to the Owner. The Applicator's warranty obligation shall run directly to the Owner.

PART 2 - PRODUCTS

2.1 ROOFING MATERIAL REQUIREMENTS

.1 Use materials that conform to RGC Guarantee Standards and to appropriate CSA, CGSB and ASTM standards.

.2 Use materials that match exactly existing materials.

.3 Use only components supplied or accepted by membrane manufacturer.

.4 Use materials that will provide CAN/ULC-S107M Class C roof coverings.

.5 Components to be used that are other than those supplied or manufactured by the membrane manufacturer or the metal roofing manufacturer shall be submitted for review and acceptance by the Departmental Representative.

.6 The specifications, installation instructions, limitations, and/or restrictions of the respective manufacturers shall be reviewed by the Departmental Representative for acceptability for the intended use with the roofing manufacturer's products.

2.2 MATERIALS

.1 All membrane, insulation, membrane flashing, metal roofing, metal flashing and components shall match existing.

.2 Membrane Roofing:
- .1 Styrene butadiene styrene (SBS) bitumen coated polyester fleece reinforced sheets containing minimum 15% SBS additive, both base and cap sheet must be by same manufacturer and shall match existing.
- .2 Membrane sheet thicknesses and insulation to match existing.
- .3 Membrane flashings: composite reinforced SBS membrane with thermofusible plastic film, both sides, min. 3 mm thick.
- .4 Roofing nails: to CSA B111, Table 12, galvanized steel or aluminum, of sufficient length to penetrate wood minimum 20 mm.
- .5 Primer: as recommended by membrane manufacturer for membrane/substrate types and application requirements.
- .6 Adhesive/Mastic: as required and as recommended by membrane manufacturer for membrane/substrate types and application requirements.
- .7 Caulking: non-hardening open and/or closed cell flexible rod to ASTM D1056 and D1565 requirements, outsized minimum of 30% and compatible with membrane/primers and as recommended by air/vapour barrier membrane manufacturer.
- .8 Sealants: non-hardening type compatible with membrane as recommended by the membrane manufacturer.

.3 Metal Roofing:
- .1 Metal roofing profile, gauge and colour shall match existing.
- .2 Proprietary fasteners and metal panel clips must be listed as acceptable by the metal panel machine manufacturer for use with the metal roofing systems, be formed from a minimum 22 gauge (0.030"), grade 33 steel and be corrosion resistant.
- .3 Closures: Weatherproof, laminated, semi-rigid, cross-linked polyethylene foam, tightly fit to panel profile.
- .4 Caulking: Gunnable Grade, Single component Urethane caulk
- .5 Sealant: Butyl tape sealant
- .6 Underlayment: proprietary type underlay, as listed in the RGC Accepted Materials List..
- .7 Slip sheet: reinforced sisal paper or a heavy felt kraft paper.

PART 3 - EXECUTION

3.1 EXAMINATION OF EXISTING CONDITIONS

.1 Inspect existing conditions and substrates upon which work of this section is dependent. Report to the Departmental Representative in writing any defects or discrepancies. Commencement of work implies acceptance of existing conditions and assuming full responsibility for the finished condition of the work.

.2 Defective work resulting from application to unsatisfactory conditions will be considered the responsibility of those performing the work of this section.

.3 Advise the Departmental Representative of adjustments to specified roofing procedures recommended by the manufacturer or due to site conditions. Written approval from Departmental Representative is required to make any adjustments to the specified procedures

3.2 PREPARATION

.1 All work shall be carried out in accordance with drawings, specifications and contract documents

.2 Ensure that substrate is rigid, dry, smooth, compatible; free of fins, sharp edges and is clean of all debris and foreign matter.

.3 Procedures for application of materials should be in accordance with manufacturer's recommendations; otherwise the Departmental Representative should be notified if any conflict with this specification arises.

.4 Protect surrounding surfaces against damage from roofing work.

.5 Inspect wood blocking, cants and the like. Do not install roofing unless such items are adequately installed to withstand stresses imposed by thermal movement of the roof components

.6 Contractor is to take care as not to damage any previously performed work, any closely located buildings and all grounds in the vicinity during roofing operations. Contractor shall protect against dust infiltration and other such occurrences. Garbage chutes are to be located as to minimize their exposure to the building and its occupants. Protect walls by means of tarpaulins where garbage chutes and hoisting equipment is located. Cover dumpsters and bins so that debris does not blow away.

3.3 INSTALLATION

.1 Membrane and metal roofing repairs to be carried out with new materials using the same type of membrane and metal roofing already installed in the existing system. All supplied roof materials to be compatible with the existing roof system components.

.2 Cut out damaged and deteriorated existing sections in logical rectangular segments as required. Dispose of all debris and dirt to an appropriate site.

.3 Strip back existing roofing membrane minimum 1 metre.

.4 Tie new roof assembly to existing using methods compatible with materials encountered, as required to maintain existing warranties where applicable and to ensure watertight junctions.

.5 Metal roofing systems shall be adjusted to final position before being permanently fastened to structural supports. If such supports are improperly aligned, levelled or plumbed, the problem

shall be reported to the Departmental Representative in order that the necessary corrections be made before proceeding with the work.

.6 Openings, and any necessary flashing, shall be provided as called for by the tender documents

.7 When cutting or drilling prefinished material, care shall be exercised to ensure that cuttings do not remain to rust on exposed prefinished surfaces. Where practicable, cutting and drilling shall be conducted so that cuttings do not strike or accumulate on exposed cladding surfaces. Edges cut with an abrasive blade must be hand trimmed.

3.4 PROTECTION OF FINISHED WORK

.1 Limit access across installed roof to:
- .1 roofing trade,
- .2 roof inspection and testing agency,
- .3 Departmental Representative,
- .4 Consultant and
- .5 roofing manufacturer's representative.

.2 Where other traffic cannot be avoided provide traffic paths and immediate work area protection using 1200 x 2400 mm size sheets of 12 mm thick plywood. Arrange to prevent tripping and wind uplift while providing protection to installed roof.

.3 Make good damage caused by insufficient protection. Refer to Section 01 60 00.

END OF SECTION 07 55 10

List of Drawings

M-1	Main Floor Plan, Field Operation Centre, Block B, HVAC Modification
M-2	Mezzanine Plan, Block B, HVAC Modification
M-3	Roof Plan and Details, Block B, HVAC Modifications
M-4	Schematic, Block B, HVAC Modifications

PART 1 GENERAL

1.1 Related Sections

.1 This Section specifies the common work results for the Mechanical Divisions, including:

.1 Division 22 Plumbing

.2 Division 23 Heating Ventilation & Air Conditioning

.3 Division 25 Integrated Automation (EMCS)

.2 Read Division 1 General Requirements in conjunction with the specifications for Mechanical Divisions. Division 1 and this Section shall form a part of and shall apply to all Mechanical Divisions. The most stringent requirements of this and other Mechanical Sections must be adhered to.

.3 The Mechanical work shall consist of the supply and installation of complete and operable mechanical systems and shall include all necessary labour, plant, materials, and incidentals for the work involved as listed in the Mechanical Divisions. All sections in the Mechanical Divisions specifications are related sections and shall be read in conjunction with each other, whether or not “Related Sections” are explicitly mentioned under each section.

.4 Hazardous building materials under Mechanical Divisions that will be disturbed during construction shall be removed and disposed in accordance to Division 2. Hazardous building materials under Mechanical Divisions include but not limited to asbestos containing duct mastic, pipe elbows, plumbing gaskets, filters, air scrubbers etc.

1.2 Submittals

.1 Submittals: in accordance with Section 01 01 50 – General Instructions.

.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 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 01 50 – General Instructions: 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 01 50 – General Instructions.

.2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection. Also see “Mandatory Requirements for O&M Manuals” this in Section.

.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 performance verification test results.

.2 Special performance data as specified.

.3 For each fan and pump installed, provide performance data in "Curve" or multi rating table.

.4 For each plumbing fixture, floor and roof drain installed, provide manufacturer's "cut" of that item and "cuts" of associated brass goods.

.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 Copies of extended guarantees and warranties for equipment items such as hot water tanks and heat exchangers shall be included in a separate section of the manual.

.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. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to site mechanical drawings. Update drawings to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.5 The drawings shall indicate the inverts and dimensioned locations of all services at the property line and where they penetrate the building perimeter.

.9 As-built drawings:

.1 Departmental Representative will provide CAD drawings to Contractor who will be responsible for producing the as-built drawings. Contractor shall update CAD drawings using CAD drafting procedures, to show all changes made.

.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 one (1) hard copy for check prints to Departmental Representative for approval, and make corrections as directed. Upon acceptance by Departmental Representative, Contractor shall make multiple copies of as-built drawings (electronic and hard copies), and submit completed as-built drawings with Operating and Maintenance Manuals in accordance with Division 1.

1.3 Regulations

.1 Comply with most stringent requirements of NBC, Provincial and Municipal regulations and by-laws, specified standards, codes and this specification. Practices contained in these standards or standards suggested or recommended by reference organizations, are to be taken as minimum requirements.

.2 Furnish certificates confirming work installed conforms to requirements of authorities having jurisdiction.

.3 Drawings and specifications should not conflict with these Regulations but where there are apparent discrepancies, notify the Departmental Representative in writing and obtain clarifications before proceeding with the work.

1.4 Quality Assurance

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

1.5 Guarantee Warranty

.1 Correct promptly at own expense, defects or deficiencies in the work in accordance with the Warranty requirements of the Contract.

.2 The Departmental Representative shall be the judge as to whether the failure is due to defective workmanship, improper usage or ordinary wear and tear.

.3 Make good any damage resulting from defective materials or workmanship.

.4 Rectify any deficiencies or omissions in respect to plans or Specifications which may appear during the guarantee period even though work has been accepted as complete.

1.6 Definitions

.1 Definitions used in this Division will have the following meaning:

.1 "Concealed": pipes, ducts, etc., in trenches, chases, furred spaces, pipe shafts, or hung ceilings.

.2 “Exposed": regarding insulation and painting of piping, ducts, etc., will mean that they are not "concealed", as defined herein.

.3 "Piping": includes, in addition to pipe, all fittings, valves, hangers, other accessories which comprise a system.

.4 "Provide": to supply and install, complete and ready for use.

1.7 Drawings

.1 Drawings:

.1 Are not intended to show structural details or architectural features.

.2 Are not to be scaled.

.3 Except where dimensioned, indicate general mechanical layouts only.

.4 The drawings are mainly schematic and do not attempt to show all offsets. Make such offsets at no additional cost to contract. Offset angles shall be as small as possible.

.5 All figured dimensions shall have precedence over scale. Detail drawings shall have precedence over small scale drawings; any difference between same shall be decided upon by the Departmental Representative.

.2 Provide field (shop) drawings to indicate relative position of various services when required by Departmental Representative and obtain approval before commencing work.

.3 Shop drawing review by Departmental Representative is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that Departmental Representative approves the detail design inherent in the shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for quantities and dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub-trades.

1.8 Maintenance

.1 Furnish spare parts in accordance with Section 01 01 50 – General Instructions as indicated in the detailed product specification clauses.

.2 Provide access doors for concealed expansion joints, traps, strainers, cleanouts, balance dampers, fire dampers, other parts requiring accessibility for operating and maintenance.

.3 In suspended panel ceilings, use panel in place of access door; provide in such panel a button or other means of identification and easy removal when necessary.

1.9 Delivery, Storage and Handling

.1 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

1.10 Discrepancies and Omissions

.1 Bidders finding discrepancies in, or omissions from, Drawings, Specifications, or other documents, or having any doubt as to the meaning or intent of any part thereof, shall at once notify the Departmental Representative, who will send explanatory written instructions to all bidders. No verbal information will be considered valid.

.2 Should there be conflict(s) within or between the Specifications and/or Drawings, the most stringent or higher quality requirement shall apply.

1.11 Mandatory Requirements for O&M Manuals

.1 Employ an independent firm with minimum five (5) years experience in preparing professional quality O&M manuals.

.2 Hard Copy Requirements:

.1 Hard copies shall be placed in D-ring binders with clear overlay on front and spine with labels inserted on front cover and spine. Labels shall include the following information: Front cover label shall include the project name, project location, owner, architect, mechanical consultant, general contractor, mechanical contractor, firm preparing the manuals, and the month and year that the manuals were prepared. It shall also bear the label “Operating & Maintenance Manual for Mechanical Systems”.

.2 Spine label shall include the project name, project location, and the year that the manuals were prepared. It shall also bear the label “Operating & Maintenance Manual for Mechanical Systems”.

.3 Indicate Volume X of Y if more than one volume is required.

.4 Insert a Title page and Table of Contents in clear plastic covers.

.5 Title page shall include the project name, project location, as well as the name, address, phone number of the owner, architect, mechanical consultant, general contractor, mechanical contractor, firm preparing the manuals, and the month and year that the manuals were prepared. It shall also bear the label “Operating & Maintenance Manual For Mechanical Systems”.

.6 Index the binder according to the following system:

Tab 1.1 Mechanical Drawing Schedule

Tab 1.2 Description of Systems

- Provide a schematic drawing and component description for each major mechanical system including air handling systems, boiler and hot water heating piping distribution systems and (where applicable) water chillers and chilled water distribution systems. The schematic drawing shall identify each component with a letter designation corresponding to a description briefly explaining the purpose of each component and how it relates to the other components, and be presented in a current version of AutoCAD or similar computer aided drafting program.

- The component description shall be clearly written in a language that may be easily understood by the building operators and maintainers who will be using them.

Tab 1.3 Operating Division

Provide the following:

- Specific operating instructions for each major item of equipment, including air handling systems, pumps, boilers, chillers, etc.

  - Ventilation requirements, Energy considerations, Automatic temperature control settings, Information regarding air filters and pressure drops for clean and dirty conditions.

  - Trouble Shooting Procedure Guide in spreadsheet form with the most likely causes and recommended actions for all foreseeable problems. Trouble Shooting Procedure guides are required for all the major items of equipment including air handling systems, exhaust fans, circulating pumps, mechanical cooling equipment, etc.

  - Mechanical Equipment Starting Procedures.

Tab 1.4 Maintenance and Lubrication Division

Tab 1.5 Equipment Supplier and Contractor Schedule

- Provide a list of Equipment Suppliers and Contractors and include their address, telephone number.

- Provide the Equipment Make/Manufacturer

Tab 2.0 Guarantees, Certificates and Reports

- Including assurance letters, balancing and commissioning reports

Tab 2.1 Valve Tag Schedule

Tab 2.2 Labeling and Identification Schedule

- Piping colour code schedules
- Access panel identification schedules

Tab 2.3 Chemical Cleaning and Treatment

- Chemical cleaning shop drawings, water treatment data

Tab 3.0 Equipment Shop Drawings and Maintenance Data

- Organize this section into numbered tabs.
- Insert final shop drawings that have been reviewed and as-built control schematics.
- For each fan and pump installed, provide performance curves indicating the design point of intersection and the actual operating point.
- For each plumbing fixture, floor and roof drain installed, provide manufacturer's "cut" of that item and "cut" of associated brass goods.
- In addition to the shop drawings provided for the various items of mechanical equipment, this section shall also include the Manufacturers' Literature on:
  - Operating and maintenance instructions
  - Spare parts lists
  - Trouble Shooting information

Tab 4.0 Balance Report

The divider tabs shall be custom laminated mylar plastic and shall be in accordance with the following colour scheme:

- Tabs 1.1 to 1.5 – Orange
- Tabs 2.0 to 2.3 – Green
- Tab 3.0 – Yellow

.7 Furnish sufficient copies of equipment manufacturer's literature, a set of drawings, approved shop drawings, and Mechanical Specification to the company preparing the O&M manuals to meet the above requirements.

.2 Digital Manual Requirements

.1 The digital version of the manuals and the hard cover version shall be prepared by the same company.

.2 In addition to the operating and maintenance manuals provided in hard covered binders, two copies of all information shall be provided in digital format as follows:

.3 The information shall be organized into sections in a user-friendly format to make it easy to search for specific information. An indexing system shall be included that remains on an expandable portion of the screen that allows the end user to scroll through the manual information that appears on the main portion of the screen. The digital version content and organization for each manual shall be arranged in a manner identical to the hard copy version. The specific requirements are listed below:

.1 Utilize Adobe Acrobat PDF format.

.2 If there is more than one volume of manual, indicate “Volume X of Y” for each volume.

.3 Include a copy of the latest Adobe Acrobat Reader.

.4 The final Digital copies are to be copied to CDR with a custom CDR label. The custom CDR label shall include: Project Name, Location of Project, Date of Assembly, name of Mechanical Consultant, and shall be titled “Operating & Maintenance Manual for Mechanical Systems”.

.5 The Digital Manual shall be enhanced with the following features: Bookmarks, Thumbnails, Internet Links, Internal Document Links and Optical Character Recognition (OCR). Refer to Scanning Requirements and Organizational Requirements listed below.

.4 Scanning Requirements:

.1 All pages contained within the hard copy manual are to be scanned and/or digitized to Adobe Acrobat PDF format.

.2 Provide a minimum 300 DPI for all scanned pages.

.3 All scanned shop drawings may be searched for text with minimum 75% Optical Character Recognition (OCR).

.4 All shop drawings are to be scanned to a minimum 8.5”X11” size. If the original page size is 11”X17”, the digital copy shall also be 11”X17”. Page sizes exceeding 11”X17” may be shrunk down to 11”X17”.

.5 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.

.5 Organizational Requirements:

.1 Digital Manual shall be organized in the same manner as the approved Hard Copy Manual. (e.g. Tabs 1.1, 1.2, 1.3, 1.4, 1.5, 2.0, 3.0, 4.0, etc).

.2 Bookmark all major tabs and subsections.

.3 Bookmark each set of shop drawings (Section 3.0).

.4 Link the Table of Contents page to the referenced sections.

.5 Insert an introduction/summary page for Sections 1.2, 1.3, 1.4, and 3.0 indicating major subsections. Link these pages to their referenced sections.

.6 Link the system descriptions to the referenced schematic drawings contained in section 1.2.

.7 Insert Internet Links and Internal Document Links from Section 1.5 to Mechanical Equipment Manufacturers/Suppliers/Contractors official websites.

.8 Mechanical Equipment Shop Drawings located in Section 3.0.

.6 Use the following colour code for links contained in Sections 1.2, 1.3, 1.4, and 1.5.:

.1 Internet Links (light blue with underline).

.2 Internal Document Link (dark blue) (excludes AutoCAD schematic links).

.7 Insert a title page for each major piece of equipment located in Section 3.0. The title page shall include the Shop Drawing name, and a link (dark blue in colour) to Section 1.5.

.8 It is the responsibility of the Mechanical Trade to provide high quality documentation for scanning.

.9 Digital Manual shall be reviewed by the Departmental Representative for content and layout prior to final submission.

1.12 Security Fasteners

.1 Use fasteners compatible with material through which they pass.

1.13 Firestopping

.1 Apply firestop sealant and systems around all penetrations through openings in fire rated wall, floor and ceiling assemblies.

.2 Seal around conduits penetrating fire separations.

.3 References:

.1 ULC-S115-05 – Standard Method of Fire Tests of Firestop Systems.

.4 Product Data

.1 Submit product data and layout plan in accordance with Section 01 01 50.

.2 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.

.3 Submit plan showing location of each penetration and product data to indicate type of firestopping being installed at each location.

PART 2 PRODUCTS

2.1 Access Doors

.1 Access door size shall be as indicated and where not indicated, make 305mm x 406mm [12" x 16"] minimum or 610mm x 457mm [24" x 18"] where persons have to enter. For acoustical ceilings, conform to architectural panel pattern.

.2 Unless otherwise indicated, access doors shall be hinged, flush type, steel framed panel, 14 gauge minimum, satin finished galvanized steel or type 304 stainless steel, with anchor straps for wet areas, washrooms, and all walls finished in ceramic tile.

.3 Hinges shall be concealed, spring hinge to allow door to open 175°. Locking devices shall be flush cam type, screwdriver operated, doors and frames shall have prime coated rust inhibiting paint, unless made of stainless steel.

.4 Where doors are required in fire rated walls, access doors shall be uninsulated and for all fire rated ceilings and walls where maximum temperature rise limitation is applicable, shall be insulated. All fire rated access doors shall have Warnock Hersey or ULC listed 2 hour fire rating and shall be installed in accordance with NFPA 80 and manufacturer’s installation instructions.

2.2 Security Access Doors

.1 Security type access doors shall be fully welded construction. Panels and frames shall be manufactured of 10 gauge steel. In addition to concealed spot welding, individual knuckles on the full length piano hinge shall be welded to the frame and panel. Piano hinge shall have non-removable pin. The return flange on the door panel shall provide rigidity and tamper-resistance edge. Provide deadbolt locks with a Schlage “C” keyway. Electro-statically applied off white finish.

2.3 Firestopping

.1 Fire stopping and smoke seal systems: in accordance with ULC-S115.

.1 Systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended.

.2 Fire stop system rating: to match wall/floor/roof assembly of rating indicated.

.2 Service penetration assemblies: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No. 40 U19.

.3 Prefabricated flange units, with outer metal flange die-stamped from 0.3 mm thick 316 stainless steel, with inset of premoulded silicone elastomeric ring, factory moulded, U.L.C. or W.H. listed as a through penetration fire stop. Flange hinged for fixing over pipe and then secured tight with self-tapping screw.

.4 Fire-resistance rating of installed fire stopping assembly not less than the fire- resistance rating of surrounding wall assembly.

.5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.

.6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: prefabricated silicone elastomeric seal; do not use a cementitious or rigid seal at such locations.

.7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

PART 3 EXECUTION

3.1 Installation

.1 Coordinate work with work of other sections to avoid conflict.

.2 Locate distribution systems, equipment, and materials to provide minimum interferences and maximum usable space.

.3 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials, regardless of installation sequence.

.4 Provide tamperproof screws for new and relocated equipment located in inmate accessible areas.

3.2 Cleaning

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 Cutting and Patching

.1 Make arrangements with General Contractor for all cutting and patching in this work.

.2 Minimize cutting and patching. Set sleeves and mark openings in concrete or masonry.

.3 Conduct ground penetrating radar (GPR) scans prior to coring or cutting existing concrete structure.

3.4 Waterproofing

.1 Where any work pierces waterproofing including waterproofing concrete, the method of installation shall be as approved by the Departmental Representative before the work is done. Supply and install all necessary sleeves, caulking, roof curbs, and flashing required and make the openings watertight.

3.5 Protection of Work

.1 Protect equipment and material during construction from the weather, moisture, dust, painting, plastering and physical damage. Clean and return to "as new" condition.

.2 Mask or grease and cover machined surfaces. Firmly secure covers over equipment openings and open ends of piping, conduit and ductwork as work progresses. Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

.3 Any equipment that has operating parts, bearings or machined surfaces that show signs of rusting, pitting or physical damage will be rejected.

.4 Refinish damaged or marred factory finishes to the satisfaction of the Departmental Representative, using equal quality materials.

3.6 Field Quality Control

.1 Site Tests: conduct following tests in accordance with Section 01 01 50 – General Instructions and submit report as described in PART 1 - SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Where specified, obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.7 Demonstration and Operating Instructions

.1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Provide training to Departmental Representative for the controls and operation of mechanical equipment and systems installed and/or modified as part of this project.

.3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.4 Use operation and maintenance manual and as-built drawings as part of instruction materials.

.5 Instruction duration time requirements as specified in appropriate sections.

.6 During substantial performance review of the work the Mechanical Contractor, together with the Departmental Representative, Controls Contractor, and other Subcontractors designated by the Departmental Representative, shall instruct the Owner's operating personnel in the proper operation and maintenance of all systems and equipment installed under the contract.

.7 It shall be the Mechanical Contractor's responsibility to have the specified equipment manuals prepared, previously approved by the Departmental Representative, and ready for presentation to the Owner at this meeting.

.8 Convene the meeting with the aforementioned parties at the time called for in the substantial performance review. The arrangements shall include written notices to all the parties concerned. Should the equipment manuals, or system installation not be complete and operable at the proper time, he shall then convene the operating instruction

meeting at a later date and pay any additional costs including time and travelling expenses for the personnel involved which are attributable to the delay.

.9 Keeping a sign-in sheet is mandatory for the demonstration and training session. Submit a copy of the sign-in sheet to Departmental Representative for record.

3.8 Access Doors

.1 Furnish access doors for concealed expansion joints, traps, strainers, cleanouts, balance dampers, fire dampers, other parts requiring accessibility for operating and maintenance. Access doors shall be provided to General Contractor for installation and shall be coordinated.

.2 In suspended panel ceilings, use panel in place of access door; provide in such panel a button or other means of identification and easy removal when necessary.

3.9 Firestopping

.1 Preparation:

.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. 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.

.2 Installation:

.1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.

.2 Seal holes or voids made by through penetrations, poke-through termination devices, and openings or joints to ensure continuity and integrity of fire separation are maintained.

.3 Tighten self-tapping screw on flange unit to ensure adequate tight and permanent seal.

.4 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. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

.5 Avoid cutting or penetrating of existing firestop systems already installed by other trades. If unavoidable, especially in renovations, remove existing material and provide new fire stopping system to complete the installation in accordance with this specification.

.3 Inspection:

.1 Notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

.2 Final inspection of through-penetration firestopping shall be performed by the Manufacturer’s Authorized Representative in accordance with ASTM E 2174,

"Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard. At project closeout, provide a letter to certification to the Departmental Representative indicating all fire stopping supplied and installed for the project meets Building Code requirements and has been installed in accordance with the Manufacturer's installation instructions. Include a copy of the letter in the O&M manual.

.4 Schedule:

.1 Fire stop and smoke seal at:

.1 Penetrations through fire-resistance rated walls, floors and ceilings.

.2 Around mechanical and electrical assemblies penetrating fire separations.

.2 Existing floor, wall and ceiling assemblies where there is fire stopping at existing penetration(s) shall be deemed to have fire resistive rating. New penetrations through such assemblies shall be fire stopped. Review existing condition on site and keep records.

END OF SECTION

PART 1 GENERAL

1.1 Use of Systems

.1 Use of existing permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under the following conditions:

.1 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.

.2 There is no possibility of damage from any cause.

.3 Supply ventilation systems are protected by filters, which shall be inspected daily, changed every week or more frequently as required.

.4 Return systems have approved filters over all openings, inlets, outlets.

.5 All systems will be:

.1 operated as per manufacturer's recommendations or instructions.

.2 operated by Contractor.

.3 monitored continuously by Contractor.

.6 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Departmental Representative.

.7 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as- new" condition, filters in air systems replaced.

PART 2 PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 01 50 General Instructions

.2 Section 23 05 00 Common Work Results – Mechanical

.3 Section 23 05 29 Hangers & Support for Piping & Equipment

.4 Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems

.5 This Section applies to all related work under Divisions 22 and 23.

1.2 References

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.

1.3 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 01 50 – General Instructions.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

PART 2 PRODUCTS

2.1 Not Used

.1 Not Used

PART 3 EXECUTION

3.1 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.

3.2 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, or components.

3.3 Pipework Installation

.1 Protect openings against entry of foreign material.

.2 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.5 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.6 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 chain operators on valves NPS 2-1/2 and larger where installed more than 2,400mm above floor in Mechanical Rooms.

.7 Install dielectric coupling between dissimilar metals.

.8 Install in accordance with Section 23 05 29 – Hanger & Support for Piping & Equipment.

3.4 Sleeves

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies (where steel sleeves are part of the listed 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, concrete floors on grade: Terminate flush with finished surface.

.2 Other floors: Terminate 25mm above finished floor.

.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.

3.5 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 304 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe.

3.6 Cleaning of Piping Systems

.1 Before start-up, clean interior of piping systems in accordance with requirements of Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

.2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.7 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.

.3 Maintain specified test pressure without loss for 24 hours minimum unless specified for longer period of time.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.6 Conceal work only after approval and certification of tests by Departmental Representative.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 01 50 — General Instructions

.2 Section 23 05 00 — Common Work Results – Mechanical

.3 This Section applies to all related work under Divisions 22 and 23.

1.2 References

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-2013, Energy Code for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)

.3 Workplace Hazardous Material Information System (WHMIS)

.4 National Energy Code for Buildings (NECB) 2011.

1.3 Section Includes

.1 Electrical work to conform to Division 26 including the following:

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 23. Refer to Division 26 for quality of materials and workmanship.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

1.5 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.6 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 01 50 – General Instructions.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 General

.1 Motors to be premium efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.

2.2 Motors

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 373 W [1/2 HP] : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.

.3 Motors 373 W [1/2 HP] and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 208V, unless otherwise specified or indicated.

2.3 Belt Drives

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

.3 For motors under 7.5 kW [10HP] : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW [10HP] and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave to be determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

2.4 Drive Guards

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:

- .1 Expanded metal screen welded to steel frame.
- .2 Minimum 1.2mm thick sheet metal tops and bottoms.
- .3 38mm dia holes on both shaft centres for insertion of tachometer.
- .4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

- .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
- .2 Securely fasten in place.
- .3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fastened in place.

.4 Removable for servicing.

PART 3 EXECUTION

3.1 Installation

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 91 00	Commissioning
.3	Section 23 05 00	Common Work Results – Mechanical
.4	Section 23 05 13	Common Motor Requirements for HVAC Equipment
.5	Section 23 08 00	Commissioning of Mechanical Systems

1.2 References

.1 ANSI/UL 508 Industrial Control Equipment

.2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)

.3 Workplace Hazardous Material Information System (WHMIS)

1.3 Section Includes

.1 Electrical work to conform to Division 26 including the following:

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 23. Refer to Division 26 for quality of materials and workmanship.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

1.5 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.6 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 01 50 – General Instructions.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.7 Warranty:

.1 The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses

incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

PART 2 PRODUCTS

2.1 General

.1 Furnish complete Variable Frequency Drives (VFD's), as specified herein, for mechanical equipment where noted on drawings, equipment schedules, or specifications.

.2 All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, or other NEMA type according to the installation and operating conditions at the job site. The VFD's UL listing shall allow mounting in plenum or other air handling compartments. If a NEMA 12 enclosure is required for the plenum rating, the manufacturer must supply a NEMA 12 rated VFD.

.3 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor de-rating.

.4 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

.5 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

.6 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. When these VFDs are to be located in Canada, CSA or C-UL certifications shall apply. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.

.7 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.

.8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

.9 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without de-rating.

.10 An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load

and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.

.11 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

.12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.

.13 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs, not including either galvanic or optical isolation on both analog I/O and discrete I/O, shall include additional isolation modules.

.14 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

.15 Interface Features:

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

.2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

.3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

.16 Bypass:

.1 Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

.2 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

.17 Provide VFD with conductive micro-fiber bearing protection ring.

PART 3 EXECUTION

3.1 Installation

.1 Install per manufacturer's instructions.

.2 Install required safety labels.

3.2 Start-up Service

.1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

.2 Commissioning:

.1 In accordance with Section 01 91 00 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems.

END OF SECTION

PART 1 GENERAL

1.1 Section Includes

.1 Materials and installation for thermometers and pressure gauges in piping systems.

.2 This Section applies to all related work under Divisions 22 and 23.

1.2 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 23 05 00	Common Work Results – Mechanical
.4	Section 23 05 53	Mechanical Identification

1.3 References

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.

.2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB).

.1 CAN/CGSB-14.4-[M88], Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-14.5-[M88], Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.4 Submittal

.1 Submittals in accordance with Section 01 01 50 – General Instructions.

.2 Submit shop drawings and product data.

1.5 Health and Safety

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

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

.2 Collect, separate and place in designated containers for packaging in accordance with Waste Management Plan.

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

.4 Place materials defined as hazardous or toxic waste in designated containers.

.5 Ensure emptied containers are sealed, labeled and stored safely for disposal away from children.

PART 2 PRODUCTS

2.1 General

.1 Design point to be at mid point of scale or range.

.2 Ranges: as indicated.

2.2 Thermometers

.1 Industrial, adjustable angle, liquid-in-glass:

.1 Case: aluminum.

.2 Stem: Aluminum, 89mm [3-1/2"} length, adjustable angle.

.3 Window: acrylic or glass.

.4 Accuracy: 1%

.5 Scale length: 180mm [7"] minimum.

.6 Reading: dual Celsius and Fahrenheit.

.7 Socket: comply with industrial standard dimension.

2.3 Thermometer Wells

.1 Copper pipe: copper or bronze, 3/4 NPT.

.2 Steel pipe: brass or stainless steel, 3/4 NPT.

2.4 Pressure Gauges

.1 100 mm [4.0"] dial type: to ASME B40.100, Grade 1A, phosphor bronze bourdon tube having 1.0% accuracy full scale unless otherwise specified.

.1 Casing: Stainless Steel.

.2 Reading: S.I./Imperial.

.3 Range: indicate mid-scale under normal operating conditions.

.2 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketted pressure relief back with solid front.

.5 Bronze stop cock.

PART 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 all piping. Provide heat conductive material inside well.

.2 Install on inlet and outlet of:

.1 Hot water coils.

.2 Chilled water coils.

.3 Install wells as indicated for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

.1 Install in the following locations:

.1 Suction and discharge of pumps, and across pump strainers. Provide a single pressure gauge with point needle valves to isolate each point.

.2 Upstream and downstream of PRV's.

.2 Use extensions where pressure gauges are installed through insulation.

END OF SECTION

PART 1 GENERAL

1.1 Related Section

.1 Section 01 01 50 General Instructions

.2 Section 01 35 33 Health and Safety Requirements

.3 Section 23 05 00 Common Work Results – Mechanical

.4 Section 23 05 48 Vibration & Seismic Control for Ductwork, Piping and Equipment

.5 All work installed under Divisions 22 and 23 shall conform to this Section.

1.2 References

.1 American National Standards Institute / Sheet Metal and Air Conditioning Contractors National Association (ANSI/SMACNA):

.1 ANSI/SMACNA 001-2008, Seismic Restraint Manual, Guidelines for Mechanical Systems, 3rd Edition.

.2 American Society of Mechanical Engineers (ASME):

.1 ASME B31.1-12, Power Piping.

.3 American Society for Testing and Materials (ASTM):

.1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):

.1 MSS SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.5 National Plumbing Code 2010.

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 all 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 to be in accordance with MSS SP58.

.2 Performance Requirements:

.1 Design supports and hangers to withstand seismic events as specified Section 23 05 48 – Vibration & Seismic Control for Ductwork, Piping and Equipment.

1.4 Submittals

.1 Submittals: in accordance with Section 01 01 50 – General Instructions.

.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 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.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.

.4 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.5 Quality Assurance

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 01 50 – General Instructions.

.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 01 50 – General Instructions.

PART 2 PRODUCTS

2.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 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.

2.3 Upper Attachment

.1 Concrete:

.1 Inserts for cast-in-place concrete: galvanized steel wedge. ULC listed for pipe NPS 3/4 through NPS 8 - Grinnell/Anvil Fig. 281.

.2 Carbon steel plate with clevis for surface mount: malleable iron socket with expansion case and bolt. Minimum two expansion cases and bolts for each hanger – Grinnell/Anvil, plate fig. 49, socket fig. 290, expansion case fig. 117.

.2 Steel Beam (bottom flange):

.1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp - Grinnell/Anvil fig. 292.

.3 Steel Beam (top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil Fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.

.4 Steel Joist:

.1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket - Grinnell/Anvil: washer plate, fig. 60; clevis, fig. 66; socket, fig. 290.

.5 Steel Channel or Angle (bottom):

.1 Cold piping NPS 2 and under; malleable iron C clamp - Grinnell/Anvil fig. 86.

.2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp - Grinnell/Anvil fig. 226.

.6 Steel Channel or Angle (top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.

.7 Wood beam or ceiling:

.1 Ceiling plate and flanges: malleable iron – Grinnell/Anvil Fig. 128R.

.2 Eye socket: galvanized steel – Grinnell/Anvil fig. 189 or 190.

2.4 Middle Attachments (Rod)

.1 Carbon steel black (electro-galvanized/cadmium plated for mechanical rooms) continuous threaded rod - Grinnell/Anvil fig. 146.

.2 Ensure that hanger rods are subject to tensile loading only.

2.5 Pipe Attachments

.1 Piping with less than 25 mm [1"] horizontal movement, NPS 2 and under: adjustable swivel ring hanger - Grinnell/Anvil fig. 69.

.2 Piping with less than 25 mm [1"] horizontal movement, NPS 2-1/2 and over: adjustable clevis hanger - Grinnell/Anvil fig. 260.

.3 Suspended hot piping with horizontal movement more than 25 mm [1"], all steam piping: pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181 up to NPS 6 and Grinnell/Anvil fig. 171 NPS 8 and larger.

.4 Bottom-supported hot piping and steam piping: pipe roller stand - Grinnell/Anvil fig. 271.

.5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers - Grinnell/Anvil fig. 171 single pipe roll hanger with Grinnell/Anvil fig. 178.

.6 Use oversize pipe hangers for:

.1 Cold piping, all sizes.

.2 Hot piping, NPS 2-1/2 and over.

.3 Steam piping (supply, condensate return), all sizes.

.7 Perforated band iron, wire or chain hangers will not be approved.

.8 All hangers for copper pipe shall be copper, copper clad, felt lined or use plastic tape wrapped pipe at hanger.

2.6 Riser Clamps

.1 Steel or cast iron pipe: galvanized carbon steel - Grinnell/Anvil fig. 261.

.2 Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121.

2.7 Protection Shields

.1 Cold piping, all sizes: protection shield with calcium silicate pipe insulation under shield with uninterrupted vapour barrier.

.2 Hot piping with less than 25 mm [1"] horizontal movement, NPS 2 and under: insulation over pipe hanger.

.3 Hot piping with less than 25 mm [1"] horizontal movement, NPS 2-1/2 and over: protective shield with calcium silicate insulation under shield.

.4 Hot piping with horizontal movement more than 25 mm [1"], all sizes: protective shield with calcium silicate insulation under shield.

.5 Steam piping (supply and condensate), all sizes: protective shield with calcium silicate insulation under shield.

2.8 Wall Supports

.1 Horizontal pipe adjacent to wall:

.1 Angle iron wall brackets with specified hangers.

.2 Vertical pipe adjacent to wall.

.1 Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263.

.2 Channel type support.

2.9 Floor Support

.1 Horizontal pipe.

.1 Do not support piping from the floor unless specifically indicated.

.2 Vertical pipe.

.1 Mid-point of risers between floor slabs - adjustable fabricated steel supports.

PART 3 EXECUTION

3.1 Installation

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems per Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

.3 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations. Supporting piping from underside of light weight roof deck (without concrete) is not permitted.

.5 Use expansion anchor on existing concrete structure.

3.2 Hanger Spacing

.1 Mechanical piping: in accordance with table below.

.2 Plumbing piping: in accordance with the most stringent requirements of the table below as well as the following:

.1 National. Plumbing Code.

.2 Authority Having Jurisdiction.

.3 Pipe hanger rods shall be sized in accordance to SMACNA Seismic Restraint Manual based on Seismic Hazard Level (SHL). For SHL, see Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

MAXIMUM HANGER SPACING						
PIPE DIA. NPS	STEEL SCH.40	COPPER L,K Hard Drawn	CAST.I STD.	GLASS	ABS/PVC	PEX
1/2	1.8 m [6'-0"]	1.8 m [6'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
3/4 & 1	2.4 m [8'-0"]	2.4 m [8'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
1-1/4	2.4 m [8'-0"]	3.0 m [10'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
1-1/2 & 2	2.4 m [8'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]		1.2 m [4'-0"]	0.8 m [2'-6"]
2-1/2, 3, 4 & 5	2.4 m [8'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]	2.4 m [8'-0"]	1.2 m [4'-0"]	0.8 m [2'-6"]
6 & 8	3.0 m [10'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]	2.4 m [8'-0"]	1.2 m [4'-0"]	0.8 m [2'-6"]

3.3 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.

3.4 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 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.5 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.

3.6 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 01 50 General Instructions

.2 Section 23 05 00 Common Work Results – Mechanical

.3 This Section applies to all related work under Divisions 22 and 23.

1.2 References

.1 National Building Code of Canada (NBC)

.2 American National Standards Institute / Sheet Metal and Air Conditioning Contractors National Association (ANSI/SMACNA):

.1 ANSI/SMACNA 001-2008, Seismic Restraint Manual, Guidelines for Mechanical Systems, 3rd Edition.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

.2 Provide vibration isolation systems shop drawings complete with performance and product data. Shop drawings shall demonstrate compliance with the National Building Code and shall bear the seal of a Professional Engineer.

.3 Provide detailed drawings of all seismic restraint systems for piping and equipment.

1.4 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 01 50 – General Instructions.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 Vibration Isolation System – General

.1 Performance of vibration isolation systems shall be designed by manufacturer specializing in vibration isolation materials and devices.

.2 Size and shape of bases type shall be coordinated with submitted equipment.

.3 Products shall of the same manufacturer unless otherwise noted.

2.2 Elastomeric Pads

.1 Type EP1 - neoprene waffle or ribbed; 9 mm [3/8”] minimum thick; 50 durometer; maximum loading 350 kPa [50 psi].

.2 Type EP2 - rubber waffle or ribbed; 9 mm [3/8”] minimum thick; 30 durometer natural rubber; maximum loading 415 kPa [60 psi].

.3 Type EP3 - neoprene-steel-neoprene; 9 mm [3/8”] minimum thick neoprene bonded to 1.71 mm [16 gauge] steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa [50 psi].

.4 Type EP4 - rubber-steel-rubber; 9 mm [3/8”] minimum thick rubber bonded to 1.71 mm [16 gauge] steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa [60 psi].

2.3 Hangers

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, molded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with molded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.

2.4 Acoustic Barriers for Anchors and Guides

.1 Acoustic barriers: between pipe and support, consisting of 25 mm [1”] minimum thick heavy duty duck and neoprene isolation material.

2.5 Flexible Pipe Connectors

.1 Inner corrugated hose: stainless steel.

.2 Outer braid: Braided wire mesh stainless steel outer jacket.

.3 Type of end connection: threaded for 50mm [2”] or smaller; flange for 65mm [2-1/2”] or larger.

.4 Operating conditions:

.1 Working pressure: 1379 kPa [200 psi].

.2 Working temperature: 4540 °C [850 °F].

2.6 Seismic Control Measures

.1 General:

.1 Design anchorage and attachment methods for all systems and/or equipment as specified herein.

.2 Seismic control systems to work in all directions.

.3 Fasteners and attachment points to resist same maximum load as seismic restraint.

.4 Drilled or power driven anchors and fasteners not permitted.

.5 No equipment, equipment supports or mounts to fail before failure of structure.

.6 Supports of cast iron or threaded pipe not permitted.

.7 Seismic control measures not to interfere with integrity of firestopping.

.8 For equipment mounted on housekeeping pad, specify the minimum distance between anchor bolt and edge of housekeeping pad.

.2 Static equipment:

.1 Anchor equipment to equipment supports. Anchor equipment supports to structure.

.2 Seismic restraints:

.1 Cushioning action to be gentle and steady.

.2 Shall never reach metal-like stiffness.

.3 Vibration isolated equipment:

.1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

.2 Provide seismic restraints in addition to vibration isolation system to resist complete isolator unloading.

.4 Piping systems:

.1 Provide seismic restraints for all piping in accordance to the latest edition of SMACNA Seismic Restraint Manual.

.2 To be compatible with requirements for anchoring and guiding of piping systems.

.3 Wet weight of piping shall be to be used for designing seismic restraint systems.

.4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.

.5 Where cable is used for restraining vibration isolated piping systems, install cable with sufficient slack to avoid short-circuiting of vibration isolators.

.5 Ductwork systems:

.1 Provide seismic restraints for all ductwork in accordance to the latest edition of SMACNA Seismic Restraint Manual as described below:

.1 All rectangular ducts with cross sectional areas 0.56m^2 [6 ft^2] and larger.

.2 All round ducts with diameters 711 mm [28”] and larger.

.2 Seismic restraints may be omitted for the following conditions:

.1 All ductwork suspended by hangers 305mm [12”] or less in length, as measured from the top of the duct to the bottom of the structural support for the hanger.

.6 Bracing methods:

.1 Approved by Departmental Representative.

.2 Structural angles or channels.

.3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

.1 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.

.3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 Field Quality Control

.1 Provide the services of the Professional Engineer(s) who designed the restraint systems for "Field Review" of the installed components, and submit the following to the Departmental Representative:

.1 Schedule B, signed and sealed; provided at the commencement of the project.

.2 Signed and sealed shop drawings of seismic restraints for equipment, piping and ductwork; provided prior to installation.

.3 Typewritten inspection reports; provided during the construction period.

.4 Schedule C-B, signed and sealed; provided after performing "Field Review".

3.4 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 01 01 50 General Instructions

.2 Section 01 35 33 Health and Safety Requirements

.3 Section 23 05 00 Common Work Results – Mechanical

.4 This Section applies to all related work under Divisions 21, 22 and 23.

1.2 References

.1 Canadian Standards Association (CSA International):

.1 CAN/CSA 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, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.3 Quality Assurance

.1 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.2 Health and Safety:

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

1.4 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 01 50 – General Instructions.

.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 01 50 – General Instructions.

.2 Dispose of unused paint and coating material at official hazardous material collections site approved by Departmental Representative.

.3 Do not dispose of unused paint and coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

PART 2 - PRODUCTS

2.1 Manufacturer's Equipment Nameplates

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	11 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 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: Size #9.

.2 Source and Destination identifiers: Size #6.

.3 Terminal cabinets, control panels: Size #5.

.3 Equipment elsewhere: Sizes as appropriate.

2.3 Piping Systems Governed by Codes

.1 Identification:

.1 Natural gas and propane: to CSA/CGA B149.1.

.2 Sprinklers: to NFPA 13.

2.4 Identification of Piping Systems

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive [plastic-coated cloth] [vinyl] with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

Background colour:	**Legend, arrows:**
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background Colour Marking	Legend
Hot water heating supply	Yellow	HEATINGSUPPLY
Hot water heating return	Yellow	HEATINGRETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN

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 Plastic tags with 12 mm stamped identification data.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 Controls Components Identification

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 Language

.1 Identification in English.

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Timing

.1 Provide identification only after painting specified has been completed.

3.3 Installation

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide 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.

3.7 Cleaning

.1 Proceed in accordance with Section 01 74 11 – Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 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. Refer to Section 23 38 16.13 Fume Hoods (Existing Laboratory Fume Hoods) and Section 25 05 01 - EMCS: General Requirements for fume hood performance and controls requirements.

1.2 Qualifications of TAB Company

.1 Testing and balancing shall be performed by an agency that specializes in this type of work. Provide proof that the agency has successfully completed five projects of similar size and scope

.2 All work shall be performed by persons with proven ability and thoroughly versed in the type of testing and balancing. Submit names, complete with experience, record and references for review by the Consultant prior to work being carried out.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.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 installed equipment and systems so as 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 installed 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 be to satisfaction of authority having jurisdiction.

.2 TAB of existing equipment already in operation but not affected by the renovation.

1.5 Coordination

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as 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. 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 all 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:

- .1 Installation of ceilings, doors, windows, other construction affecting TAB.
- .2 Application of weather-stripping, sealing, caulking.
- .3 All pressure, leakage, other tests specified elsewhere Division 23.
- .4 All provisions for TAB installed and operational.

.3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
  - .1 Filters in place, clean.
  - .2 Duct systems clean.
  - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
  - .4 Correct fan rotation.
  - .5 Fire, smoke, volume control dampers installed and open.
  - .6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 Application Tolerances

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 5%, minus 5%.

.2 Hydronic systems: plus or minus 10%.

1.11 Accuracy Tolerances

.1 Measured values to be accurate to within plus or minus 2% of actual values.

1.12 Instruments

.1 Prior to TAB, submit to Departmental Representative list of instruments to be used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 Submittals

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 Preliminary TAB Report

.1 Prior to calling Substantial Completion, submit for checking and approval of Departmental Representative prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB Report

.1 Format to be in accordance with Associated Air Balance Council Manual.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Include final TAB report in O&M manual. Provide one (1) copy of final TAB Report to Departmental Representative.

1.16 Verification

.1 Reported results subject to verification by Departmental Representative.

.2 Provide manpower and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results to be at discretion of Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 Settings

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.18 Completion of TAB

.1 TAB to be considered complete when final TAB Report received and approved by Departmental Representative.

1.19 Air Systems

.1 Standard: TAB to be to most stringent of this section or TAB standards of AABC, NEBB, SMACNA and ASHRAE.

.2 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop, temperatures (dry bulb, wet bulb, dew point, duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.3 Locations of equipment measurements: To include, but not be limited to, following as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.4 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 Water Systems (HVAC):

.1 Water circulating systems shall be balanced by means of balancing fittings and tabulated results shall include the following:

.1 Differential head across all circulating pumps.

.2 Flow and return water temperature to supply and return header for all zones.

.3 Water temperature supplied to and returning from each coil and heating element.

.2 Contractor shall arrange with balancing technician to have water flow through radiation elements checked prior to installation of radiation enclosure.

1.21 Other TAB Requirements

.1 Testing of Fire Dampers & Fire Stop Flaps:

.1 Conduct a "trip" test on all fire dampers and fire stop flaps to ensure that fire mechanisms function correctly and that dampers attain a fully closed position when tripped.

.2 Send a copy of test results tabulating the fire damper location, size, and date of trip test, to the Departmental Representative for record purposes. Copies shall also be inserted in Equipment Maintenance Manuals.

.3 Dampers and Flaps which fail to function correctly shall be re-tested after corrective action has been completed. Any fusible links damaged when conducting tests shall be replaced by the Contractor. A signed and dated test label shall be attached to each fire damper upon completion of test and resetting of fire damper.

PART 2 - PRODUCTS

2.1 Not Used

.1 Not used.

PART 3 - EXECUTION

3.1 General

.1 Test and balance new equipment and systems serving the existing building.

END OF SECTION

PART 1 GENERAL

1.1 Summary

.1 Related Sections:

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 01 91 00	Commissioning
.4	Section 23 05 00	Common Work Results – Mechanical
.5	Section 23 05 93	Testing, Adjusting and Balancing
.6	Section 23 31 14	Metal Ducts

1.2 References

.1 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.

1.3 Submittals

.1 Make submittals in accordance with Section 01 01 50 – General Instructions.

.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

.1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

.2 Prepare report of results and submit to Departmental Representative within 48 hours of completion of tests. Include:

.1 Schematic of entire system.

.2 Schematic of section under test showing test site.

.3 Required and achieved static pressures.

.4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate (L/s) for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturer's field reports specified.

1.4 Quality Assurance

.1 Health and Safety:

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

PART 2 PRODUCTS

2.1 Test Instruments

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3% of flow rate and pressure.

.3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.

.5 Re-calibrated every six months thereafter.

2.2 Equipment Tolerance

.1 Equipment and system components such as VAV boxes, duct heating leakage: 2%.

PART 3 EXECUTION

3.1 Manufacturer’s Instructions

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

3.2 Test Procedures

.1 Maximum lengths of ducts to be tested to be 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 Reference Standard.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 Site Tolerances

.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Prorate 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 VAV and mixing boxes and duct on downstream side of VAV box: leakage 2%.

.3 Large low pressure duct systems up to 500 Pa: leakage 2%.

.4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 Testing

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

3.5 Field Quality Control

.1 Performance Verification:

.1 Departmental Representative to verify reported results.

.2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 Cleaning

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 23 05 00	Common Work Results - Mechanical
.4	Section 23 05 29	Hangers and Supports for Piping and Equipment
.5	Section 23 05 53	Mechanical Identification

1.2 References

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1 ANSI/ASHRAE/IESNA 90.1-2013; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials International, (ASTM)

- .1 ASTM B209M-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C335/C335M-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .9 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 South Coast Air Quality Management District (SCAQMD), California State

- .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.5 Thermal Insulation Association of Canada (TIAC):

.1 Mechanical Insulation Best Practice Guide, 2013.

.6 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-11, Standard for Thermal Insulation Polyotrene, Boards and Pipe Covering.

.7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 Definitions

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED"-will mean "not concealed" as defined herein.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.4 Submittals

.1 Submittals: in accordance with Section 01 01 50 – General Instructions.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 – General Instructions.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

.4 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 Quality Assurance

.1 Qualifications:

.1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

.2 Health and Safety:

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

1.6 Delivery, Storage and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 – General Instructions.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 PRODUCTS

2.1 Fire and Smoke Rating

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 Insulation

Thermally insulate existing and new supply air duct 1m upstream and downstream of replaced VAV boxes [Air Valves].

.1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C 335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612. Provide factory applied vapour retarder jacket to CGSB 51-GP-52Ma as scheduled in PART 3 of this Section.

.4 Evidence shall be provided to the Departmental Representative on the site of ULC listings of all products being used. Duct insulation adhesives and coatings shall be non-toxic as defined by WCB Regulations.

2.3 Jackets

2.4 Accessories

.1 Vapour retarder lap adhesive:

.1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

.5 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.6 Contact adhesive: quick-setting

.1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

.7 Canvas adhesive: washable.

.1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.

.8 Tie wire: 1.5 mm stainless steel.

.9 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.10 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation.

.11 Fasteners: 2 mm diameter pins with 35 mm square clips, length to suit thickness of insulation.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Pre-Installation Requirement

.1 Pressure testing of ductwork systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 Installation

.1 Install in accordance with TIAC National Standards and National Energy Code 2015.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

.3 Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.5 Seal vapor barrier penetrations with vapor barrier adhesive.

.6 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.7 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

.8 All ductwork exposed to weather shall have waterproof seams for weathertight construction. Ductwork exposed to weather which are not insulated or finish painted, shall be coated with two applications of bitumastic waterproofing compound to prevent corrosion. Exposed ducts, which are insulated, shall have aluminum jacket. Manufactured insulation thickness shall not be altered.

3.4 Duct Insulation Schedules

.1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular, cold, dual temperature supply air ducts	C-1	Yes	50
Rectangular, warm air ducts	C-1	No	25
Outside air ducts to mixing plenum	C-1	Yes	25
Exhaust ducts between dampers and louvers	C-1	No	25
Rectangular ducts outside	**C-1**	**Special**	**50**
Round ducts outside	C-2	Special	50

.2 Finish: Conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, exposed elsewhere	CRF/2	CRD/2
Outdoor, exposed to weather	CRF/3	CRD/3

3.5 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 23 05 00	Common Work Results - Mechanical
.4	Section 23 05 05	Installation of Pipe Work.
.5	Section 23 05 29	Hangers and Supports for Piping and Equipment
.6	Section 23 05 53	Mechanical Identification.
.7	Section 23 07 16	HVAC Equipment Insulation.

1.2 References

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1 ANSI/ASHRAE/IESNA 90.1-2013; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials International, (ASTM)

- .1 ASTM B209M-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C335/C335M-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .9 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Thermal Insulation Association of Canada (TIAC):

.1 Mechanical Insulation Best Practice Guide, 2013.

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-11, Standard for Thermal Insulation Polyotrene, Boards and Pipe Covering.

.7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 Definitions

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED"-will mean "not concealed" as defined herein.

.2 TIAC Codes:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 Submittals

.1 Submittals: in accordance with Section 01 01 50 – General Instructions.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 – General Instructions.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

.4 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 Quality Assurance

.1 Qualifications:

.1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

.2 Health and Safety:

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

1.6 Delivery, Storage and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 – General Instructions.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 Fire and Smoke Rating

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 Insulation

.1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: Rigid molded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/CGSB-51.9 / ASTM C547.

.2 Maximum "k" factor: to CAN/CGSB-51.9.

.4 TIAC Code A-2: Rigid molded calcium silicate without factory applied vapour retarder jacket.

.1 Calcium silicate: to CAN/CGSB-51.2 / ASTM C533.

.2 Maximum "k" factor: to CAN/CGSB-51.2.

.5 TIAC Code A-3: Rigid molded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/CGSB-51.9 / ASTM C547.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/CGSB-51.9 / ASTM C547.

.6 TIAC Code C-2: Mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702 / ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702 / ASTM C553.

.6 TIAC Code A-6: Flexible unicellular tubular elastomer.

.1 Insulation: flexible closed-cell elastomer to ASTM C534.

.2 Jacket: to CGSB 51-GP-52Ma. Required for outdoor application.

.3 Maximum "k" factor: 0.27.

.4 Vapour transmission: 0.08 perm-inch.

.5 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants.

.7 To be formaldehyde free, low VOC; resists mold and mildew.

.8 Evidence shall be provided to the Departmental Representative on the site of ULC listings of all products being used. Duct insulation adhesives and coatings shall be non-toxic as defined by WCB Regulations.

2.3 Insulation Securement

.1 Tape: Self-adhesive, aluminum, reinforced, 50mm wide minimum.

.2 Contact adhesive: Quick setting.

.1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

.3 Canvas adhesive: Washable.

.1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.

.4 Tie wire: 1.5mm diameter stainless steel.

.5 Bands: Stainless steel, 19mm wide, 0.5mm thick.

2.4 Cement

.1 Thermal insulating and finishing cement:

.1 To CAN/CGSB-51.12.

.2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449.

2.5 Vapour Retarder Lap Adhesive

.1 Water based, fire retardant type, compatible with insulation.

2.6 Indoor Vapour Retarder Finish

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Outdoor Vapour Retarder Finish

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m.

2.8 Jackets

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CGSB 51-GP-53M with pre-formed shapes as required.

.2 Colours: White.

.3 Minimum service temperatures: 20°C [68°F].

.4 Maximum service temperature: 65°C [150°F].

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.2 Canvas:

.1 220 and 120 gm/m cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

.1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.

.3 Aluminum:

.1 To ASTM B 209 with and without moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

PART 3 - EXECUTION

3.1 Pre-Installation Requirement

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces to be clean, dry, free from foreign material.

3.2 Installation

.1 Install in accordance with TIAC National Standards and national Energy Code 2015 .

.2 Apply materials in accordance with manufacturer's instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.5 Supports, hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized pipe supports, saddles and shoes. See Section 23 05 29 – Hangers and Supports for Piping and Equipment.

.6 Seal vapor barrier penetrations with vapor barrier adhesive.

.7 The thickness of the insulation shall be the thick of the insulation after installation.

3.3 Removable, Pre-fabricated, Insulation and Enclosures

.1 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: high temperature fabric for indoor applications and aluminum for outdoor applications.

3.4 Installation of Elastomeric Insulation

.1 Insulation to remain dry at all times. Overlaps to manufacturer's instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.5 Piping Insulation Schedules

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: SS Bands at 300mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-2.

.1 Securements: SS Bands at 300mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.4 Direct contact with pipe and hanger is not acceptable. Install hanger outside of sheet metal protection shield covering an insert section of high density calcium silicate insulation.

.4 TIAC Code: A-3.

.1 Securements: SS Bands at 300mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.5 TIAC Code: A-6.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-CA; per manufacturer's recommendation.

.6 TIAC Code: C-2 with vapour retarder jacket.

.1 Insulation securements: SS Bands at 300mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.7 Thickness of insulation to be as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000mm long.

.2 Do not insulate exposed run-outs to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC Code	Run out	To NPS1	1 ¼-2	2 ½-4	5-6	8 & over
Hot Water Heating	60-94	A-1	25	38	38	38	38	38
Chilled Water	5-15	A-1	25	38	38	38	38	38

.8 Finishes:

.1 Exposed indoors: PVC jacket.

.2 Exposed in mechanical rooms: PVC jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: Water-proof Aluminium, or SS jacket.

.6 Finish attachments: SS screws or bands, at 150 mm oc. Seals: wing or closed.

.7 Installation: To appropriate TIAC code CPF/1 through CPF/5.

3.6 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1	Section 01 91 00	Commissioning
.2	Section 23 05 93	Testing, Adjusting and Balancing
.3	Section 23 38 16.13	Fume Hoods (Existing Laboratory Fume Hoods)

1.2 Quality Assurance

.1 The commissioning of mechanical systems shall be executed in accordance with the intent of:

.1 ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for the Commissioning Process.

.2 ANSI/ASHRAE/IES Standard 202-2013, Commissioning Process for Buildings and Systems.

1.3 General

.1 Commissioning of the mechanical systems, including the HVAC, and Plumbing and Drainage Systems, shall be carried out by an independent Commissioning Agent acceptable to the Departmental Representative with technicians specifically trained in commissioning procedures.

.2 The Mechanical Subcontractor shall retain a Commissioning Agent, who shall be active in the commissioning process and actively encourage his own forces and sub-trades to work together to achieve optimum system performance for the mechanical systems in a timely manner. Refer to Section 01 91 00 – Commissioning for additional requirements.

.3 It is not intended that this work shall, in any way, replace normal factory startup service for equipment or relieve the Contractor or his sub-trades of their responsibility for providing first-class installation in satisfactory working order.

.4 As part of the final commissioning report, submit a Certificate stating that the commissioning procedures have been completed, that complete factual reports have been distributed and that directions have been given to the Contractor to correct faults and omissions and finally, that follow-up testing, after the correction of faults and omissions has been completed and recorded.

.5 Be responsible for the performance and commissioning of all equipment supplied under the Sections of Division 21, 22, 23. Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.

.6 In consultation with the General Contractor, ensure that sufficient time is allowed and fully identified on the construction schedule for the proper commissioning of all mechanical systems.

1.4 Commissioning and Demonstration

.1 Submit a schedule for the commissioning phase of the work. This schedule shall show:

.1 Equipment start-up schedule.

.2 Submission dates for the various documents required prior to substantial completion.

.3 Timing of the commissioning, testing, balancing, and demonstration process.

.2 Commissioning is concluded when the air and water system is balanced and the installation is in full working order and acceptable for use. The work shall include the following:

.1 Balancing of the air systems as specified in this section.

.3 Plug all air pressure and flow measuring holes.

.4 Adjust vibration isolators and earthquake restraints for optimum performance.

.5 Verification and certification of the sealing of all HVAC penetrations through fire separations (rated & non-rated) and sound separations. Forms in Section 23 08 02 shall be used for this purpose.

.6 Verification of water tightness of all roof and exterior wall penetrations.

.7 Verification that coil drain pan operates.

.8 Set up all automatic control valves/dampers and automatic temperature control devices.

.9 Set up and test all alarm and protective devices.

.10 EMCS:

.1 Commissioning of EMCS is primarily responsible by Controls Contractor. Refer to Section 25 05 01 EMCS General Requirements.

.2 The Commissioning Agent shall assign one person experienced and qualified in commissioning control systems through practical experience and a comprehensive knowledge of the interactive nature of HVAC systems and DDC controls **to verify** the performance of the control systems by conducting random tests of the control sequences until the Commissioning Agent is satisfied that the controls are performing according to the intended control sequences.

.3 The Controls Contractor shall loan a current copy of all control software/devices needed for full access to the control system, at no charge to the Commissioning Agent. The software/devices shall be returned to the Controls Contractor in good working order at the completion of the commissioning process, or the Commissioning Agent must reimburse the Controls Contractor for the purchase price of the material.

.3 At the conclusion of commissioning, demonstrate the operation of the systems to the Departmental Representative. For demonstration and instruction to Operating staff requirements, refer to this section of the specification and also to section 25 05 01 EMCS: General Requirements.

.4 The verification process shall include the demonstration of the following:

.1 The ease of access that has been provided throughout for servicing coils, motors, drives, control dampers and damper operators.

.2 Location of and opening and closing of all access panels.

.3 Operation of all automatic control dampers and automatic temperature control devices.

.4 Operation of all alarm and protective devices.

.5 Operation of all equipment and systems under each mode of operation, and failure.

.5 At the completion of commissioning, testing, balancing and demonstration submit the following to the Departmental Representative:

.1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.

.2 Completed copies of all commissioning check lists plus copies of start-up reports from specialty contractors and vendors.

.3 “As-Built” record drawings, as specified.

.4 A list of all alarm and protective devices tested, with the final operating settings.

.6 Training

.1 During "Substantial Performance" review, the Mechanical Contractor, Control Subcontractor, and other Subcontractors designated by the Departmental Representative shall provide training to the operating personnel in the proper operation and maintenance of all systems and equipment installed under the contract.

.2 It shall be the Mechanical Contractor's responsibility to have the specified equipment manuals prepared, previously approved by the Departmental Representative, and ready for presentation to the Departmental Representative at this meeting.

.3 Convene the meeting with the aforementioned parties at the time called for in the substantial performance review. The arrangements shall include written notices to all the parties concerned. Should the equipment manuals, or system installation not be complete and operable at the proper time, he shall then convene the operating instruction meeting at a later date and pay any additional costs including time and travelling expenses for the personnel involved which are attributable to the delay.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section contains sample Prefunctional Checklists. Most checklists contain items for several contractors. Contractor is to assign responsibility for each line item using the responsibility column.

B. Those executing the checklists shall perform only items that apply to the specific application at hand. These checklists do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Coordinate with Section 01810 Fundamental Commissioning Requirements to utilize these checklists.

C. Items that do not apply should be noted along with the reasons on the form. Contractor shall ensure that checklist items by their subcontractors are completed and checked off. "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item.

1.2 PREFUNCTIONAL CHECKLISTS

A. Sample Prefunctional Checklists Included in this section are:

1. Packaged HVAC Units
2. Exhaust Fans
3. Pumps
4. Building Automation System (DDC)
5. Test & Air Balance
6. Piping (Hydronic)
7. Ductwork

B. Contractor shall develop prefunctional checklists with the start-up plans. Electronic copies of these checklists are available upon request.

C. Sample forms of similar rigor will be provided to the Contractor by the CA upon request for other equipment (e.g. VAV terminal units).

PART TWO - PRODUCTS

NOT USED

Sample Prefunctional Checklist

Packaged HVAC Units, Unit ID #'s: _____

Components Include: ____Supply Fans, ____Return/exhaust Fans, ____coils, ____ valves, ____ VFDs, ____ dampers, ____compressors, ___ condensers

Associated Checklists: Piping (Hydronic)

1. Submittals / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. ___ List attached.

_____	_____	_____	_____
Mechanical Contractor	Date	Controls Contractor	Date
_____	_____	_____	_____
Electrical Contractor	Date	Sheet Metal Contractor	Date
_____	_____	_____	_____
TAB Contractor	Date	General Contractor	Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- The Contractors who are assigned responsibility for sections of the checklist shall also be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

2. Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
Cabinet and General Installation					
Permanent labels affixed, including for fans					
Casing condition good: no dents, leaks, door gaskets installed					
Access doors close tightly - no leaks					
Boot between duct and unit tight and in good condition					
Vibration isolation equipment installed & released from shipping locks					
Maintenance access acceptable for unit and components					
Sound attenuation installed					
Thermal insulation properly installed and according to specification					
Instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)					
Clean up of equipment completed per contract documents					
Filters installed and replacement type and efficiency permanently affixed to housing					
Piping and Coils					
No leaking apparent around refrigerant fittings					
All coils are clean and fins are in good condition					
All condensate drain pans clean and slope to drain per spec					
OSAT, MAT, SAT, RAT sensors properly located and secure (related OSAT sensor shielded)					
Sensors calibrated (See calibration section below)					
If split system, refrigerant piping in good condition and suction insulated					
P/T plugs and isolation valves installed per drawings					
Fans and Dampers					
Supply fan and motor alignment appear correct					
Supply fan belt tension & condition good					

Check Equip Tag →					Contr.
Supply fan protective shrouds for belts in place and secure					
Supply fan area clean					
Supply fan and motor properly lubricated					
Return/exhaust fan and motor aligned					
Return/exhaust fan belt tension & condition good					
Return/exhaust fan protective shrouds for belts in place and secure					
Return/exhaust fan area clean					
Return/exhaust fan and motor lube lines installed and lubed					
Filters installed and replacement type and efficiency permanently affixed to housing--construction filters removed					
Filter pressure differential measuring device installed and functional (magnahelic, inclined manometer, etc.)					
All dampers close tightly					
All damper linkages have minimum play					
Motors: premium efficiency verified, if specified?					
Compressor and Condenser					
Refrigerant sight glass clear of bubbles (if OSAT > 70F)					
Moisture indicator shows no moisture					
Correct oil level (check site glass during operation)					
Compressors and piping were leak tested, as required					
Crankcase heater on when unit is off					
Condenser coils clean and in good condition (air cooled)					
Adequate clearance for airflow around condenser					
Ducts (preliminary check)					
Sound attenuators installed					
Duct joint sealant properly installed					
No apparent severe duct restrictions					
Turning vanes in square elbows as per drawings					

Check Equip Tag →					Contr.
OSA intakes located away from pollutant sources & exhaust outlets					
Pressure leakage tests completed					
Branch duct control dampers operable					
Balancing dampers installed as per drawings and TAB's site visit					
Electrical and Controls					
Power disconnects in place and labeled					
All electric connections tight					
Proper grounding installed for components and unit					
Safeties in place and operable					
Current overload heaters installed and correct size					
Auxiliary heaters installed					
Sensors calibrated (see section below)					
All building control system interlocks hooked up with packaged controls and functional					
Enthalpy control and sensor properly installed (if applicable)					
Related thermostats are installed					
Related building automation system points are installed					
All control devices and wiring complete					
TAB					
Installation of system and balancing devices will allow balancing to be done per specified NEBB or AABC procedures & contract docs					
Final					
Safeties installed and safe operating ranges are established					
Functional test procedures for this equipment reviewed and approved by installing contractor					
If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces.					

Checklist items of Part 2 are all successfully completed for given trade… ____Yes ____No

3. Operational Checks (These augment manufacturer's list. This is not a functional performance test)

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
Supply fan rotation correct					
Return / exhaust fan rotation correct					
No unusual noise or vibration in supply and exhaust fans					
Fans > 5 hp Phase Checks: (% imbalance = 100 x (avg. - lowest) / avg.) List fan & record all 3 voltages in cell. Imbalance less than 2%?					
Record full load running amps for each fan. _____rated FL amps x _____srvc factor = _____ (Max amps). Running less than max?					
Inlet vanes aligned in housing, actuator spanned, modulate smoothly and proportional to input signal and EMS readout.					
All dampers (OSA, RA, EA, etc.) stroke fully without binding and spans calibrated and BAS reading site verified (follow procedure in Calibration and Leak-by Test Procedures). List dampers checked: _____ _____					
Valves stroke fully and easily and spanning is calibrated (follow procedure in Calibration and Leak-by Test Procedures). List each actuated valve here when spanned: _____ _____					
Valves verified to not be leaking through coils when closed at normal operating pressure (follow procedure in Calibration and Leak-by Test Procedures).					
The HOA switch properly activates and deactivates the unit					
Safeties installed and safe operating ranges for this equipment provided to the commissioning agent					
Specified sequences of operation and operating schedules have been implemented with all variations documented					

Check Equip Tag →					Contr.
Specified point-to-point checks have been completed and documentation record submitted for this system					

Checklist items of Part 3 are all successfully completed for given trade… ___Yes___No

4. Sensor and Actuator Calibration [Contr. = _____]

All field-installed temperature, relative humidity, CO, CO_2 and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated using the methods and tolerances given in the Calibration and Leak-by Test Procedures document. All test instruments shall have had a certified calibration within the last 12 months: Y/N_____. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

Sensor or Actuator & Location	Loc-ation OK	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?

Sensor & Location	Loc-ation OK	1st Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N?

Gage reading = reading of the permanent gage on the equipment. BAS = building automation system. Instr. = testing instrument. Visual = actual observation. The Contractor's own sensor check-out sheets may be used in lieu of the above, if the same recording fields are included and the referenced procedures are followed.

All sensors are calibrated within required tolerances … ____Yes ____No

-- END OF CHECKLIST --

Sample Prefunctional Checklist

Exhaust Fans, Unit ID #'s: _____

1. Submittals / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.___ List attached.

_____	_____	_____	_____
Mechanical Contractor	Date	Controls Contractor	Date
_____	_____	_____	_____
Electrical Contractor	Date	Sheet Metal Contractor	Date
_____	_____	_____	_____
TAB Contractor	Date	General Contractor	Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- The Contractors who are assigned responsibility for sections of the checklist shall also be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

2. Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
Cabinet and General Installation					
Permanent labels affixed					
Casing condition good: no dents or leaks					
Mountings checked and shipping bolts removed					
Vibration isolators installed					
Equipment guards installed					
Pulleys aligned					
Belt tension correct					
Plenums clear of debris					
Fans rotate freely					
Fire and balance dampers installed					
Back draft dampers installed per drawings and operate freely					
Duct system complete					
Electrical					
Electrical connections complete					
Disconnect switch installed					
Overload heaters in place					
Control connections complete					

Checklist items of Part 2 are all successfully completed for given trade… ____Yes ____No

3. Operational Checks (These augment mfr's list. This is not a functional performance test)

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
Fan rotation correct					

Check Equip Tag →					Contr.
Electrical interlocks verified					
Any fan status indicators functioning					
No unusual vibration or and noise					
Record full load running amps for each fan. _____rated FL amps x _____srvc factor = _____ (Max amps). Running less than max?					
Check voltage: Rate = _____ Actual = _____ Within 5%?					
The disconnect switch properly operates					
After 24 hours of operation, recheck belt tension and alignment					

Checklist items of Part 3 are all successfully completed for given trade… ___Yes____No

-- END OF CHECKLIST --

Sample Prefunctional Checklist

Pumps, Unit ID #'s: _____

4. Submittals / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.___ List attached.

_____	_____	_____	_____
Mechanical Contractor	Date	Controls Contractor	Date
_____	_____	_____	_____
Electrical Contractor	Date	Plumbing Contractor	Date
_____	_____	_____	_____
TAB Contractor	Date	General Contractor	Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- The Contractors who are assigned responsibility for sections of the checklist shall also be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
General Installation					
Label permanently affixed					
Pumps installed in place and properly grouted, bases filled					
Vibration isolation devices installed and functional					
Factory alignment checked and appears correct					
Field alignment, if required, completed					
Seismic anchoring installed					
Temperature and pressure gauges and sensors installed					
Pump and motor lubricated					
Piping (immediately around pump, see full piping checklist)					
Pipe fittings completed and piping properly supported					
No leaks in pipe fittings and accessories at pump?					
Piping and pump properly insulated					
Strainers in place and cleaned out					
Piping system properly flushed					
Valves properly tagged					
Electrical and Controls					
Disconnect switches in place and labeled					
Electrical connections tight					
Proper grounding installed for components and unit					
Motor overloads calibrated					
Control system interlocks hooked up and functional					
Control devices, tubing and wiring complete					

Check Equip Tag →					Contr.
VFD					
VFD powered up and wired to controlled equipment					
VFD interlocked to control system					
Pressure or other controlling sensor properly located and per drawings and calibrated					
Controller location not subject to excessive temperatures					
Controller location not subject to excessive moisture or dirt					
Controller size matches motor size					
Internal settings designating the application are correct					
Input of motor FLA represents 105% to 115% of motor FLA rating					
Appropriate Volts vs Hz curve is being used; energy saver on?					
Accel and decel times are around 10-50 seconds, except for special applications. Actual decel = Actual accel =					
Upper frequency limit set at 100%, unless explained otherwise					
Unit is programmed with written programming record available					
VFD kW demand at panel matches BAS readout					
TAB					
Installation of system and balancing devices permits balancing to be completed following specified NEBB or AABC procedures and contract documents					
Final					
Startup report completed with this checklist attached					
Safety controls tested, calibrated and safe operating ranges for this equipment provided to the commissioning agent					
Internal settings designating the application are correct					

Checklist items of Part 2 are all successfully completed for given trade… ____Yes ____No

5. Operational Checks (These augment mfr's list. This is not a functional performance test)

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag →					Contr.
The HOA switch properly activates and deactivates the unit under manual and automatic control.					
Pump rotation verified correct					
No unusual noise or vibration					
No leaking apparent around fittings					
Measure line to line voltage phase imbalance for each pump:					
(%Imbalance = 100 x (avg. - lowest) / avg.) Record imbalance of each pump in cell. Imbalance less than 2%?					
Record full load running amps for each pump. FL amps x factor (Max amps). Running less than max?					
Specified sequences of operation and operating schedules have been implemented with variations documented					
Specified point-to-point checks have been completed and documentation record submitted for this system					

Checklist items of Part 3 are all successfully completed for given trade… ___Yes____No

1. Sensor and Actuator Calibration [Contr. = _____]

Field-installed temperature, CO, and pressure sensors and gages on this piece of equipment are calibrated. Test instruments NIST certified for calibration within the last 12 months: Y/N_____.

Sensors installed in the unit at the factory with NIST calibration certificates provided need not be field calibrated.

Sensor or Actuator & Location	Loc-atio n OK	1st Gage Value	Instr. Meas'd Value	Final Gage Value	Pass Y/N?

Sensor or Actuator & Location	Loc-atio n OK	1st Gage Value	Instr. Meas'd Value	Final Gage Value	Pass Y/N?

Gage reading = reading of the permanent gage on the equipment. Instr. = testing instrument. Visual = actual observation.

Sensors are calibrated within required tolerances … ____Yes ____No

■ END OF CHECKLIST –

Sample Prefunctional Checklist

Building (DDC) Automation System, Unit ID #'s: _____

1. Submittals / Approvals

Submittal. The above equipment and systems are installed and ready for functional testing. The checklist items are completed and have been checked off by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of outstanding areas. ___ List attached.

_____	_____	_____	_____
Controls Contractor	Date	General Contractor	Date
_____	_____	_____	_____
Electrical Contractor	Date	Mechanical Contractor	Date

Prefunctional checklist items must be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended startup procedures or reports.
- Note items that do not apply with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting prefunctional testing, one of similar rigor shall be used.
- The Contractors who are assigned responsibility for sections of the checklist shall also be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, GC = general contractor, PC = plumbing contractor, MC = mechanical contractor, CC = controls contractor, SM = sheet metal contractor, TAB = test and balance contractor, EC = electrical contractor, CA = commissioning agent.
- A significant part of the BAS functional testing requirements is the successful completion of the functional tests of equipment the BAS controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies in those tests lend the required BAS functional testing incomplete.
- Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the BAS testing requirements, except for any integrated functions or interlocks listed below. In addition to the controlled equipment testing, the following tests are required for the BAS, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

2. Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Equip Tag->			Contr.
Cabinet and General Installation			
General appearance good, no apparent damage			
Equipment labels affixed			
Layout and location of control panels matches drawings			
Areas or equipment panels serve clear in control drawings			
Wiring labeled inside panels (to controlled components)			
Controlled components labeled/tagged			
BAS connection made to labeled terminal(s) as shown on drawings			
Shielded wiring used on electronic sensors			
110 volt AC power available to panel			
Battery backup in place and operable			
Panels properly grounded			
Environmental conditions according to manufacturer's requirements			
Date and time correct			
Misc. Functions			
Provide a verbal discussion of specified functions and features that are set up, debugged and fully operable			
Demonstrate power failure and battery backup and power-up restart functions			
Specified trending and graphing features demonstration			
Demonstrate global commands features			
Demonstrate security and access codes			

Check Equip Tag->			Contr.
Demonstrate occupant over-rides (manual, telephone, key, keypad, etc.)			
Demonstrate O&M schedules and alarms			
Scheduling features fully functional and setup, including holidays			
Demonstrate date and time setting in central computer and verify field panels are the same.			
Demonstrate included features not specified to be setup are installed (list)			
Demonstrate occupancy sensors and controls			
Demonstrate functionality of 100% of field panels using local operator keypads and 10% of local ports (plug-ins) using portable computer/keypad			
Demonstrate graphic screens and value readouts completed			
During equipment testing demonstrate set-point changing features and functions			
Demonstrate communications to remote sites			
Through sampling during equipment tests verify sensor calibrations			
Final as-builts or redlines (per spec) control drawings, final points list, program code, set-points, schedules, warranties, etc. per specs, submitted for O&Ms.			
Verify that points that are monitored only, having no control function, are checked for proper reporting to BAS.			

3. Installation: Checks - Device and Point Checkout Contr. = [ ]

The following procedures are required to be performed and documented for each and every point in the control system. The following procedures are minimum requirements. The control contractor is encouraged to identify better and more comprehensive checkout procedures in their submitted plan. These procedures are not a substitute for the manufacturer's recommended start-up and checkout procedures, but are to be combined with them, as applicable. The documentation may be provided on the vendor's stock form, as long as all the information in the sample table below can be clearly documented on the form.

Similar checkout and calibration requirements are found on the equipment prefunctional checklists. Redundant documentation is not required. Cross reference, by name and form number, to other forms that contain documentation left blank on the current form.

Procedures:

a. [Wire] Verify that the wiring is correct to each point.

b. [Actu] If the device is or has an actuator, verify full free movement through its full range.

c. [Addr] Verify that the software address is correct.

d. [Load] For devices with a controller, verify that current software program with proper setpoints has been downloaded.

e. [DevCal] Device stroke/range calibration. This applies to all controlled valves, dampers, fans, pumps, actuators, etc. Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and positively verify each and every control device minimum and maximum stroke and capacity range.

f. [SensLoc] Verify that all sensor locations are appropriate and away from causes of erratic operation.

g. [SensCal] Sensor calibration. Calibrate or verify calibration of all sensors and thermostats, including temperature, pressure, flow, current, kW, rpm, Hertz, etc. Verify that the sensor readings in the control system are within the sensor accuracies specified in this section, using hand-held or other external measuring instruments.

h. [OperCk] For controlled devices (dampers, valves, actuators, VAV boxes, etc.), after mechanical equipment control becomes operational, perform an operational test of each control loop. Follow procedure 6.2 below. Operational checks are preparatory to the later functional testing.

i. Other Abbreviations: [BAS] Building automation system or gage-read value; [Instru] Instrument (calibrated) read value; [Ofset] Offset programmed into the point to correct the calibration.

Items of Parts 2 and 3 are all successfully completed for given trade… ___Yes ____No

4. Sensor and Actuator Calibration [Contr. = _____]

Field-installed temperature, CO_2, CO, and pressure sensors and gages on this piece of equipment are calibrated. Test instruments NIST certified for calibration within the last 12 months: Y/N_____.

Sensors installed in the unit at the factory with NIST calibration certificates provided need not be field calibrated.

SAMPLE FORM: Controls Checkout Documentation Table

Point	Object	Field Device	Hardware Checks			Load	Dev	Sens	Senscal			Final Check	
			Wire	Actu	Addr				BAS	Instru	Offset	Oper	
			1	2	3	4	5	6	7	7	7	8	9

Sensors are calibrated within required tolerances … ____Yes ____No

-- END OF CHECKLIST --

Sample Prefunctional Checklist

Test & Air Balance (TAB), Review Checklist

Components Included: ____ Airside, ____ Waterside

The purpose of this checklist is to verify that necessary components for TAB have been included.

1. Submittals / Approvals

Submittal. The TAB Plan has been developed and reviewed against the checklist below.

This plan is submitted for approval, subject to the attached list of outstanding items yet to be completed.

_____ _____ _____ _____

TAB Contractor Date General Contractor Date

- The TAB Plan checklist does not take the place of the recommended formats or procedures in standards referenced in the specifications, but it is intended to augment them.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).

Approvals. This filled-out checklist and the TAB Plan have been reviewed. Their completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

2. TAB Plan Checklist

Check if included in Plan. Write N/A if not applicable. Enter Note number if deficient.

Check	Air Side	Chilled Water	Heating Water
Specified qualifications and certifications of parties performing TAB work were submitted			
TAB contractor has reviewed drawings, walked through the site and verified that there are sufficient balancing dampers, valves, isolation dampers and valves and test ports installed to perform TAB per spec. Deficiencies in design or installation that will adversely affect or preclude proper TAB have been reported.			

Check	Air Side	Chilled Water	Heating Water
TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system and outlet.			
Prior to plan, TAB contractor met with controls contractor to become familiar with using the terminal unit programmer for TAB			
Field checkout sheets and logs provided as part of plan			
Proposed final test report sheets provided as part of plan			
Field and final test report sheets list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each			
Discussion of what notations and markings will be made on the duct and piping drawings.			
List of air flows, water flows, sound levels, system capacities and efficiency measurements to be performed, and a description of specific test procedures, parameters, formulas and test instrument type to be used for the measurements have been provided. Sample forms have been included.			
Detailed step-by-step procedures for TAB work: Terminal flow calibration (for each terminal type), diffuser proportioning, branch/sub-main proportioning, total flow calculations, rechecking, and others. Similar for water side.			
Details of how total flow will be determined (Air: Sum of terminal flows via BAS calibrated readings or via hood read of terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic meter.)			
Specific procedures that will ensure (and which can be verified) that both air side and water side are operating at the lowest possible pressures and energy consumption.			
Outside air ventilation criteria under clearly understood by TAB contractor			
Details of if and how minimum outside air cfm will be verified and set and for what level (total bldg, zone, other.)			
Details of how building static and exhaust fan/relief damper capacity will be checked.		N/A	N/A
The identification and types of measurement instruments to be used and their most recent calibration date			
Proposed selection points for sound measurements			
Details of any TAB work to be done in phases, by floor, or of areas to be built out later			

Check	Air Side	Chilled Water	Heating Water
Details regarding specified deferred or seasonal TAB work			
Details of specified false loading of systems to complete TAB work			
Details of exhaust fan balancing and capacity verifications, including required room pressure differentials.			
Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency)			
Plan for formal progress reports (scope and frequency)			
Plan for formal deficiency reports (scope, frequency and distribution)			

Checklist items of Part 2 are successfully completed … ____Yes ____No

-- END OF CHECKLIST --

Sample Prefunctional Checklist

Piping (Hydronic)

Associated Checklists: Air Handling Units and Pumps

1. Submittals / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.___ List attached.

_____ _____ _____ _____

Plumbing Contractor Date General Contractor Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- The Contractors who are assigned responsibility for sections of the checklist shall also be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, GC = general contractor, PC = plumbing contractor, MC = mechanical contractor, CC = controls contractor, TAB = test and balance contractor, EC = electrical contractor, CA = commissioning agent.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

2. Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check		Contr.
Piping		
Pipe fittings complete and pipes properly supported allowing for thermal expansion and contraction and building expansion joints.		
Pipe joints properly installed		
Required seismic anchoring installed		
Pipes properly labeled		
Pipes properly insulated		
Piping properly sloped		
Proper construction isolation		
Strainers in place and clean		
Isolation valves and balancing valves installed		
Test ports (P/T) installed near all control sensors and as per spec		
Piping system properly flushed and cleaned and temporary piping removed (report attached)		
10% of strainers and Owner-selected low-point drains opened and witnessed by Owner to be clean. (List points checked below).		
Piping hydrostatic pressure test completed according to contract documents (report attached)		
No leaking apparent around fittings		
ASME pressure vessel data sheet or certification tag posted and inspection complete for each expansion tank and storage tank		
Expansion tanks verified to not be air bound and system completely full of water. System purged of air.		
Air vents and bleeds at high points of systems functional		
Water hammer arrestors installed and tested		
Backflow preventer proper location		
Adequate depth of bury for service piping		
Cross connection protection		
Valves		

Check		Contr.
Valve tags permanently affixed		
Valves installed in proper direction		
Pressure reducing valves set at proper pressure		
No leaks		
Flexible connections at equipment installed		
Dielectric fittings for dissimilar metals installed		
Vibration Isolation installed		
Fire-rated pipe penetrations installed properly		
Valves that require a positive shut-off are verified to not be leaking when closed at normal operating pressure. List: _____		
Sensors and Gages		
Temperature, pressure and flow gages and sensors installed. List : _____ _____		
TAB		
Installation of system and balancing devices allowed balancing to be completed following specified NEBB or AABC procedures and contract documents		

Checklist items of Part 2 are all successfully completed for given trade… ____Yes ____No

END OF CHECKLIST

Prefunctional Checklist

Ductwork

Associated Checklists: HVAC Units

1. Submittals / Approvals

Submittal. The above equipment is complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. None of the outstanding items preclude safe and reliable functional tests being performed.
___ List attached.

Mechanical Contractor	Date	Sheet Metal Contractor	Date
General Contractor	Date	Electrical Contractor	Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

Commissioning Agent	Date	Owner's Representative	Date

2. Installation Checks

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

Check Run to/from →					Contr.
Ducts					
Sound attenuators installed					
Duct joints properly installed and sealed					
No apparent severe duct restrictions					
Turning vanes in square elbows as per drawings					
OSA intakes located away from pollutant sources & exhaust outlets					
Pressure leakage tests completed					
Branch duct control dampers operable					
Ducts clean					
Balancing dampers installed as per drawings					
Proper roof penetration curbs and flashing					
Fire-rated penetrations, fire/smoke dampers properly located					
Ducts insulated or lined per drawings					
Ductwork and plenums are clean and free of construction debris					
TAB (Test, adjust, air balance)					
Terminal units/Diffusers, registers, grilles are adjusted for air flow quantity and direction					

Checklist items of Part 2 are all successfully completed for given trade… ____Yes ____No

END OF CHECKLIST

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 01 91 00	Commissioning
.4	Section 23 05 29	Hangers & Supports for Piping & Equipment
.5	Section 23 05 48	Vibration & Seismic Controls for Ductwork, Piping & Equipment
.6	Section 23 07 19	Thermal Insulation for Piping
.7	Section 23 08 00	Commissioning of Mechanical Systems

1.2 References

.1 American Society of Mechanical Engineers (ASME)

- .1 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
- .2 ASME B16.24-2011, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
- .3 ASME B16.26-2013, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .4 ASME B31.5-2013, Refrigeration Piping and Heat Transfer Components.

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM A 307-2012, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B 280-2013, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA International)

- .1 CSA B52-2009, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

- .1 EPS 1/RA/1-[96], Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

.6 Federal Halocarbon Regulations, 2003.

1.3 Submittals

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Shop Drawings, Product Data and Samples. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings and product data in accordance with Section 01 01 50 – General Instructions.

.2 The Refrigeration contractor shall prepare and include the coil and condensing unit balance curves detailing the S.S. temperature, the estimated line loss, and the system balance point that meets the required total and sensible cooling capacities at the specified ambient temperatures. A refrigerant piping schematic, showing refrigerant pipe sizes, lengths, and refrigerant receiver size requirement, shall also be submitted to confirm installation is in accordance with manufacturer's recommendations, and does not contravene warranty requirements

.3 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Closeout Submittals:

.1 Provide maintenance and engineering data for incorporation into manual specified in Section 01 01 50 – General Instructions.

.2 Provide halocarbons documentations in accordance with Section 23 05 00 – Common Works Results – Mechanical.

1.4 Quality Assurance

.1 Health and Safety:

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

.2 Provide 12 months service for all refrigeration system components and fluids at no additional cost to Owners. Start of 12 month service period shall be the first summer occasion on which unit is adjusted for cooling conditions.

1.5 Delivery, Storage And Handling

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling .

.4 Divert unused materials from landfill to recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS

2.1 Tubing

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Hard copper: to ASTM B 280, type ACR.

.2 Annealed copper, Type L: to ASTM B 280, with minimum wall thickness as per CSA B52 and ASME B31.5. .

2.2 Fittings

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A 307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 Pipe Sleeves

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 Valves

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

PART 3 EXECUTION

3.1 Installation

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework.

.2 The installation shall be completed in compliance with Federal Halocarbon Regulations, 2003.

3.2 Brazing Procedures

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.3 Piping Installation

.1 General:

.1 Soft annealed copper tubing: bend without crimping or constriction.

.2 Hard drawn copper tubing: do not bend.

.3 Minimize use of fittings.

.2 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.

.3 Provide inverted deep trap at top of risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

.2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

.5 Insulation

.1 Insulate with vapour-sealed elastomeric insulation in accordance with Section 23 07 19 – Thermal Insulation for Piping.

.2 Insulation shall be sealed at seams and butt joints with adhesive.

.3 Outdoor exposed piping shall be finished with aluminum jacket in accordance with Section 23 07 19 – Thermal Insulation for Piping.

3.4 Pressure and Leak Testing

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

.3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.5 Start-up and Commissioning

.1 Charge refrigerant, start-up and submit written report to Departmental Representative.

.2 Commissioning:

.1 In accordance with Section 01 91 00 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems

.3 Halocarbons Management:

.1 In accordance with Section 23 05 00 – Common Works Results – Mechanical.

3.6 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 23 05 00	Common Work Results-Mechanical
.3	Section 23 05 93	Testing Adjusting and Balancing

1.2 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 01 50 – General Instructions.

.2 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Departmental Representative.

.3 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

.4 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.5 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.3 Scope

.1 All existing and new air systems installed by this contract shall be cleaned by a Cleaning Contractor.

.2 The Cleaning Contractor shall visit the site in the case of existing systems or shall review the drawings and specifications of new systems, in order to be fully acquainted with the scope of work and requirements before tendering. No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site or inspect the contract documents.

.3 The following air systems shall be cleaned, as applicable:

- .1 Relief
- .2 Supply
- .3 Return
- .4 Exhaust
- .5 Air Conditioning

.4 All components within each system shall be thoroughly cleaned to the Departmental Representative's satisfaction and shall include but not be limited to the following:

- .1 Intake exhaust and relief louvres
- .2 Bird screens
- .3 Auto dampers
- .4 Filter frames
- .5 Coils
- .6 Fans & motors - complete assembly

.7 All plenum surfaces

.8 Terminal heating/cooling coils

.9 Supply air grilles, registers and diffusers

.10 Ductwork

.11 Mixing boxes, air terminal units

.12 Return, exhaust and relief air grilles and diffusers.

1.4 Qualifications

.1 Cleaning shall be performed by a cleaning service company with high capacity cleaning equipment designed specifically for the work involved, executed by personnel specifically trained for the application.

PART 2 PRODUCTS

2.1 Cleaning Equipment

.1 Cleaning shall generally by high capacity power vacuum.

.2 High pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise.

PART 3 EXECUTION

3.1 Cleaning HVAC Systems

.1 The Cleaning Contractor shall provide access as required for the work and shall reseal and make good any duct or insulation damaged in the process of this work.

.2 Remove cheesecloth from grilles, etc., let over from the temporary use of the air systems.

.3 Air systems must not be shut down without prior approval from the owner

.4 The Cleaning Contractor shall be responsible for removing and replacing filter media. In new buildings this Contractor will remove the temporary filters and replace with new after cleaning the systems. In existing buildings this Contractor may re-use existing filter media (cleaned if possible) or new media will be provided by the Owner as established by the Departmental Representative.

.5 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is to be balanced.

.6 Re-install any grilles, registers and diffusers which may have been removed for cleaning purposes.

3.2 Report

.1 After completion of the work, the Contractor shall provide four copies of a certificate stating that all systems have been cleaned as specified and that all access panels for all cleaning openings are in place. This certificate shall be placed in the Operating and Maintenance Manuals.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 23 05 00	Common Work Results - Mechanical
.4	Section 23 05 48	Vibration and Seismic Controls for Ductwork, Piping and Equipment
.5	Section 23 05 94	Pressure Testing of Ducted Air Systems
.6	Section 23 07 13	Thermal Insulation for Ducting
.7	Section 23 31 10	Cleaning of Mechanical Duct Systems

1.2 References

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials (ASTM)

.1 ASTM A312/A312M-2014, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

.2 ASTM A480/A480M-2013, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.3 ASTM A635/A635M-2013, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.4 ASTM A653/A653M-2013, 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), 1999, c. 33 .

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Agency (NFPA)

.1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 91-2010, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Non-combustible Particle Solids.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 ANSI/SMACNA 006-2006, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.

.3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.8 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

.9 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 Submittals

.1 Submit shop drawings and product data in accordance with Section 01 01 50 – General Instructions.

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets for the following:

.1 Sealants.

.2 Adhesive

.3 Duct tape.

.4 Duct liners.

1.4 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 33 - Health and Safety Requirements.

1.5 Delivery Storage and Handling

.1 Protect on site stored or installed absorptive material from moisture damage.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

.7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 Seal Classification

.1 Classification as follows:

Pressure Class	Maximum Pressure (Pa)	SMACNA Seal Class
High Pressure	2,500	[A]
Medium Pressure	1,500	[A]
Low Pressure	500	[B]

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

2.2 Ductwork - General

.1 Duct dimension noted on drawings are clear inside dimensions. Insulation thickness shall be as noted on the drawings.

.2 All seams, joints and raw edges shall be sealed and covered with glassfab.

.3 Insulation shall be applied with mechanical fasteners and suitable adhesives. Duct insulation adhesive and coatings shall be non-toxic as defined by WCB Regulations.

.4 Round duct: with spiral seams. Sections shall be joined with a RT1 slip joint, screw fastened and sealed with no visible duct sealant to interfere with finish painting.

.5 Exposed round duct shall be installed in a neat workmanlike manner parallel to building walls and roof with no sags or misalignment, and shall be true and round.

.6 All new Exhaust Air Systems Ductwork installed under this contract shall be constructed to 1,500 Pa medium pressure duct. All new Exhaust Air Systems Ductwork installed under this contract shall be SMACNA Stainless Steel SS316

sheet metal gauge 18ga [0.0500in-1.2mm sheet thickness] with maximum 600mm reinforcement spacing.

.8 Contractor to provide written confirmation that all ductwork installed under this contract is as specified and meets Seal and Leakage Classification as specified.

2.3 Fittings

.1 Fabrication: to SMACNA. Fittings shall be 2 gauges heavier than connecting ductwork.

.2 Radius elbows:

.1 Rectangular: Centre-line radius equal to 1.5 times width of duct, with single thickness turning vanes.

.2 Round: Centre-line radius equal to 1.5 times diameter. 5-gore for 300mm [12”] and larger; die-stamped for 254mm [10”] and smaller.

3 Mitered elbows, rectangular:

.1 To 400mm [16”]: with single thickness turning vanes.

.2 Over 400mm [16”]: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: 45° entry on branch.

2 Round main and branch: enter main duct at 45° or with conical connection. The use of spin-in collars is not acceptable.

.5 Transitions:

.1 Diverging: 20° maximum angle.

.2 Converging: 30° maximum angle.

.6 Offsets: full radius elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

2.4 Galvanized Steel

.1 Lock forming quality: to ASTM A653, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA.

.4 Applications:

.1 All supply and return air ductwork unless otherwise noted.

2.6 Stainless Steel

.1 Material: 316 stainless steel to ASTM A312.

.2 Thickness: minimum 1.2mm [18 gauge], built for structural strength.

.3 Joints: continuously welded.

.4 Duct system shall be fitted with copper-grounding straps, connected to the duct and to an effective grounding system.

.5 Applications:

.1 Fume exhaust duct.

.2 Canopy exhaust duct.

.3 As noted on drawings.

2.7 Hangers and Supports

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500mm [20”].

.2 Hangers, hanger configuration and attachment to structure: to SMACNA.

2.8 Duct Liner

.1 Fibrous glass duct liner: air stream side faced with FSK facing.

.2 Rigid:

.1 Use on flat surfaces.

.2 25mm [1”] or 50mm [2”] thick fibrous glass rigid board duct liner.

.3 Density: 36 kg/m³ [2.2 lb/ft^3].

.4 Thermal resistance: RSI-0.76 [R-4.3] for 25mm [1”], RSI-1.53 [R-8.7] 50mm [2”].

.3 Flexible:

.1 Use on round or oval surfaces.

.2 25mm [1”] or 50mm [2”] thick fibrous glass blanket duct liner as indicated.

.3 Density: 24 kg/m³ [1.5 lb/ft^3].

.4 Thermal resistance: RSI-0.74 [R-4.2] for 25mm [1”], RSI-1.47 [R-8.3] 50mm [2”].

.4 Fasteners shall be weld pins with metal retaining clips and square head.

.5 Flame and smoke ratings:

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.9 Sealant

.1 For indoor and outdoor applications:

.1 Water based, fiber reinforced, non-toxic, elastomeric duct sealant. Suitable for indoor and outdoor use, non-sagging, non-cracking, UV resistant, freeze/thaw stable, paintable. Temperature range of -32°C to 99°C [-26°F to 210°F]. ULC listed and comply with NFPA 90A and NFPA 90B.

.2 Flame and smoke ratings:

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

.2 For outdoor applications only:

.1 Solvent based, fiber reinforced, elastomeric duct sealant. Suitable for outdoor unit, non-sagging, non-cracking, UV-proof, freeze/thaw stable, paintable. Temperature range of -45°C to 120°C [-50°F to 250°F].

.3 Maximum VOC limit 420 g/L to SCAQMD Rule 1168 and SMACNA Technical Resource Bulletin (TRB) #9-09.

2.10 Adhesive

.1 Water-based vinyl copolymer adhesive. Temperature range of -23°C to 71°C [-10°F to 160°F]. ULC listed and comply with NFPA 90A and NFPA 90B. Adhesive shall be non-toxic as defined by WorksafeBC Regulations.

.2 Flame and smoke ratings:

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

.3 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

2.11 Duct Tape System

.1 Not Acceptable

PART 3 EXECUTION

3.1 General

.1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA, and as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

.7 All openings in ductwork shall be sealed with temporary duct cover during construction. Failure to maintain duct cleanliness will require the inside of all air ducts, plenums and equipment in the air stream to be cleaned with an industrial vacuum cleaner before system balancing is started.

.8 Apply protective galvanize coating to galvanized ductwork and accessories which have been welded.

.9 Apply duct sealer to all joints of metal ducts, connections to diffusers, plenums and flexible duct.

.10 Provide medium pressure duct for the following:

.1 Ductwork serving systems with air terminal units, extending from the air handling unit discharge to the inlet of air terminal units.

.2 As indicated.

.11 The use of plastic duct tape is not permitted.

.12 Thermal insulation to Section 23 07 13 – Thermal Insulation for Ducting.

3.2 Hangers

.1 Strap hangers: Install in accordance with SMACNA.

.2 Rectangular duct: Extend strap hanger down on both sides of duct, turn under bottom 25mm [1”] minimum. On each strap provide two sheet metal screws on the side and one in the bottom.

.3 Angle hangers: complete with locking nuts and washers.

.4 Hanger spacing: to SMACNA.

.5 Seismic restraint to Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

3.3 Ductwork Exposed to Weather

.1 All ductwork exposed to weather shall have watertight seams.

.2 Exposed ducts which are not insulated or finished with paint shall be coated with two applications of bitumastic waterproofing compound to prevent corrosion.

.3 Supports for ductwork exposed to weather and miscellaneous metals exposed to weather shall be electro-galvanized or hot dip galvanized steel, or coated with two applications of bitumastic waterproofing compound.

3.4 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.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425mm on centres.

.3 Acoustically lined round ducts shall have perforated inner metal liner.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

.4 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.

.5 Replace damaged areas of liner.

.6 Protect leading and trailing edges of duct sections with sheet metal nosing having 15mm [1/2"] overlap and fastened to duct.

.7 Provide 50mm [2"] liner for ductwork exposed to weather which is not insulated.

3.5 Watertight Duct

.1 Provide watertight duct for:

.1 AHU-101/2 and AHU-103 new ductwork systems.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder or weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards fume hoods served.

.1 Slope header ducts down toward risers.

3.6 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.

3.8 Leakage Tests

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Perform leakage tests in sections.

.4 Perform trial leakage tests, as instructed to demonstrate workmanship.

.5 Install no additional ductwork until trial tests have been achieved.

.6 Test section minimum of 30m [100 ft] long with not less than three branch takeoffs and two 90^a elbows.

.7 Complete tests before insulation or concealment.

3.9 Cleaning

.1 Perform cleaning operations as specified in Section 01 01 50 – General Instructions, Section 23 31 10 – Cleaning of Mechanical Duct Systems and in accordance with manufacturer's recommendations.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 01 50 General Instructions

.2 Section 01 35 33 Health and Safety Requirements

.3 Section 23 05 00 Common Work Results – Mechanical

.4 Section 23 31 10 Cleaning of Mechanical Duct Systems

.5 Section 23 33 00 Air Duct Accessories

1.2 References

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 ANSI/SMACNA 006-2006, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.

.2 SMACNA – Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 2002.

.2 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S112-10, Standard Method of Fire Test of Fire Damper Assemblies.

.2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.

.3 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.

.3 National Fire Protection Agency (NFPA)

.1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.3 Submittals

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.

.1 Indicate the following:

.1 Volume dampers.

.2 Remote control damper regulators.

.3 Fire dampers.

.4 Backdraft dampers.

.5 Relief dampers.

.2 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.4 Quality Assurance

.1 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 01 50 – General 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 01 50 – General Instructions.

1.6 Extra Materials

.1 Provide maintenance materials in accordance with Section 01 01 50 – General Instructions.

.2 Provide following:

.1 Six (6) fusible links for each type of fire damper.

PART 2 PRODUCTS

2.1 General

.1 Manufacture to SMACNA standards.

2.2 Single Blade Volume Dampers

.1 Blade: Of same material as duct. Two gauges heavier than duct but not less than 0.6mm [24 gauge], stiffened.

.2 Maximum dimension: 305mm [12”] height for rectangular ducts.

.3 Axles: 9.5mm [3/8”] continuous square rod up to 457mm [18”] wide duct, and 13mm [1/2”] continuous square rod up to 1,219mm [48”] wide duct.

.4 Linkage: shaft extension with locking quadrant and position indicator.

.5 Bearings: bronze oilite.

.6 Frame: of the same material as duct. Complete with angle stop for rectangular duct.

2.3 Multi-Bladed Volume Dampers

.1 Opposed blades: 1.2mm [18 gauge] of same material as adjacent duct, stiffened.

.2 Maximum blade width: 150mm [6”].

.3 Axles: 9.5mm [3/8”] or 13mm [1/2”] continuous square rod.

.4 Bearings: bronze oilite.

.5 Linkage: shaft extension with locking quadrant and position indicator.

.6 Frame: 51mm [2”] or 40 x 13 x 3 mm [1-1/2”x1/2”x1/8”] structural or roll-formed channel, complete with angle stop.

2.4 Backdraft Dampers

.1 Multi-blade, gravity-operated, centre pivoted, constructed of same material as duct with nylon bearings.

2.5 Relief Dampers

.1 Multi-blade, insulated, counter-weight, centre pivoted, constructed of same material as duct with brass bearings, set to open at 12.4 Pa [0.05 in. w.g.] static pressure unless otherwise noted.

PART 3 EXECUTION

3.1 General

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

3.2 Volume Damper

.1 For supply, return and exhaust systems, locate balancing dampers in each branch duct.

.2 Run-outs to registers and diffusers: install single blade damper located as close as possible to main ducts.

.3 All dampers to be vibration free.

.4 Attach fluorescent tape to regulator handle for concealed volume dampers.

.5 Provide remote control damper regulator for volume dampers above inaccessible ceiling where ceiling access panel is not provided, and as indicated.

3.3 Field Quality Control

.1 Tests:

.1 Tests to cover period of not less than 2 days and demonstrate that system is functioning as specified.

3.4 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 01 91 00	Commissioning
.4	Section 23 05 13	Common Motor Requirements for HVAC Equipment
.5	Section 23 05 48	Vibration & Seismic Controls for HVAC Piping & Equipment
.6	Section 23 08 00	Commissioning of Mechanical Systems
.7	Section 23 33 00	Air Duct Accessories
.8	Section 23 31 10	Cleaning of Mechanical Duct Systems

1.2 References

.1 Air Movement and Control Association (AMCA)

- .1 ANSI/AMCA 99-10, Standards Handbook.
- .2 ANSI/AMCA 204-12: Balance Quality and Vibration Levels for Fans.
- .3 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .4 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
- .5 AMCA 301-90, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB 1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.

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, HP, 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.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210.

1.4 Submittals

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings and product data in accordance with Section 01 01 50 – General Instructions.

.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 and sheaves details.

.5 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.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.

.6 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.5 Quality Assurance

.1 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 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 01 50 – General Instructions.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Waste Management and Disposal:

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

PART 2 PRODUCTS

2.1 Fans General

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers where specified.

.3 Sizes as specified.

.2 Accessories and hardware: as specified.

.3 Scroll casing drains: as indicated.

.4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.5 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for Ductwork Piping and Equipment.

.6 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 Centrifugal Fans

.1 Fan wheels:

.1 welded steel construction.

.2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.

.3 Air foil or backward inclined blades, as indicated.

.2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life (L50) of 200,000 hours.

.3 Housings:

.1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, steel, for smaller wheels, braced, and with welded supports.

.2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.

.3 Provide bolted or latched airtight access doors with handles.

.4 Provide belt driven sets with adjustable motor bed plate and variable pitch driver sheave.

2.3 Cabinet Fans – General Purpose

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single wheel with centrifugal fan in factory fabricated, acoustically insulated casing complete with vibration isolators and seismic control measures, motor and other accessories as noted.

.3 Fabricate casing of zinc coated or phosphate treated steel of 18 gauge 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.

2.4 In-Line Centrifugal Fans

.1 Characteristics and construction: as for centrifugal fan wheels.

.2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.5 Roof-Mounted Centrifugal Exhaust Fans

.1 General: Spun aluminum, roof-mounted, centrifugal exhaust ventilator as scheduled:

.2 Construction: Bolted and welded construction with corrosion resistant fasteners. Spun aluminum structural components, minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. Aluminum base with one piece inlet spinning, continuously welded curb cap corners. Discharge baffle and/or windband with rolled bead. Two piece top cap with stainless steel quick release latches. Integral conduit chase into motor compartment. Lifting lugs.

.3 Wheel: centrifugal backward inclined, all aluminum construction, cast aluminum hub, aerodynamic aluminum inlet cone. Balanced in accordance with AMCA Standard 204.

.4 Motor: heavy duty type with permanently lubricated sealed bearings.

.5 Discharge: upblast or downblast as schedule.

.6 Drive: direct or belt drive as scheduled.

.7 Belt drive units shall have motor, bearings and drives mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. Enclosed in a weather-tight compartment, separated from the exhaust airstream.

.1 Bearings - Heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

.2 Drives - Precision machined, cast iron type, keyed and securely attached to the wheel and motor shafts. Sized for 150 percent of the installed motor horsepower.

.8 Roof curb: pre-fabricated 18 gauge galvanized steel, insulated, continuously welded corners, wood nailer, minimum height to meet RCABC standard, damper tray.

.9 Accessories: aluminum backdraft damper, disconnect switch.

2.6 LABORATORY FUME HOOD EXHAUST SYSTEM
PLUME DILUTION EXHAUST FANS [PDEF]

1.1 References:

.1 Performance ratings: Conform to AMCA standard 210, 260 and 300. Fans must be tested in accordance with AMCA 210, 260 and 300 in an AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300), and induced flow fan for high plume dilution blowers (AMCA 260).

.2 Fans shall be UL and CUL listed per UL 705 safety standard.

.3 Fans shall meet the criteria of NFPA-45.

.4 Classification for Spark Resistant Construction shall conform to AMCA 99.

1.2 Acceptable Manufacturers

.1 In strict accordance with this specification, laboratory exhaust systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to energy consumption, sound levels, vibration levels, footprint, maintenance requirements, operational characteristics, capacities, and intent specified herein. Approval to bid does not relieve the alternate exhaust system supplier from complying with the minimum requirements or intent of this specification.

.2 The Departmental Representative shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle cost.

.3 Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.

1.3 Submittals:

.1 Submit shop drawings and product data sheets including performance data, fan performance curves, vibration levels, maintenance requirements and sound power levels.

.2 Fan manufacturer shall furnish a certificate of guarantee stating that the fan, mixing plenum, outlet nozzle, acoustical silencer nozzle, stack extension if any, and all related accessories specified herein have been pre-tested at the factory and that the curves supplied in 1.3.1 have been de-rated for any and all system effects created by the accessories.

1.4 Warranty

1. Fan manufacturer shall provide a 7 year parts warranty from time of purchase to include fan, plenum, motor and drive mechanisms including pillow blocks, sheaves, shafts, couplings and belts. This warranty shall be held solely by the fan manufacturer. It is unacceptable to extend the warranty of a provided component supplier (i.e. motors, dampers, actuators). All warranty claims shall be the sole responsibility of the fan manufacturer.

1.5 Mixed-flow induced dilution fans:

.1 Impellers shall be mounted directly to the motor shaft to provide Arrangement 4 Direct Drive. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service. Models that are not Arrangement #4 will be rejected.

.2 Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with aerodynamically stable operation at any point on the fan curves.

.3 Fan Performance shall be as stated on the schedule. The Static Pressure stated on the schedule shall be at the inlet to the “Fan System” and does not include any losses of

equipment provided by the fan manufacturer (ie: HRU, Filters, Silencers, etc…). All losses for the equipment provided by the fan manufacturer shall be detailed in the fan manufacturers technical proposal and or submittal.

.4 Fan and all drive components shall have a combined bearing life of a minimum of L_{10} = 150,000 hours.

.5 Maintenance shall only be required on a minimum of 18 month intervals. This maintenance shall be limited to re-greasing of the motor bearings.

.6 Stationary discharge guide vane sections shall be provided to increase fan efficiencies.

.7 Fan dynamic balance not to exceed 0.5 mil, peak-to-peak for nominal 900RPM, 1200RPM, and 1800RPM fans, or 0.055 in/sec -peak for 1800 RPM, 0.035 in/sec — peak for 1200 RPM, and 0.030 in/sec-peak for 900 RPM fans measured at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators unless otherwise specified.

.8 Factory test reports detailing vibration levels at the blade pass area shall be provided. Vibration levels shall be reported in both the axial and radial direction. If fan vibration is greater than 0.5 mils peak-to-peak at the blade pass area, fan manufacturer shall be responsible for providing vibration isolators on each fan and flexible connection at each duct inlet. Manufacturer shall add 0.5" additional static pressure to the fan system to compensate for losses through the flexible connection. Vibration isolators, 2” deflection seismic rated spring, must be installed on each individual fan with a minimum of four per fan. In addition, fan manufacturer shall be responsible for providing a method to repair or replace flexible connection or vibration isolators without shut down of the fan system. This includes any engineering, additional ductwork, and isolation dampers required to perform repairs while the system is still fully operational. Fan manufacturer shall also provide labor to change out or repair flexible connection and vibration isolators for a seven (7) year period from shipment.

.9 If a belt drive fan is supplied the fan manufacturer shall include a seven (7) year service contract for maintaining the belts, sheaves and drive mechanism. This is to include monthly inspections as noted in the ANSI Z9.5, 4.14.7.2 and any tensioning, and belt replacement during the seven (7) year period. This contract shall be detailed in the proposal and included in its total value.

.10 Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports.

.11 Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant.

.12 Entrainment windbands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Windbands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.

.13 Fan shall be constructed to AMCA “C” standards per AMCA 99 with a non-ferrous inlet bell provided in order to reduce sparking in the event of a motor bearing failure.

.14 Fans shall be modular construction and capable of being assembled on the roof.

.15 Chemical resistant gaskets shall be provided at all companion flanged joints.

.16 Fasteners shall be 316 stainless steel.

.17 A bolted access door shall be provided for impeller inspection on each fan.

.18 Fans and accessories shall have internal drain systems to prevent rain water from entering building duct system.

.19 Electric motors shall be TEFC Mill & Chemical duty with a 1.15 service factor and an L_{10} bearing life of 150,000 hours. Premium Efficient motors shall have regreasable bearings with grease relief fittings in every NEMA frame. Fan motors shall be C-Face and foot mounted.

.20 Extended motor lube lines of Teflon tubing covered with braided stainless steel shall be provided. Extended lube lines shall be mounted to a bracket located on the fan housing with grease relief fittings on each line.

.21 A NEMA 3R non-fused disconnect switch shall be provided, mounted and wired to the motor.

.22 All steel and aluminum surfaces components within the airstream that are not stainless steel or fiberglass must be surface prepped by abrasive blast clean to SSPC-SP10. Chemically cleaning of these components as a form of surface preparation is not acceptable. These components must be coated with a high solids epoxy with low VOC chemical resistant barrier coating epoxy. The coating system, a total thickness of up to 12 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 7000 hour ASTM B117 Salt Spray Resistance. Standard finish color to be gray. All coatings that include a zinc rich epoxy primer are strictly prohibited. Zinc coatings react with alkalis and acids, thus causing premature failure of the coating system and should never be used for laboratory applications.

.23 The fan supplied must meet the system exhaust CFM and the motor BHP shall not be larger than that shown on the fan schedule. If the BHP is larger than that shown then the fan manufacturer shall provide money for the additional energy cost for a seven (7) year period. The cost shall be $7,530.00 per BHP greater than that shown in the schedule. The fan manufacturer shall also provide any additional money required for wiring changes or any other changes required for installation of the equipment. These additional charges shall be detailed on the proposal and include in its total value.

.24 Fan and Mixing Box systems supplied by the manufacturer must have a foot print as shown on the drawings / schedule. Exhaust systems with larger footprints shall not be acceptable.

.25 The static pressure shown on the schedule is based on the static pressure requirements at the inlet to the mixing box. Any system deviating from the basis of design shall include and detail in their proposal additional losses for flexible connectors, fan losses, elbows, mixing box, etc. that are not included in their fan curves. In addition any deviation from the basis of design shall be subject to requirements stated in sections 1.3.2, 2.1.8 and 2.1.23.

3.1 Accessories

.1 Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule. Multiple fan plenums shall be insulated double wall construction with structural stiffeners. Double wall plenums, except for fans over 3hp shall have an overall minimum wall thickness of 1.5", and the insulation shall have a minimum R value of 4.34. Outer skin of double wall plenums shall be coated 12Ga Galvaneal steel. Inner skin shall be uncoated 18Ga 316 stainless steel. Multiple fan plenums shall be able to withstand a minimum of 12 in. w.g. of negative pressure. Single fan plenums shall be of continuously welded, heavy gauge steel construction. For single thickness plenums, coatings shall be the same as specified for the fans. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs. Safety screens shall be supplied over inlet of fan.

.2 Bypass dampers shall be provided with all mixing plenums for outside air with primary exhaust. Bypass damper(s) shall be sized to bypass the airflow capacity of one fan at the required static pressure of the system. Dampers will be opposed blade low leakage air foil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum construction. Rain hoods shall be provided with each damper. The dampers shall be controlled by a 24v electric proportional control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage. Actuators must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. Actuators shall have Brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication.

.3 An acoustic louver shall be provided at the inlet to the bypass dampers on systems requiring sound attenuation.

.4 Low leakage isolation dampers shall be constructed of aluminum air foil extrusions and epoxy coated. Operators shall be 2 position, spring return and shall have On-off spring return damper actuators that are direct coupled type which require no crankarm and linkage and be capable of direct mounting to a jackshaft. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall have a manual positioning mechanism accessible on its cover. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. Auxiliary switches, 2 SPDT, shall be provided with one switch having the capability of being adjustable.

.5 Vortex breakers shall be provided on all side inlet and multiple fan plenums.

.6 Acoustical Silencer Nozzle shall be designed as an integral component of the exhaust fan discharge nozzle and shall not increase the height of the overall assembly. Integral Acoustical Silencer Nozzle with a minimum of 12dBA insertion loss. Lining the interior of the windband is not an acceptable method of attenuation due to line of site sound in the free area between the nozzle and windband.

.1 The Acoustical Silencer Nozzle shall provide the attenuation values as specified in the following schedule. The published insertion loss values shall be obtained from an AMCA 300 test with the silencer installed on the fan specified. Ratings based on separate silencer and fan testing is not acceptable.

OCTAVE BAND CENTER FREQUENCY (Hz)									
FAN SIZE / SILENCER MODEL	LENGTH	63	125	250	500	1000	2000	4000	8000
TS-2	64"	0	4	9	11	12	13	9	4

.2 The silencer shall be constructed with an outer shell of fiber reinforced plastic. The inner liner shall be perforated corrosion resistant steel. The silencer shall match the color of the fans. Acoustic media shall be isolated from the air stream by a non fibrous acoustical media.

.7 Jib Crane Pedastal shall be welded to the fan roof base

.8 Portable jib crane shall be provided to allow for motor removal

2.7 Laboratory Exhaust VFD Package:

.1 All control wiring shall be brought by to a single point in both the rooftop exhaust unit and VFD/mechanical room equipment.

.2 Provide field installed VFD in mechanical mezzanine and provide all wiring as required for operation of laboratory plume dilution exhaust fans system. Provide conductive micro-fiber bearing protection ring. Coordinate wiring requirements with Div. 26 – Electrical.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Fan Installation

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 – Vibration and Seismic Controls for Ductwork, 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 in Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment. Provide seismic bracing for suspended equipment as specified in Section 23 05 48.

3.4 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 Field Quality Control

.1 Commissioning:

.1 In accordance with Section 01 91 00 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 01 91 00	Commissioning
.4	Section 23 05 00	Common Work Results – Mechanical
.5	Section 23 08 00	Commissioning of Mechanical Systems
.6	Section 23 31 10	Cleaning of Mechanical Duct Systems

1.2 References

.1 American National Standards Institute (ANSI)

.1 ANSI/ASHRAE 51/AMCA 210-07, Laboratory Methods of Testing Fans for Rating.

.2 ANSI/NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 International Organization of Standardization (ISO)

.1 ISO 3741-2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.3 Underwriter's Laboratories (UL)

1.3 System Description

.1 Performance Requirements:

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from certified ADC (Air Diffusion Council) 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 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.

.2 Test data: to ANSI/AMCA 210.

.1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.

.2 Sound power level with minimum inlet pressure of 250 Pa in accordance with ISO 3741 for 2nd through 7th octave band.

.3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.

.2 Indicate the following:

.1 Capacity.

.2 Pressure drop.

.3 Noise rating.

.4 Leakage.

.3 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.

.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.

.4 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.5 Quality Assurance

.1 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 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 01 50 – General Instructions.

.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 01 50 – General Instructions.

1.7 Related Work

.1 Supply and installation of Venturi Air Valves shall be part of the Division 23 Sheet Metal Sub Contractors scope of work and installed in accordance with installation standards as specified.

.2 Balancing Contractor shall be responsible for final onsite measurement and verification of the air valve flow and co-ordination of any corrective action required by the air valve supplier, as well as re verification after corrective action taken.

.3 **Note:** The Constant Volume Pressure Independent Venturi Air Valves specified require no power by the Electrical Contractor or external controls by the Controls Contractor.

1.8 Scope of Work

.1 Provide pressure independent variable air volume type Venturi Air Valves as specified in this section and as listed in mechanical schedules on the mechanical plans.

.2 Provide on-site labour as required to co-ordinate Fume Hood air valve airflow requirements and settings with Balancing Contractor, Fume Hood certification contractor and/or Commissioning Agent/Authority.

.3 Provide on-site owner instruction and on site preventative maintenance and repair service during the warranty period.

1.9 Warranty

.1 Warranty shall commence upon the date of Substantial Completion of the building and extend for a period of forty eight (48) months whereupon any defects in materials or system performance shall be repaired by the manufacturer at no cost to the owner.

.2 The Air Valve supplier shall provide all on site labour to service and/or repair any problems identified by the owner during the projects year warranty period.

1.10 Preventive Maintenance:

.1 The Air Valve supplier shall provide at no additional cost to the owner during the warranty period, all required preventive maintenance for the airflow controls provided under this section.

PART 2 PRODUCTS

2.1 LABORATORY AIRFLOW CONTROL GENERAL SYSTEM DESCRIPTION

.1 The Laboratory Venturi Pressure Independent Air Valves shall precisely control the exhaust flow rate from the laboratory Fume Hoods, Bio Safety Cabinets, Extraction Exhaust and/or Ventilated Storage Cabinets to maintain desired airflows within +/- 5% of design flow provided sufficient duct static is provided to maintain accurate pressure independent control and metering of airflow.

2.2 VENTURI PRESSURE INDEPENDENT VARIABLE VOLUME EXHAUST AIR VALVES [FEV-X; VAV-X]

.1 The airflow control device shall be a venture-type air valve. Each airflow device shall be factory tested and calibrated to be job specific as detailed in the specifications.

.2 **Pressure Independence**: The airflow control valve shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold supply or exhaust system.

.3 **Valve Accuracy**: The airflow control valve shall maintain specified airflow within 5% of airflow set point provided the static pressure differential across the valve is within

specification Note: low pressure air valves require a minimum duct static of 75 PA pressure across the valve. Maximum static pressure across the valve is 750 PA.

No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence

.4 **Corrosive Exhaust Air Valve Construction**: Venturi air valves for corrosive airstreams shall be constructed of 14 gauge spun aluminum for the body with a baked on corrosion resistant phenolic (P403 Heresite) coating. The shaft shall be made of 316 stainless steel with Teflon coating. Shaft support brackets, pivot arm, internal linkage, bolts and nuts shall be 316 stainless steel. The pressure independent cone shall be 16 gauge aluminum with a baked on corrosion resistant phenolic (P403 Heresite) coating Cone pressure independent springs shall be spring grade stainless steel. All shaft bearing surfaces wear resistant with Teflon Additive.

.5 **Draw Bands:** shall be provided for all coated air valves c/w gasket and two bolts design for even tightening to be provided for single body Air Valve installation to allow for quick and easy installation or removal for single non flanged air valves. Provide Teflon tape for sealing the duct seam under the draw band.

.6 **Air Valve Sizing:** Refer to schedule on mechanical plans for selected sizing.

.7 **Airflow Adjuster:** Provide adjuster for manually setting the airflow set point.

.8 **Base Channel for Future Actuator**: Provide optional base channel to allow for future air valve upgradability to two state or variable volume operation.

.9 **Airflow feedback Potentiometer: Air valves shall incorporate a factory installed potentiometer for monitoring of the air valve flow. The Factory shall provide airflow performance with listed potentiometer values to airflow values specific for each air valve as determined during the factory airflow station testing and valve characterization & calibration verification.**

.10 **Pressure Differential Pressure Tapping:** Air valves shall be supplied with a factory installed pressure taps to allow for measuring the differential pressure across the valve venturi and future upgradability.

.11 **Air Valve Airflow Certification:** Each airflow control device shall be factory calibrated to the job specific airflow's as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than ± 1% of signal over the entire range of measurement.

.12 **Air Valve tagging and records:**
All airflow control devices shall be individually marked with device specific, factory calibration data. As a minimum, it should include tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

PART 3 EXECUTION

3.1 SYSTEM START-UP AND TRAINING

.1 A factory-authorized representative of the laboratory airflow controls manufacturer shall provide on-site assistance to balancing contractor as required. The Balancing Contractor shall be responsible for final verification and reporting of all airflows.

.2 The airflow control system supplier shall provide a minimum of four hours of owner training, by factory trained and certified personnel.

3.2 ELECTRICAL COMPONENTS, WIRING AND CONDUIT

.1 No electrical connection required.

3.3 LABORATORY AIRFLOW CONTROLS SEQUENCES OF OPERATION:

.1 **Variable Volume Exhaust Airflow Control:**

1. Provide for pressure independent phenolic coated Venturi Air Valves fast acting to provide variable airflow control from existing fume hoods and/or other connected Lab Exhaust devices.

.2 **DDC Control System interface:**

1. No external Controls or Monitoring required. Provide

3.4 Manufacturer's Instructions

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

3.5 Installation

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Locate so that controls, dampers and access panels are easily accessible.

3.6 Field Quality Control

.1 Commissioning:

.1 In accordance with Section 01 91 00 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems.

3.7 Cleaning

.1 Proceed in accordance with Section 01 01 50 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 GENERAL

RELATED SECTIONS

.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 25 05 01 - EMCS: General Requirements

REFERENCES

.5 Test the existing "as-installed" fume hoods and associated fan system modifications to applicable governing standards, such as but not limited to Worksafe BC OHS Regulation 30 and PWGSC MD15128-2013 Laboratory Fume Hoods.

.6 Canadian Standards Association (CSA)

.1 CSA C22.1 Canadian Electrical Code Part 1

.2 CSA Z316.5 Fume Hoods and Associated Exhaust System.

.7 CSA National Standards Institute (ANSI)/American Industrial Hygiene Association (AIHA)

.1 ANSI/AIHA Z9.5 Laboratory Ventilation.

.8 American Society for Testing and Materials (ASTM)

.1 ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

.2 ASTM A480/A480M: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

PERFORMANCE REQUIREMENTS

.9 Upgraded Fume hoods shall be tested to meet or exceed the Worksafe BC OHS Regulation 30 and PWGSC MD15128-2013 Laboratory Fume Hoods.

PART 2 PRODUCTS

EXISTING LABORATORY FUME HOODS

.1 Fume Hood Materials:

.1 Provide professionally fabricated and installed a blank-off plate at the existing fume hood sash bypass air opening. Basis of Design: H.H. Hawkins custom designed & fabricated panels to match existing fume hood interior liner construction

.2 Exterior Panels and Framing Members; Cold rolled and leveled mild steel; zinc plated. Interior fastening devises; truss head stainless steel screws. Exterior panel ASTM A1008 finished as in art. 2.4.

.3 Screws: For attachment of exterior structural member; sheet metal type, zinc plated. Interior fastening devises; truss head stainless steel screws. Exterior panel members shall be fastened by means of concealed devices. Exposed screws are not acceptable.

.2 FUME HOOD FINISH

.1 Colours: Provide fume hoods in manufacturer's colours as selected by Departmental Representative. A one or two colour scheme may be used.

.3 AIR FLOW MONITOR/ALARM

.1 Existing fume hoods shall be equipped with a low air flow monitor/alarm system provided by Controls Contractor. Remove existing air flow monitors. Refer to Section 25 05 01 - EMCS: General Requirements

.2 The alarm assembly shall consist of an enclosure complete with all internal wiring and electrical components, a pressure differential switch, a sensor and connecting plastic tubing. All electrical components shall be UL and CSA certified.

.3 Low air flow condition signal shall consist of an audible buzzer and a signal red jewel light signal light. All wiring of hood alarm system shall meet UL and CSA certification approval, and shall be prewired to spec. grade duplex outlet box mounted on top of fume hood superstructure

.4 It shall be possible to silence the audible portion of the alarm by pressing a silencing relay switch.

.5 When low flow condition is rectified and face velocity and volume return to specified levels, system shall automatically reset and begin monitoring function.

.6 An amber pilot light shall energize when the system is on.

.7 Installation instructions and readjusting procedures shall be supplied with each unit.

.8 Test circuits, relays and switches shall permit verification of signal function by user.

.9 Entire system shall be tamper resistant. Systems that permit users to easily reset signal points are not acceptable.

.10 Low flow monitor system shall provide for remote signal locations by the addition of alarm boxes and the necessary wire.

PART 3 EXECUTION

INSTALLATION

.1 Work in close cooperation with other trades installing Air Valves, ductwork, wiring and other services.

END OF SECTION

PART 1 GENERAL

1.1 Halocarbons

.1 Comply with all of:

.1 Federal Halocarbon Regulations, 2003;

.2 *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems* (the Environment Canada "Refrigeration Code of Practice") Cat. No.: En14-207/2015E-PDF. . April, 2015.

.2 Work on Halocarbon Systems includes installation, servicing, leak testing or charging of a refrigeration system or an air-conditioning system or doing any other work on the system that may result in the release of a halocarbon.

.3 All work on Halocarbon Systems shall be carried out only by a "Certified Person" as defined by the Federal Halocarbon Regulations 2003.

.1 Provide copies of all technicians' certificates to the Departmental Representative.

.4 Halocarbons listed under Item 1 through 10 of Schedule 1 of Federal Halocarbon Regulations, 2003 (SOR/2003-289) are <u>not</u> acceptable refrigerants.

.5 Document **all** work on Halocarbon Systems using CSCs halocarbon form "**Information Required for Refrigeration Systems at Federal Correctional Facilities**". Obtain the latest form from Departmental Representative. Affix the completed form to equipment, and submit a copy of the form to Departmental Representative.

.6 Comply with the following timelines:

.1 Upon delivery of halocarbon-containing equipment to site, submit the following information to Departmental Representative within 24 hours of service;

.1 Make

.2 Model

.3 Serial number

.4 Type of halocarbon

.5 Halocarbon charging capacity of system (kg or lbs)

.6 Factory Halocarbon Charge (kg or lbs)

.7 Cooling capacity (kW, Btuh, or Tons)

.2 Leak-test factory-charged halocarbon-containing equipment containing over 10kg of refrigerant in accordance with the Refrigeration Code of Practice within one week of equipment delivery to site.

.3 Leak-test field-charged halocarbon-containing equipment in accordance with Section 4.4 of the Refrigeration Code of Practice at the time of field charging of system.

.4 For all work on Halocarbon Systems, submit forms to Departmental Representative within 48 hours of work.

.5 For release of halocarbons >10 kg and <100 kg, submit forms to Departmental Representative within 24 hours of discovery of release.

.6 For release or potential release of halocarbons > 100 kg, submit forms to Departmental Representative **immediately**.

.7 Conduct annual leak tests of halocarbon-containing equipment with 19kW (5.4 tons) or greater cooling capacity in accordance with the Federal Halocarbon Regulations, 2003 until such time as Interim Certificate of Completion is issued.

END of SECTION

AIR HANDLING UNITS								
Mark		AHU-5E						
Service		Building B						
SF-5	Supply Fan Air Flow - L/s (cfm)	4,840	10,250					
	Supply Fan total S.P. - Pa (in w.g.)	1,375	5.50					
	Supply Fan Size/Type	APF						
	Supply Fan RPM							
	Supply Fan BHP | Horsepower	-	20					
Power		600/3/60						
Weight - kg (lbs.)								
Notes		1						

Refer to specification for accessories not scheduled.
Refer to drawings for installation details.
Static pressures noted are fan total pressure.
Motors to be sized so normal operating load is not more than 90% of rated motor capacity.

1. Complete with supply fan VFD, single power connection, and disconnect.

VARIABLE AIR VOLUME AIR TERMINAL UNITS (Single Duct)										
Mark	FEV- 26		FEV- 27		FEV- 28		FEV- 29		FEV- 31	
Model	size 8		size 8		size 8		size 8		size 8	
Air Flow - L/s (cfm) - minimum	63	133	63	133	63	133	63	133	63	133
Air Flow - L/s (cfm) - maximum	241	510	257	545	255	540	212	450	236	500
Minimum pressure drop - Pa (in w.g.)	75	0.3	75	0.3	75	0.3	75	0.3	75	0.3
Maximum pressure drop - Pa (in w.g.)	750	3	750	3	750	3	750	3	750	3
Notes	1		1		1		1		1	

Mark	FEV- 32		VAV- 609		VAV- 611		VAV- 613		VAV- 617	
Model	size 8		size 8		size 8		size 8		size 8	
Air Flow - L/s (cfm) - minimum	63	133	55	115	55	115	55	115	55	115
Air Flow - L/s (cfm) - maximum	241	510	222	470	219	465	189	400	217	460
Minimum pressure drop - Pa (in w.g.)	75	0.3	75	0.3	75	0.3	75	0.3	75	0.3
Maximum pressure drop - Pa (in w.g.)	750	3	750	3	750	3	750	3	750	3
Notes			2		2		2		2	

Mark	VAV- 619		VAV- 620							
Model	size 8		size 8							
Air Flow - L/s (cfm) - minimum	55	115	55	115						
Air Flow - L/s (cfm) - maximum	205	435	222	470						
Minimum pressure drop - Pa (in w.g.)	75	0.3	75	0.3						
Maximum pressure drop - Pa (in w.g.)	750	3	750	3						
Notes	2		2							

Units to be pressure independent and interlocked with fume hood sash sensor.

Notes:

1. Air terminal unit shall be Low-Pressure variable air volume supply valve.
2. Air terminal unit shall be Low-Pressure variable air volume exhaust valve.

SPLIT AIR CONDITIONING UNITS										
Indoor Unit Mark	IAC-1									
Location	B112									
Type	Indoor Ceiling									
Nomial Capacity - kW (MBH)	12.3	42								
MCA	2									
Max. Fuse	15									
Weight - kg. (Lb.)	25.0	55								
Condensing Unit Mark	CU-1									
Location	Roof									
Power Supply	208/1/60									
SEER	14.4									
Weight - kg. (Lb.)	112	247								
MCA	26									
Breaker	40									
Power	208/1/60									
Notes	1, 2									

Provide the following optional accessories:
Condensate pump and reservoir sensing w/ alarm contact monitored by DDc.
-Input/output Interface module for connection to DDC. See Specification 25 90 11.
points list to control on/off, setpoint, operation mode, fan speed. Monitor unit status & space temperature.
- Wired space wall-mounted controlller.
-Provide appropriate Windscreen on outdoor air unit outlet, allowing operation down to -29 deg. C
outdoor air temperature.
Refer to Specification for accessories not scheduled. Refer to drawings for installation details.

As part of the shop drawing submission, the Refrigeration contractor shall prepare and include the coil and condensing unit balance curves detailing the S.S. temperature, the estimated line loss, and the system balance point that meets the required total and sensible cooling capacities at the specified ambient temperatures. A refrigerant piping schematic, showing refrigerant pipe sizes, lengths, and refrigerant receiver size requirement, shall also be submitted to confirm installation is in accordance with manufacturer's recommendations, and does not contravene warranty requirements. Refrigeration contractor shall employ equipment manufacturer's service representative to supervise system start up and instructing of Owner's personnel.

Notes:
1. Single point power connection at condensing unit.

PART 1 GENERAL

1.1 Related Sections

.1	Section 01 01 50	General Instructions
.2	Section 01 91 00	Commissioning
.3	Section 23 05 00	Common Work Results - Mechanical
.4	Section 23 08 00	Commissioning of Mechanical Systems
.5	Section 23 38 16.13	Fume Hoods (Existing Laboratory Fume Hoods)

1.2 General

.1 Provide, install, program and commission a BACnet-based DDC controls system to achieve the performance specified in the following clauses. **The DDC controls system shall be integrated to the incumbent Johnson Controls [JCI] DDC system.**

Provide Johnson Controls [JCI] DDC system installed by factory-trained Authorized Dealer.

Controls Contractor to:

a. Remove and blank off all existing manual FEF on-off switches at individual fume hood cabinets. Remove existing fume hood air flow monitors.

b. Provide new pressure-independent, venturi-type, fast-acting (<1s), VAV fume hood exhaust valve (FH-EXV) on the fume hood exhaust air ductwork and matching fume hood sash height sensor to properly regulate variable air flow in response to sash height. The system shall be complete with an airflow monitoring device, provided and interfaced with DDC by Controls contractor that will enter an alarm mode should the actual airflow through the sash operate beyond Worksafe BC limits.

Provide Fume Hood Ventilation Control System: Low-Pressure Venturi Valve, Sash Sensor, Touch- screen multi-function fume hood monitor, and Room Controller for BACnet BMS compatibility. All equipment and wiring to be provided by Controls Contractor.

c. Provide a new pressure-independent, venturi-type, fast-acting (<1s) VAV fume hood make-up air valves (FH-MAV) on the room supply air ductwork to properly regulate the variable make-up air flow in response to fume hood operation.

Provide Fume Hood Ventilation Control System Low-Pressure Venturi Valve

d. Expand the existing Johnson Controls (JCI) DDC system to monitor the operating status of all new fume hood ventilation control systems. Parameters such as sash height and airflow of each fume hood (and associated supply air VAV box) shall be readily viewable by the Building Operator.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.

.2 Control devices as listed in I/O Summaries.

.3 Data communications equipment necessary to effect an EMCS data transmission system including gateway and LAN hardware and software for connection to incumbent BACnet network.

.4 Field control devices.

.5 Software and graphics upgrade complete with full documentation for software and equipment.

.6 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.

.7 Acceptance tests, technical support during commissioning, full documentation.

.8 Wiring interface co-ordination of equipment supplied by others.

.9 Miscellaneous work as specified in these sections and as indicated.

.3 Acceptable Material (BACnet-based):

.1 Johnson Controls.

1.3 Metric Reference

.1 Conform to CAN/CSA-Z234.1.

.2 Provide required adapters between Metric and Imperial components.

1.4 Standard Compliance

.1 All equipment and material to be from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.5 Existing Control Components

.1 Utilize any existing control wiring and/or piping as indicated.

.2 Field control devices that are usable in their original configuration may be re-used provided that they conform to applicable codes, standards, specifications. Do not modify original design of any existing devices without written permission from the Departmental Representative. Provide for new, properly designed device where components are not certain as to reusability. Provide list of equipment so included in bid. Include unit price of all for this equipment.

.3 Within 30 days of award of contract, and prior to installation of any new devices, inspect and test all existing devices intended for re-use. Furnish test report listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.

.4 Non-functioning items:

.1 Provide with report specification sheets or written functional requirements to support findings.

.2 Departmental Representative will provide directions related to repair or replacement existing items judged defective yet deemed necessary for EMCS.

.5 Submit written request for permission to disconnect any controls and to obtain equipment downtime before proceeding with work.

.6 Assume responsibility for existing controls to be incorporated into EMCS, to commence upon approval for disconnection of controls or equipment downtime.

.1 Be responsible for repair costs due to negligence or abuse of Owner's equipment.

.2 Responsibility for existing devices to terminate upon acceptance of EMCS or applicable portions thereof.

.7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

1.6 Submittals

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

.2 Provide six copies of schematic control diagrams for review. Each valve, actuator and instrument shall be given an identification label which will refer directly to control diagram.

.3 Provide damper shop drawings which include data such as arrangement, velocities, and static pressure drops for each system on shop drawings.

.4 Provide shop drawings including complete operating data, system drawings, wiring diagrams, and type written detailed operational description of sequences, and description and engineering data on each control system component.

.5 At completion of work, make detailed check of automatic control system and submit written report to the Departmental Representative.

.6 Provide sufficient copies of complete parts and repair manuals for binding in O&M Manuals.

.7 Provide "record" control drawings and schedules; incorporate into O&M Manuals.

.8 The submittals shall be prepared using the dynamic graphics software normally provided with system and be incorporated into the dynamic graphics system for on-line reference. Provide original, registered software disks of Windows, the Graphics Software package, the Operating System software, and the project graphic schematics, floor plan layouts, and control drawings.

1.7 Extra Materials

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

.2 Provide following:

.1 Two (2) Air Valves of each type.

1.8 Preliminary Design Review Meeting

.1 Convene a Preliminary Design Review meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Departmental Representative retains right to revise sequence or subsequent Control Description Logic prior to software finalization without cost to Departmental Representative and Owner.

1.9 Monitoring and Control Features

.1 Operator defined digital and analogue alarms and automatic alarm condition reporting.

.2 Direct keyboard override of all inputs and outputs, with an indication on the display for any point that is operating under keyboard override.

.3 Addition, deletion, definition and modification of all points from operator keyboard.

.4 Trend log graphing and reporting of user selected points at user defined intervals.

.5 Run time logging of digital points.

.6 Ability to accept a variety of standard analogue and digital input signals.

.7 Ability to generate a variety of standard analogue and digital output signals.

1.10 Offline Storage

.1 The DDC system shall have the capability to be taken off-line in the event of failure or for maintenance and returned to operation without the need for entering any portion of the software program manually.

.2 An off-line disk storage device shall be utilized to provide software backup and reload. Backup and verification of the entire system, with full applications software, shall be less than TWO (2) seconds per real point.

1.11 Power Surge Protection

.1 The DDC system shall be protected from power line surges and voltage transients by installation of a power line filter.

1.12 Power Failure Protection

.1 The DDC system shall have automatic protection from any power failure of at least TWENTY-FOUR (24) hours duration.

.2 This protection shall at a minimum include continuous real-time clock operation and automatic system restart upon power return.

.3 Outputs shall have the option of being set to “staggered start” upon power reset.

1.13 Electrical Components, and Conduit

.1 Provide all control system components, except those supplied as part of packaged equipment controls, but including all auto sequencing devices, electric relays, safety devices and electrical interlocks required to accomplish specified sequences. Refer to the electrical motor schedule in the electrical drawings and/or specification, which delineate the limits of electrical work in Division 26 (Electrical) serving mechanical systems.

.2 Provide all control circuit transformers required for control systems and not supplied by Division 26 including line voltage power connection from indicated outlets shall be included by Division 23.

.3 All line voltage wiring shall be copper with RW90 X-Link P.E. insulation #12 minimum size. AWG wire shall be sized to meet code.

.4 Wiring is to be in conduit in all wall spaces and exposed locations as well as in pipe chases, service spaces, attics, and crawl spaces which are entered for service access. Wiring in suspended ceiling spaces does not require conduit but shall be neatly installed parallel to building lines using bridle rings. All wiring installed under this contract shall be plenum rated FT-6 or FT-4, if approved by all authorities having jurisdiction. Locate wiring away from top or bottom of ceiling joists or trusses to minimize possibility of accidental damage. Number 18 gauge wire may be used in Class 2 circuits unless voltage drops are excessive. THHN wire will not be acceptable. Twisted shielded wiring, minimum of 22 gauge wire shall be used for all DDC or co-axial communication wiring. Line voltage alternating current wiring shall not be run in the same conduit, or cabling as DDC wiring.

.5 Use 1m of flexible conduit for all connections to vibrating equipment. Use liquid tight flex cable and connections where required.

.6 The Control Contractor shall locate magnetic starters from the electrical drawings. All electrical work provided by this Contractor shall comply with all requirements of the Division 26 electrical specification, the Canadian Electrical Code and Local Codes and Ordinances.

.7 Wire all line voltage thermostats, pressure switches or aquastats for single phase equipment.

.8 Division 26 has been requested to provide specific devices, including magnetic starters supplied with 120 volt holding coils, HOA switching and space for the addition of auxiliary contacts. The Control Contractor shall provide all necessary normally open and normally closed contacts, wired to a terminal strip within the starter enclosure, required to achieve the specified control interlocking and sequencing. Manual starters for 120 volt equipment are to contain On-Off selector, external H.O.A., integral overload protection and pilot lights. The Controls Contractor shall provide control wiring interlocks from the control contacts provided on the automatic branch lines of the assembly, which will be contained within the associated Motor Control or Starter Assembly.

.9 Refer to Division 26 Specifications and Motor Schedule for the scope of work to be provided by the Electrical Contractor. Division 23 shall supply and install all components, in addition to those outlined within the Division 26 documents, as may be deemed necessary to provide all interlocks or sequences as called for elsewhere within the specifications. Include for the supply and installation of 2- 4 pair U.T.P. Level 5, plenum rated cables from the hub location to the communications backboard. Coordinate with Division 26 and the Owner for interconnection of the hub into the Telephone System services.

.10 All power supplies for controls are this Contractor's responsibility unless otherwise specified in the Electrical Specifications. All control transformers to be located in fan rooms or mechanical rooms only and are to be mounted in serviceable locations.

.11 Line voltage will not be run with signal or trunk wiring or be present in the same junction box.

.12 All shielded wiring will be grounded at the BMS panels and prevented from grounding at the terminal end.

.13 Run all wiring parallel to building lines. All wiring to be installed in a neat, workmanlike manner.

.14 Support wiring independent of piping, ductwork, and equipment. Keep wiring clear of hot piping, ductwork/equipment.

.15 Identify all junction boxes with control company label.

.16 There are to be no splices in any of the control wiring except at devices or control panels.

1.14 Identification, Calibration and Programming

.1 Provide a written sequence of operation for each piece of equipment or system being controlled that does not require knowledge of DDC programming. Provide a print out of the complete data base, including program listings, inputs, outputs, controllers, virtual points, trend logs, alarm points, etc. Provide in an organized manner, separated for each panel.

.1 Procedures for daily operation of the system.

.2 Theory of operation of the equipment.

.3 Theory of operation of the control program.

.2 Mount an input/output layout sheet within each controller. This sheet shall include the name of the points connected to each controller channel.

.3 Identify all controllers and associated devices with symbols relating directly to the control diagram. Provide plastic labels for each input and output point with the following information:

.1 Point descriptor.

.2 Point type and channel number.

.3 Corresponding controller number.

.4 Program each controller immediately following installation. Setup and tune all control loops during the initial start-up of the systems. Submit a well documented print out of the controller program for review.

.5 At the time of the Owner's Demonstration and Instruction Period:

.1 Demonstrate and confirm that all systems are programmed and operating correctly. Submit trend logs, 1 week in duration, that confirm systems are operating as designed and follow the internal building loads in an energy efficient manner.

.2 Submit CD’s (including back-up diskettes) containing up to date copies of the programs in each controller.

.3 Submit (4) CD’s with printed PDF copies of the final programs that include all point definitions, weekly and annual schedule settings, controller setpoints and tuning parameters, and documented general control language programs. (As Built control shop drawings)

.4 Provide the original software diskettes and the users manuals for all software programs provided as part of this contract. Provide one set of original disks for each notebook, laptop, and desktop computer the software has been installed on. The controls contractor shall be responsible for registering all software with the manufacturer in the owner's name. Provide copies of the registration of all software to the Departmental Representative as part of the final inspection.

.6 Check sensor calibration and control system operation twice during the first year of operation including the first heating season and prior to the first cooling season. Include all parts and labour in service. Following each visit submit:

.1 A report indicating all work performed.

.2 Printed graphs of trend logs one week in duration with hourly samples for all analog inputs connected to each controller.

.3 Update printed and diskette copies of any changes made to programs for any controller.

.7 Provide one day of on-site instruction to the Owner's operating personnel during the first year of operation, scheduled as requested by the Owner, during one or more of the 2 visits.

PART 2 PRODUCTS

2.1 Not Used

PART 3 EXECUTION

3.1 General

.1 Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats and temperature sensors 1.5m above floor.

.2 Install damper motors on outside of ducts. Do not locate in outside air stream.

.3 The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances.

.4 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.

.5 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

.6 Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation.

.7 Permanently identify each wire, cable, conduit and tube at each terminal.

.8 Wiring and tubing shall be identified at each DDC panel by termination number. Wiring and tubing shall be identified at terminal device by termination and DDC panel numbers.

.9 All transmitters, interfaces, terminations and control relays, etc. shall be mounted in field cabinets that may be locked.

.10 Freeze protection devices shall be hard wired and also wired to alarm through DDC system.

.11 All wall mounted devices in new finished space shall be mounted on a wall box. The wall box shall be connected to the ceiling space by a conduit stub. On renovations, when sensors are mounted in existing finished walls, wiring or tubing may be fished into the walls without conduit.

3.3 Enclosure and Conduit

.1 Relays, transformers, and I/O devices and peripherals shall be installed in separate enclosures and not in the enclosures containing the controllers.

.2 All wires penetrating the enclosure that are not required to be in conduit must be neatly bundled and strapped in place.

.3 All Building Controllers will be installed in CSA rated enclosures that are complete with hinged and key-locked doors. The door will be painted and labeled suitably bearing the manufacturer’s system name/logos, the controller address, and the installing contractor’s contact information. This enclosure will be mounted at a height that provides easy access without the need of a ladder.

.4 A hard points list shall be affixed on the inside of the door/cover of the enclosure.

.5 The inside bottom of the enclosure shall be clean of dirt, metal shavings, and debris.

.6 Provide EMT conduit with set screw metal fittings where wiring is exposed and in all mechanical rooms. All conduit will be piped smoothly and neatly following building lines. Wiring above accessible ceilings and in wall cavities may be run free-air.

.7 Liquid-tight flexible conduit to be used for rooftop unit wiring c/w liquid-tight fittings. Provide spun aluminum roof jack where control wiring penetrates roof unless penetration is within waterproof rooftop unit curb.

.8 All junction boxes will have covers properly and firmly affixed after installation completion.

3.4 I/O Wiring

.1 All input/output device wiring will use #18-2 solid core cable with individually jacked conductors and jacketed sheath over the pair.

.2 Use plenum cable where required.

.3 All I/O wiring passing near or within the enclosure of a VFD will be shielded, with the shield terminated at the device end.

.4 All I/O wiring will be identified using Panduit adhesive wire-marker at the controller and end device ends. Description of point to include point mnemonic, point type and network location.

.5 All I/O wiring within controller enclosure shall be neat and tidy and suitably bundled and strapped or contained in plastic wire duct or equivalent.

.6 All I/O wiring that requires a transition to a different conductor to meet electrical code requirement shall be executed using a terminal strip.

.7 Low voltage I/O wiring may be mixed together within a conduit. Low and line voltages may not be mixed together within a conduit.

3.5 Power Wiring

.1 Provide power wiring and transformers and grounding to each controller and transducer as per the manufacturer’s specification.

.2 Each Building Controller will have its own dedicated power supply. No other controller or I/O device will be powered from this supply.

.3 Power wiring shall not be mixed with I/O wiring in a conduit.

3.6 LAN Wiring

.1 Provide LAN wiring as per manufacturer’s specification.

.2 For EIA-485 LAN wiring, use low capacitance shielded #18-2 or #22-2 cable. Ensure that each contiguous section of shield is terminated at a single point.

3.7 Control System Commissioning

.1 Upon completion of the installation of the controls system and the calibration of all sensors, this Subcontractor shall carry out all required testing, debugging, and revision of operations to suit the intent of the Sequence of Operation and to the review of the Consultant.

.2 The contractor is to supply digital point and non digital checkout data sheets for all controlled components installed in this contract, including components supplied by others. The data sheets shall indicate each components physical installation is complete, End to End, identification, tagged, the result of the functional test, calibration deviation recorded, setpoints and set-up of each device, digital and non digital.

.3 Each digital input or control device shall be checked by physical operation of the monitored device in the field with the result noted. Each digital output or controlled device shall be commanded or tested On/Off, Open/Close as required and the corresponding field device checked for correct operation with the result and comments noted.

.4 Each analog input or control device shall have its field values measured with a calibrated test instrument, with the deviation recorded and adjusted, if necessary, at the AI set up. The field measurement and analog point deviation must be reported. A hard copy of the set up for each digital and non digital controller with adjustments is required. Field set up and setpoints of other devices shall be reported.

.5 Each analog output, control or controlled device shall be field tested. The physical test data sheet is to indicate each controlled device function through its range 0, 25, 50, 75, 100% and 1 to 100% as required with no leakage or bypass of the controlled medium.

.6 Submit copies of all test data sheets intended to be used to the Departmental Representative and Commissioning Authority prior to the contractor's verification at least three months before the scheduled substantial completion of the project.

.7 The controls contractor shall provide sequence of operation check sheets, to the Departmental Representative, Commissioning Agent and Commissioning Authority, in standard letter size for each DDC and non DDC system sequence. Each sequence to be verified with each item/page signed off with comments noted.

.8 The commissioning contractor is not to commence controls checks until the above documentation is received. The Temperature Control Supplier and Installer shall loan a current copy of all control software/devices needed for full access to the control system, at no charge to the Commissioning Agent. The software/devices shall be returned to the Control Supplier in good working order at the completion of the commissioning process, or the Commissioning Agent must reimburse the Temperature Control Supplier for the purchase price of the material.

.9 All documentation, tagging, identification, as-builts, software, instruction manuals, special control connection to access all devices and panels must be in place before the granting of substantial performance.

.10 The Controls Contractor shall loan a current copy of all control software/devices needed for full access to the control system, at no charge to the Commissioning Agent. The software/devices shall be returned to the Controls Contractor in good working order at the completion of the commissioning process, or the Commissioning Agent must reimburse the Controls Contractor for the purchase price of the material. The Temperature Control Supplier shall cooperate fully with the Commissioning Agent to work together to obtain a fully operating system, providing additional technicians and trades people to assist the designated commissioning person as required. Refer to Section 01 91 31 – Commissioning Plan.

.11 The controls contractor is to provide the technicians for field checks, calibration, checkouts, and commissioning necessary for a complete and fully operational system. Provide two 2-way portable radios for the commissioning period.

.12 For existing air handler AHU-5, prior to switching to new supply fan SF-5:

.1 Include End to End checks of all controlled devices (inputs and outputs).

.2 All existing analogue outputs shall be tested at 0, 50 and 100%.

.3 Points list of existing systems to be provided by PESC.

.4 Report problems found to the Commissioning Authority and Departmental Representative.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 33 00 Submittal Procedures

.2 Section 25 05 01 EMCS: General Requirements

.3 Section 25 90 11 EMCS: Sequence of Operation,

1.2 References

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE).

ASHRAE, Applications Handbook, SI Edition.

ASHRAE Standard 135 – BAC net – A Data Communications Protocol for Building Automation and Control Networks.

ASHRAE Standard 135.1 Method of Test Conformance to BAC net.

.2 Canadian Standards Association (CSA)

C22.2 No.205, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE)

IEEE C37.90.1, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.3 Maintenance Procedures

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 01 - EMCS: General Requirements.

1.4 Submittals

.1 In accordance with Section 25 05 01 - EMCS: General Requirements. Submit product data sheets for each product item proposed for this project.

PART 2 PRODUCTS

2.1 System Descriptions

.1 Provide a fully networked system of controllers which use LAN communications to support the distributed control features as specified herein. Each controller shall be connected directly to the LAN. Each controller shall have equal LAN access priority and shall NOT REQUIRE A SEPARATE GATEWAY or interface controller to accomplish normal, network communications.

.2 Provide a means to ensure communication integrity. At a minimum indicate for each controller in system: on-line/off-line status, residence of program or no program, the scan rate (frequency at which the controller updates all I/O and runs all programs), the number of network points imported and exported.

.3 The system will display an error message, in the event of a communication error.

.4 To prevent damage to the system, each connection to the LAN shall be provided with a means of isolation, either optically or fast-blow fuse or by some other means.

.5 Upon failure of the LAN to communicate information, each controller will retain the last legitimate value of its imported network points, and continue to control the systems based on those values. Failure of any controller, or any part of a controller on the LAN, shall not affect the ability of the LAN to communicate among the remaining controllers.

.6 Each hard point and soft point shall have a user-definable, unique, system-wide logical point mnemonic. The format of the point mnemonic shall conform to the naming convention of the incumbent system.

2.2 Memory

.1 Each controller shall have enough random access memory for all of the following:

.1 Variables - ONE (1) for each hard point connected to the controller.

.2 PID Controllers - TWO (2) for each analogue output point connected to the controller.

.3 Weekly Schedules - ONE (1) for every major system connected to the controller.

.4 Annual Schedule - ONE (1) for the entire LAN.

.5 Trend Logs - ONE (1) for each pair of hard points connected to the controller with 100 samples each.

.6 Runtime Logs - ONE (1) for each digital hard and soft point.

.7 Programs - ONE (1) for each output point connected to the controller. Each program must contain enough memory for TWENTY (20) syntactically correct lines of OCL with at least four operators.

2.3 Processing Speed

.1 Scan Rate - The maximum permissible scan rate is ONE (1) second. The scan rate is defined as the time it takes to controller CPU to sample all inputs, calculate all variables, update all timers and PID controllers, check all schedules, update all trend logs and runtime logs execute all OCL programs and assign values to all outputs.

2.4 Building Controllers

.1 Building Controllers shall reside on the main LAN or highest level of communication.

.2 The controller shall communicate on the main LAN using either Ethernet (IEEE.802.3) with TCP/IP and/or EIA-485.

.3 In addition to main LAN communications, the controller shall support EIA-485 subLANs, PC, modem and intelligent thermostat communications.

.4 The controller shall have at least one port (other than the PC port) which can be configured to BACnet conformance class 3 using EIA-232 point-to-point communications for interface to other BACnet products.

.5 The controller must be modular in design with removable I/O device terminations on separate I/O cards for ease of expansion and replacement.

.6 Controllers will accommodate a maximum of 160 universal I/O points on board using a single address.

.7 All I/O points must be universal (i.e. user definable as digital or analogue). Dedicated analogue/digital points will not be accepted.

.8 All outputs must have optional HOA on board for easy override by non DDC users.

2.5 VAV Controller

.1 VAV Controller (BACnet overview): A VAV Controller is VAV terminal unit controller with integral damper actuator and on-board differential pressure based flow measurement.

.1 Data Sharing - Ability to provide the values of any of its BACnet objects and Ability to allow modification of some or all of its BACnet objects by another device.

.2 Device and Network Management - Ability to respond to information about its status.

.2 VAV Controllers shall be used for dual duct mixing boxes and single duct air terminal units.

.3 VAV Controllers shall communicate on the main LAN or subLAN using EIA-485 (MSTP). In addition to main or subLAN communications, the controller shall support PC and/or modem communications and intelligent thermostat communications.

.4 Programming the controller shall be accomplished over the LAN or directly via PC and will not require the mandatory use of any other special interface hardware or a Building Controller. Firmware based programming will be accepted.

.5 Provide 120v-24vac transformers for controls.

2.6 Operator Interface - General

.1 Upgrade software on incumbent operator work station (OWS). The software shall communicate with the DDC system via Ethernet, PC direct connection or modem. Access to the system shall be available by all three methods simultaneously.

.2 Off Line Programming: The software shall have a “simulator” facility that allows controllers to be fully programmed off line without the need of any controller hardware.

.3 Database Programming: The software shall allow the operator to easily program and modify the complete database of any controller.

.4 Operator Control Language (OCL) Programming: The software shall allow the operator to easily program and modify the control strategy language for any controller.

.5 Graphic Programming: The software shall allow the operator to easily utilize colour graphics in generating user defined, dynamic data displays or system groups. The graphic images are created in any third party application (e.g. CorelDraw, Macromedia Fireworks, Adobe Illustrator, VisioTechnical, etc) and exported as a bit mapped image (.bmp, .tif, .png) for use within the DDC system. The operator shall be able to annotate the graphic with any combination of hard points, soft points, and keywords, and have the ability to link any group to any other group from any controller in the system. The operator will have the ability to display either the description, value or status of a point, using any colour. Any point shall have the ability to be hidden from view, yet retain functionality if accessed. The graphics must support mouse and keyboard cursor access. Each system group graphic will accommodate 160 annotations.

2.7 Operator Control Language

.1 The Operator Control Language (OCL) will support the concept of output oriented code allowing many small individual programs to be written and connected to graphic screens. Each output and/or calculation will have its own dedicated program and not be part of one larger program.

.2 The DDC system shall have the capacity for timed start/stop on daily schedules, as well as the capability for the owner to develop and run user written application programs. For this, the DDC system shall have a proven OCL which shall be capable of reading the value and/or status of all system points and initiating both analogue and digital control actions from any user defined combination of calculations and logical expressions which shall at a minimum include:

.1 Addition, subtraction, multiplication and division.

.2 Square roots, summations, absolute differences.

.3 IF THEN ELSE statements.

Logical “not”, “and”, “or” , “less than”, “greater than”, and “equal to” or their equivalents.

.4 Time delays in seconds, minutes or hours.

.5 Ability to imbed comments in system generated documentation.

.6 Ability to use time-of-day and day-of year in algebraic calculations.

.7 Ability to filter continuous small changes in input signals to prevent equally small increment in output signals from occurring.

.3 All of the above functions must be accomplished via software. FIRMWARE BASED FUNCTIONS WILL NOT BE ACCEPTED.

PART 3 EXECUTION

3.1 General

.1 The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances.

.2 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.

.3 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

.4 Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 01 33 00 Submittal Procedures

.2 Section 25 05 01 EMCS: General Requirements

1.2 References

.1 American National Standards Institute (ANSI)

.1 ANSI C12.7-[1993], Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-[1978(R1987)], Requirements for Instrument Transformers.

.2 National Electrical Manufacturer's Association (NEMA)

1.3 Submittals

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Include:

.1 Information as specified for each device.

.2 Manufacturer's detailed installation instructions.

.3 Pre-Installation Tests

.1 Submit samples at random from equipment shipped, as requested by Consultant, for testing before installation. Replace devices not meeting specified performance and accuracy.

.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 Closeout Submittals

.1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 25 05 03 - EMCS: Project Records Documents.

PART 2 PRODUCTS

2.1 General

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32 °C with 10 - 90 % RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters to be unaffected by external transmitters (eg. walkie talkies).

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 3R enclosures.

.8 Devices to be installed in user occupied space must not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 Averaging Duct Sensors

.1 Shall be installed in all mixed air ducts and/or plenums, discharge air ducts and/or plenums, or any duct and/or plenum where stratification occurs.

.2 Shall have a minimum length of 1.5 meters with a duct and/or plenum cross sectional area of .75 square meters or less, and a minimum length of 6 meters for duct and/or plenum cross sectional areas in excess of .75 square meters.

.3 The sensor shall have thermistor sensing elements with a scale range lookup table in the DDC producing a linear output over its sensing range.

.4 Accuracy: plus or minus 0.05°C at 21°C.

.5 Minimum sensing range: -40°C to 40°C.

2.3 Duct Sensors

.1 Shall be installed in all ducts and/or plenums where stratification of the air flow does not occur.

.2 Shall have thermistor sensing elements with a scale range lookup table in the DDC producing a linear output over its sensing range.

.3 Minimum length: 203mm.

.4 Accuracy: plus or minus 0.2% over its operating range.

.5 Minimum sensing range: 4.5° C to 60°C.

2.4 Immersion Sensors

.1 Shall be complete with a brass immersion well.

.2 Shall have thermistor sensing elements with a scale range lookup table in the DDC producing a linear output over its sensing range.

.3 Accuracy: plus or minus 0.05°C at 21°C.

.4 Minimum sensing range: -40°C to 40°C.

2.5 Room Temperature Sensors

.1 Shall have a blind cover for all applications. Provide a secured temperature sensor for public areas.

.2 Shall have a thermister sensing element producing a linear output over its sensing range.

.3 Accuracy: plus or minus 0.2% over its operating range.

.4 Minimum sensing range: 4.5°C to 35°C.

2.6 Differential Pressure Sensors (DPS)

.1 Shall vary the output voltage with changes in differential pressure.

.2 End to end accuracy: not less than +1% of span including non-linearity, repeatability and hysteresis.

.3 Application: building pressurization control shall have auto-zeroing feature.

2.7 Current Sensors (CT)

.1 Shall vary the output voltage with a change in current.

.2 Provide actual analog current indication for status of all motors 1 horsepower and larger.

.3 In software provide multiple switch points to determine both motor status and belt breakage. Size for inrush and F.L.A.

.4 Provide alarm indication for high and low current.

.5 Provide digital current indication for all motors 3/4 HP and smaller by using current switches (CS) which shall open or close a contact from motor induced current to indicate motor status.

2.8 Room Humidity Sensors

.1 Shall be ultra fast response polymer capacitance sensor, not affected by condensation, fog, high humidity, or contaminants.

.2 Suitable for 12-40 VDC/12-35 VAC unregulated supply voltage and 4-20 ma 2 wire output, or field selectable 0-5 VDC/0-10 VDC output.

.3 Accuracy: plus or minus 2%/3%

.4 Range of 0-100% RH.

.5 Shall have ABS plastic wall mount complete with blank cover with a clear Lexan guard.

.6 Warranty: 2 years.

2.9 Control Valves and Actuators

.1 Provide automatic temperature control valves as scheduled and indicated on drawings. Sufficient clearance above control valves shall be provided to allow removal of superstructure without removing body from line. All valve stems shall be vertical. All electric valves, including zone valves, scheduled for modulating service shall be fully proportional (no floating control) suitable for 0-10 volt, or 4-20 mA input signal.

.2 Control valves, both 2 and 3 way configuration, shall have the following minimum characteristics:

.1 Body shall be brass meeting ANSI Standard B16.15 Class 250 for all valves 50 mm and smaller. Larger valves shall be cast iron, Class 125, meeting ANSI Standard B16.15.

.2 Valve stem shall be 316 stainless steel.

.3 Valves shall have brass plug, composition seat with maximum seat leakage of 0.01% of flow rating per ANSI B16.104, and equal percentage flow characteristic.

.4 Valves for terminal zone coils, fan coils and radiation shall have EPT or TFE packing material and NPT, union or flare connections.

.5 Valves for primary equipment sized 50 mm and smaller shall have screwed connections. Valves sized 65 mm and larger shall have flanged connections.

.6 Ball Valves are not acceptable for control applications.

.3 When more than one control valve is used for temperature or pressure control on a system, or equipment item they shall be sequenced. e.g. two valves on a heating coil or pressure reducing station; heating and cooling coil valves on an air handling system.

.4 Valves on hazardous services shall fail to a safe position. e.g. Valves controlling heating to domestic hot water shall fail closed to heating when not powered.

.5 Actuators shall be of the rotary or piston type for either modulating or two position control. Actuators shall be powered by an overload-proof synchronous motor. Control voltage shall be either 120 VAC, 24 VAC, 10 VDC, or 4-20 mA with spring return on power failure, where required. (ie outdoor air dampers and HVAC primary heating valves). Actuators (motors) shall have repair kits available, and be re-buildable in the field. Provide proportional actuator position feedback on all primary equipment (air handling units) to prove actuator position.

.6 All control valves shall have replaceable bonnets, and packing.

The packing shall be replaceable in the field without having to remove the valve from the piping network.

.7 All control valves shall be sized to deliver the specified flow rate in the 100% open position. Control valves using a "limited stroke" to achieve the proper flow coefficient shall not be used.

2.10 Dampers and Actuators

.1 All control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor. Provide damper actuators for all dampers shown or specified.

.2 All dampers in a mixing application shall be parallel blade with direction of closing producing opposed air streams for optimal mixing. Return air dampers shall be a tight closing, low leakage type with replaceable blade and edge seals, T.A. Morrison Series 1000 or approved equal.

.3 Actuators shall be electronic, direct coupled, as manufactured by Belimo, Siemens, or Approved Equal. Control voltage shall be 0-10 VDC, or 4-20 mA with an internal spring return on power failure. Provide a 2-10 VDC proportional actuator position feedback signal on all primary equipment (air handling units, relief air and emergency generators) to prove actuator position. Actuators shall permit manual positioning of damper when actuator is not powered.

PART 3 EXECUTION

3.1 General

.1 Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats and temperature sensors 1.5m above floor.

.2 Install damper motors on outside of ducts. Do not locate in outside air stream.

.3 The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances.

.4 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

.5 All transmitters, interfaces, terminations and control relays, etc. shall be mounted in field cabinets that may be locked.

.6 Freeze protection devices shall be hard wired and also wired to alarm through DDC system.

.7 All wall mounted devices in new finished space shall be mounted on a wall box. The wall box shall be connected to the ceiling space by a conduit stub. On renovations, when sensors are mounted in existing finished walls, wiring or tubing may be fished into the walls without conduit.

3.2 Sensors

.1 Sensors provided shall be installed in accordance with the Manufacturer's prescribed procedures.

.2 Sensors shall be rigidly mounted and mountings shall be adequate for the environment within which the sensor operates.

.3 Averaging type temperature sensors shall be used wherever mixed air or stratified temperature is to be monitored. They shall be installed in a serpentine configuration with adequate provision for the mechanical protection of the sensor and such that it is supported as required along its entire length.

.4 Duct type Thermistors shall be used for the monitoring of all uniform air temperature. Length shall be such that the sensing element is installed to not less than one third of the duct width or duct diameter from the duct wall.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

.1 Section 25 05 01 EMCS: General Requirements

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 Sequence of Operation

.1 Laboratory Exhaust Fans – Plume Dilution Exhaust Fans [PDEF-1]:

.1 PDEFs shall be started, stopped and monitored at the DDC. Fans shall be interlocked with the operation of AHU-5. Fans shall operate continuously during normal operation.

.2 Normal Operation (Integration with Existing Control Sequence)

.1 On initial start-up, restart due to power failure or return to normal power [Refer to Existing Sequence for Automatic system startup provided by PESC]

.2 Provide a discharge velocity sensor for each of the PDEF fans. The velocity sensor will provide an input to the DDC system which in turn will modulate the outdoor air damper in the exhaust duct plenum to maintain a minimum velocity of 3000 FPM.

Set fan plenum static pressure initially to 750Pa and optimize/calibrate as required for most efficient system operation.

3 Provide a hard wired pressure sensor in the new PDEF plenum. Provide new pressure sensor in each of the laboratory exhaust ducts to shut down the new PDEFs, whenever the pressure in the PDEF plenum exceeds 1250 Pa or the pressure in either of the exhaust ducts exceeds 950 Pa. Provide pressure switches with their own manual reset button and indicating light located on the exterior of the DOC panel enclosure controlling the PDEF. The indicating light will illuminate indicating which pressure switch has tripped and its associated manual reset button must be pressed before the PDEF will re-start.

.4 Only one of the new PDEF are to run at a time with the remaining fan on standby. The fans shall be controlled by their associated variable speed drive (VFD)·in order to maintain the static pressure and the fan discharge velocity at a minimum of 3000 FPM. When the discharge velocity is less than 3000 FPM, the outdoor air by- pass damper shall be modulated to open to provide make-up air to the fans. The associated VFDs shall regulate each fan to the same speed.

.5 The duty fans shall be duty cycled with the standby fan on a two week (adjustable) cycle. The isolation dampers of the stand-by fan shall be normally closed. Upon scheduled changeover or in the event of a failure of one of the PDEF, the isolation damper of the stand-by fan shall open, and the stand-by fan shall be enabled. The by-pass damper modulates to open as needed to maintain internal exhaust duct static pressure.

.6 Upon any fan failure, the DOC system will generate an alarm at the terminal.

.7 The DOC system monitors the HAND/OFF/AUTO switches for the new PDEFs. The DOC system is sent a signal when the HAND/OFF/AUTO switch is in the AUTO position.

.8 An PDEF VFD can be operated in by-pass mode by either operating (turning) the associated by-pass switch on the VFD to the ON position, or by manually turning the associated DOC control point ON.

.9 Provide current sensors installed on each of the new PDEF motors to provide operating feed back to the DOC system. This will allow monitoring of the PDEFs when in by- pass mode and normal operating mode.

.3 Exhaust Fans:

.1 EF-B1 and EF-B2 shall be controlled by wall switches, furnished and installed by Electrical Contractor. Noted for reference only.

.4 Split AC units:

.1 Provide field control wiring between the outdoor condensing unit, indoor fan coil, DDC interface module and wired remote control panel.

.2 Provide on/off, setpoint, operation mode and fan speed control through the DDC system. Monitor unit's status of on/off, alarms, compressor, and operation mode through the existing DDC system.

.3 Monitor condensate pump status.

3.2 Point List

.1 The following point lists are typical of the Analog and Digital output and input points required to achieve the intended sequence of operation and provide the required level of monitoring and control. They are intended to set a minimum level of acceptability. All additional points required to achieve the specified features and sequence of operation shall be provided by the control contractor.

.2

EXHAUST FAN CONTROL (PDEF-1)							
	POINTS				**ALARM/INDICATION**		
POINT DESCRIPTION	**AI**	**AO**	**DI**	**DO**	**HI**	**LO**	**FAIL**
EXH. FANS (START/STOP/STAT)	ASD	ASD		CR			X
AIR PRESSURE PDEF-1	DPS				X	X	

ALL FUME HOOD EXHAUST DUCTS							

.3

SPLIT DX COOLING SYSTEMS							
	POINTS				**ALARM/INDICATION**		
POINT DESCRIPTION	**AI**	**AO**	**DI**	**DO**	**HI**	**LO**	**FAIL**
IAC-1/CU1 START/STOP/STATUS				DCI	CR		X
IAC-1/CU1 MODE OF OPERATION CONTROL AND STATUS	X	X					
IAC-1/CU1 SETPOINT CONTROL		X					
IAC-1/CU-1 FAN SPEED CONTROL		X					
CU1 COMPRESSOR STATUS			X				
CONDENSATE PUMP STATUS	CT						X

.4

EXHAUST FAN CONTROL (EF-B1 and EF-B2)							
	POINTS				**ALARM/INDICATION**		
POINT DESCRIPTION	**AI**	**AO**	**DI**	**DO**	**HI**	**LO**	**FAIL**
EXH. FANS (START/STOP/STAT)	CT			CR			X

NOTE: POINT COUNT IS APPROXIMATE. CONTROLS CONTRACTOR SHALL VERIFY EXACT QUANTITY AND PROVIDE ADDITIONAL POINTS AS REQUIRED TO ACHIEVE THE SEQUENCE OF OPERATION DESCRIBED IN THE CONTRACT DOCUMENT.

ATS	Averaging Temperature Sensor	LTS	Low Temperature Switch
ASD	Adjustable Speed Drive	MOP	Proportional A.O. (4-20 ma)
CDS	Carbon Dioxide Sensor	MD	Motion Detector
CS	Current Switch	O-SW	Override Switch
CR	Digital Relay	OTS	Outdoor Air Temp. Sensor
CT	Analog Current Transformer	POT	Potentiometer
DCI	Dry Contact Input	R-ST	Relay Status

DHS	Duct Humidity Sensor
DMA	Damper Motor (Analog)
DMD	Damper Motor Digital
DPS	Diff. Press. Switch (Analog)
DTS	Duct Temperature Sensor
DHS	Duct Humidity Sensor
ES	End Switch
FSA	Flow sensor - Air
FSW	Flow sensor - Water
RHS	Room Humidity Sensor
RTS	Room Temperature Sensor
SPT	Static Pressure Transmitter
VMA	Valve Motor (Analog)
VMD	Valve Motor (Digital)
VPM	Variable pump motor
VPS	Velocity Pressure Sensor
WTS	Water Temperature Sensor

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

.2 All specification sections prefix-numbered 26

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

.2 Every reference to a CAN/ULC or CSA standard in all sections of the specification shall be a reference to the latest published edition at the time of tender.

1.3 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235. Latest published 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.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.4 SUBMITTALS

.1 Submittals: in accordance with Section 01 11 55 – General Instructions.

.2 Submit copy of electrical permit for the project to Departmental Representative prior to commencement of work. Departmental Representative will provide drawings required by Electrical Inspection Department at no cost.

.1 Pay associated fees.

.2 Notify Departmental Representative of changes required by Electrical Inspection Department prior to making changes.

.3 Furnish certificate of acceptance from Electrical Inspection Department upon completion of the work.

.3 Shop drawings:

.1 Submit shop drawings and product data.

.2 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 Submit 6 copies of shop drawings and product data to the Departmental Representative.

.4 Provide operation and maintenance data for incorporation into operation and maintenance manual specified in Section 01 11 55 – General Instructions.
Include in operations and maintenance data:

.1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.

.2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts list. Advertising or sales literature not acceptable.

.3 Wiring and schematic diagrams.

.4 Names and addresses of local suppliers for items included in maintenance manuals.

.5 Copy of reviewed shop drawings.

.5 Quality Control: in accordance with Section 01 11 55 – General Instructions.

.1 Provide CSA certified equipment and material.

.2 Submit test results of installed electrical systems.

.3 Permits and fees: in accordance with General Conditions of contract.

.4 Submit to Departmental Representative certificate of acceptance from authority having jurisdiction upon completion of Work.

.6 Record Drawings

.1 Provide record drawings of the installation as specified in Section 01 11 55 – General Instructions.

1.5 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 11 55 – General Instructions.

.2 Qualifications: electrical Work to be carried out by qualified personnel in accordance with the requirement of authorities having jurisdiction.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: where applicable separate waste materials for recycling in accordance with Section 01 11 55 – General Instructions.

1.7 SYSTEM STARTUP

.1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Where applicable and as further specified, arrange and pay for services of manufacturer's factory service Departmental Representative to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

1.8 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Section 01 11 55 – General Instructions.

.2 Material and equipment to be CSA certified.

.3 Factory assemble control panels and component assemblies.

2.2 WIRING TERMINATIONS

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

2.3 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: lamicoid plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core attached with Loctite 414 adhesive. No pre-gummed labels are acceptable.

.2 Sizes as follows:

NAMEPLATE SIZES

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

.2 Labels: plastic labels with 4mm high letters unless specified otherwise.

.3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate and label.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects, starters and contactors: indicate equipment being controlled, voltage and circuit number.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

2.4 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1 - 2015

2.5 FINISHES

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 - 2015, BC Amendments, Directives and Bulletins except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

3.3 FIRESTOPPING

.1 Where cables or conduits pass through floors and fire rated walls, pack space full with a ULC approved firestopping system.

.2 Fire stopping is specified in Section 01 11 55 – General Instructions.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

3.5 FIELD QUALITY CONTROL

.1 Carry out tests in presence of Departmental Representative or his representative. Submit written test results for review.

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

3.6 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

END OF SECTION

Part 1 **General.** Not Used

Part 2 **Products.** Not Used

Part 3 Execution

3.1 FIXING, HANGING

.1 All wiring shall be fixed to or hung from building structure and shall not be fixed to or hung from building services, i.e., ducts, pipes, electrical conduits, sprinkler pipes, etc.

3.2 CONCEALMENT

.1 Wiring, in general, shall be concealed where possible. Wiring may be concealed by running on tops of beams to make it invisible from below, in hollow walls and partitions and above ceilings.

3.3 SURFACE WIRING IN FINISHED AREAS

.1 Finished areas of the building are all areas except the mechanical rooms and similar service rooms.

.2 Any wiring proposed to be run exposed in finished areas of the buildings shall not be installed until all means of possible concealment have been investigated with the consultant. Such surface wiring shall be approved by the Departmental Representative as shall the routing.

.3 Surface wiring in finished areas shall be enclosed in EMT unless otherwise indicated.

3.4 USE OF EMT CONDUIT

.1 For concealed wiring:

.1 Wiring in ceiling spaces, e.g. above T-bar or dropped plaster ceilings shall be installed in EMT conduit.

.2 Except as otherwise indicated or specified, all systems shall be wired in EMT conduit.

.2 For exposed wiring:

.1 Exposed wiring installed in electrical and mechanical rooms shall be in EMT or conduit and wire.

3.5 **USE OF FLEXIBLE CONDUIT OR AC (BX) CABLE**

.1 AC (BX) cable or flexible conduit shall not be used except for connections to motorized equipment. Such connections shall be nominal maximum 610mm long. Use PVC jacketed flexible conduit where wiring is exposed to the weather.

.2 Where flexible conduit is used, provide ground bond wire in conduit.

.3 Flexible conduit or AC (BX) cable where used shall be installed on the square parallel to building lines and be straight and taut between fixing points. Provide in excess of code-required fixing points as necessary to maintain AC (BX) cable taut and straight.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for wire and box connectors.

1.2 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

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

.3 Section 26 05 00 – Common Work Results – For Electrical

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2No.65, Wire Connectors. Latest published version.

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper or 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 or copper alloy sized to fit copper conductors 10 AWG or less.

.3 Clamps or connectors as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Install mechanical pressure type connectors and tighten screws or secure with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.

.2 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

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

.3 Section 26 05 00 – Common Work Results – For Electrical

1.2 REFERENCES

.1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables. Latest published edition.

1.3 PRODUCT DATA

.1 Submit product data in accordance with Section 01 11 55 – General Instructions.

Part 2 Products

2.1 BUILDING WIRES

.1 Conductors: Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600V insulation of chemically cross-linked thermosetting polyethylene material rated RW90. Note: THHN not acceptable.

.3 As armoured cable in accordance with Section 26 05 10.

2.2 ARMOURED CABLES

.1 Conductors: Minimum size: 12 AWG.

.2 Type: AC 90

.3 Armour: Interlocking

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34.

.2 As cable systems in accordance with Section 26 05 10.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

.2 Section 26 05 00 – Common Work Results for Electrical

.3 Section 26 05 31 – Junction, Pull Boxes and Cabinets

.4 Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings

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

.6 Section 26 05 37 – Wireways and Auxiliary Gutters

.7 Section 26 12 17 – Dry Type Transformers Up To 600V Primary

.8 Section 26 24 17 – Panelboards Breaker Type

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

Part 3 Execution

3.1 INSTALLATION

.1 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.2 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.

.3 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.4 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.5 Do not use supports or equipment installed for other trades for conduit or cable support.

.6 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

.7 All hangers, supports and brackets shall be provided and be installed to be consistent with the requirements of Table 4.1.8.18 of Section 4 of the National Building Code 2015.

.8 Retain the services of a Structural Engineer registered with APEGBC to provide a structural review of the fixings of devices forming part of the electrical installation. Provide, as a result of this review, a signed and sealed report indicating the installation complies with the requirements of the National Building Code 2015.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

.2 Section 26 05 00 – Common Work Results – For Electrical

Part 2 Products

2.1 JUNCTION AND PULL BOXES

.1 Welded steel or aluminum construction with screw-on flat covers for surface mounting.

Part 3 Execution

3.1 JUNCTION AND PULL BOXES INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

3.2 IDENTIFICATION

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

.2 Install size 2 identification labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.1-2015, Canadian Electrical Code, Part 1.

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 Blank cover plates for boxes without wiring devices.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 CONDUIT BOXES

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

.2 Surface wiremold boxes. Boxes without knockouts.

2.4 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

Part 3 Execution

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Use FS or FD boxes or wiremold boxes for surface mounted outlets and junction boxes.

.3 Provide correct size of openings in boxes for conduit connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

.2 Section 26 05 00 – Common Work Results – For Electrical

1.2 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit. Latest published edition.

.2 CSA C22.2 No. 83, Electrical Metallic Tubing. Latest published edition.

.3 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit. Latest published edition.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 11 55 – General Instructions.

Part 2 Products

2.1 CONDUITS

.1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with steel fittings.

.2 Flexible metal conduit: to CSA C22.2 No. 56, steel or aluminum liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller, except as otherwise noted.

2.3 CONDUIT FITTINGS

.1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.

.1 Coating: same as conduit.

.2 Material: Steel (Cast fittings are not acceptable).

.2 Factory "ells" where 90 degrees bends for 21 mm and larger conduits.

2.4 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 where possible except in mechanical and electrical service rooms.

.3 Surface mount conduits in mechanical and electrical rooms, unfinished areas and elsewhere as noted on the drawings.

.4 Use electrical metallic tubing EMT except as otherwise indicated.

.5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp or wet locations.

.6 Minimum conduit size: 21mm.

.7 Bend conduit cold:

.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.8 Mechanically bend steel conduit over 19 mm diameter.

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

- .1 CAN/CSA-C22.2 No.47-13, Air-Cooled Transformers (Dry Type).
- .2 Latest version of CSA (C9-02), Dry-Type Transformers.
- .3 CAN/CSA C802.2-12, Minimum Efficiency Values for Dry-Type Transformers

1.4 PRODUCT DATA

.1 Submit product data in accordance with Section 01 11 55 – General Instructions

Part 2 Products

2.1 TRANSFORMERS

.1 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47, CSA-C9 as appropriate.

.2 Design 1:

- .1 Type: ANN with copper windings
- .2 3 phase, 60Hz, kVA input and output voltages as indicated on drawings.
- .3 Voltage taps: 4-2.5% 2 FCAN, 2 FCBN
- .4 Insulation: Class 220C, 150 degrees C temperature rise.
- .5 Basic Impulse Level (BIL): 10kV
- .6 Average sound level: standard
- .7 Impedance at 17 degrees C: standard
- .8 Enclosure: Standard.
- .9 Mounting: wall as indicated.
- .10 Finish: in accordance with Section 26 05 00 - Common Work Results – Electrical
- .11 Minimum efficiency values to requirements of CAN/CSA 802.2-12

.3 Acceptable manufacturers: Acme, Magnatek, Delta, Hammond, Siemens, Rex

Part 3 Execution

3.1 INSTALLATION

.1 Mount transformers as indicated.

.2 Ensure minimum CE code required clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

.5 Loosen isolation pad bolts until no compression is visible.

.6 Make primary and secondary connections in accordance with wiring diagram.

.7 Energize transformers after installation is complete.

.8 Provide fixing of transformers to requirements of specification Section 26 05 29 Hangers and Supports for Electrical Systems.

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

.1 CSA C22.2 No.29, Panelboards and enclosed Panelboards. Latest published edition.

1.3 SHOP DRAWINGS

.1 Submit shop drawings.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2No.29 and product of one manufacturer.

.1 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 V panelboards: bus and breakers rated for 10,000 A (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 For lighting and receptacle panelboards trim with flush locking door and concealed front bolts and hinges.

.9 Trim and door finish: baked grey enamel.

.10 Multi-way ground bar bonded to panel steel.

.11 Suitable for installation in a sprinklered room.

2.2 BREAKERS

.1 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.2 Lock-on devices on breakers for: Heat trace circuits.

2.3 EQUIPMENT IDENTIFICATION

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

.2 Nameplate for each panelboard size 4 engraved.

.3 Complete circuit directory with typewritten legend showing location and load of each circuit.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards.

.3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results - Electrical.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4, Enclosed and Dead Front Switches. Latest published edition.

1.3 SUBMITTALS

.1 Submit product data in accordance with Section 01 11 55 – General Instructions.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible or non-fusible, horsepower rated disconnect switch in CSA Enclosure type to suit the application. Enclosure 1 for indoor mounting, weatherproof type for outdoor mounting.

.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, HRC J-type.

.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 - Electrical.

.2 Indicate on size 4 nameplate the name of load controlled, as well as circuit numbering that includes reference to the originating panelboard.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses as applicable or indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 55 – General Instructions

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

1.2 REFERENCES

.1 International Electrotechnical Commission (IEC)

.1 IEC 60947-4-1, Part 4-1 plus applicable amendments: Contactors and motor-starters.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 11 55 – General Instructions.

.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 01 11 55 – General Instructions.

.2 Include operation and maintenance data for each type and style of starter.

Part 2 Products

2.1 MATERIALS

.1 Starters: to IEC 60947-4-1.

2.2 MANUAL MOTOR STARTERS

.1 Single or 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 One overload heater for single phase, 3 for 3-phase, manual reset, trip indicating handle.

.2 Accessories:

.1 Toggle switch: labelled to indicate purpose.

.2 Indicating light: green LED type.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 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 Accessories:

.1 Pushbuttons and/or Selector switches: standard, heavy duty, oil tight labelled as indicated.

.2 Indicating lights: LED type and color as indicated.

.3 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.

2.4 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.

2.5 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.6 EQUIPMENT IDENTIFICATION

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

.2 Manual starter designation label, white plate, black letters, size 1, engraved to indicate purpose.

.3 Magnetic starter designation label, white plate, black letters, size 1 engraved to indicate purpose.

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, starters to verify correct functioning.

.3 Perform starting and stopping sequences of starters and control relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION