

**AHU #4 System Upgrade  
Joseph A. Ghiz Building  
R.000003.062**

January 2015



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## **1 GENERAL**

### **1.01 WORK COVERED BY CONTRACT DOCUMENTS**

- .1 Work of this Contract comprises provision of new rooftop HVAC unit and modifications to existing AHU #4 ductwork distribution system.

### **1.02 CONTRACT METHOD**

- .1 Construct Work under stipulated price contract.

### **1.03 WORK BY OTHERS**

- .1 Co-operate with other Contractors in carrying out their respective works and carry out instructions from Consultant.
- .2 Co-ordinate work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Consultant, in writing, any defects which may interfere with proper execution of Work.

### **1.04 WORK SEQUENCE**

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.
- .3 Construct Work in stages to provide for continuous public usage. Do not close off public usage of facilities until use of one stage of Work will provide alternate usage.
- .4 Maintain fire access/control.

### **1.05 CONTRACTOR USE OF PREMISES**

- .1 Limit use of premises for Work and for access to allow:
  - .1 Owner occupancy.
  - .2 Public usage.
- .3 Co-ordinate use of premises under direction of Consultant.
- .4 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .5 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

- .6 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by [Consultant].
- .7 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

#### **1.06 OWNER OCCUPANCY**

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

#### **1.07 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

- .1 Execute work with least possible interference or disturbance to building operations and normal use of premises. Arrange with Consultant to facilitate execution of work.
- .2 Use only elevators or escalators existing in building for moving workers and material.
  - .1 Protect walls of passenger elevators, to approval of Consultant prior to use.
  - .2 Accept liability for damage, safety of equipment and overloading of existing equipment.

#### **1.08 EXISTING SERVICES**

- .1 Notify, Consultant and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Consultant 48 hours notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to tenant operations.
- .3 Provide alternative routes for personnel and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Consultant of findings.
- .5 Submit schedule to and obtain approval from Consultant for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Consultant to maintain critical building and tenant systems.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.

- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines.
- .11 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

### **1.09 DOCUMENTS REQUIRED**

- .1 Maintain at job site, one copy each document as follows:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Reviewed Shop Drawings.
  - .5 List of Outstanding Shop Drawings.
  - .6 Change Orders.
  - .7 Other Modifications to Contract.
  - .8 Field Test Reports.
  - .9 Copy of Approved Work Schedule.
  - .10 Health and Safety Plan and Other Safety Related Documents.
  - .11 Other documents as specified.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not used.

## **3 EXECUTION**

### **3.01 NOT USED**

- .1 Not used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 ADMINISTRATIVE**

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

### **1.02 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Refer to CCDC 2 GC 3.11.
- .2 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.
- .3 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Canada.

- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .5 Allow 5 days for Departmental Representative's review of each submission.
- .6 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.
- .7 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.
- .8 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.
- .9 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.

- .10 After Departmental Representative's review, distribute copies.
- .11 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .12 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.
- .13 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.
- .14 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.
- .15 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.
- .16 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .17 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .18 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .19 Delete information not applicable to project.
- .20 Supplement standard information to provide details applicable to project.
- .21 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, 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.

- .22 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.
  - .1 This review shall not mean that PWGSC 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.

### **1.03 SAMPLES**

- .1 Submit for review samples in duplicate as requested 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 become standard of workmanship and material against which installed Work will be verified.

### **1.04 CERTIFICATES AND TRANSCRIPTS**

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
- .2 Submit transcription of insurance immediately after award of Contract.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not Used.

**3 EXECUTION**

**3.01 NOT USED**

.1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Definitions:
  - .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.
  - .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.
- .2 Reference Standards:
  - .1 Canada Green Building Council (CaGBC)
    - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).
    - .2 Rating System Addenda for New Construction and Major Renovations LEED Canada-NC Version 1.0-Addendum 2007.
    - .3 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
    - .4 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide
    - .5 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.
  - .2 Canadian Construction Documents Committee (CCDC)
    - .1 CCDC 2-2008 Stipulated Price Contract.
  - .3 U.S. Environmental Protection Agency (EPA)/Office of Water
    - .1 EPA 832/R-92-005-92, Storm Water Management for Construction Activities, Chapter 3.
    - .2 EPA General Construction Permit (GCP) 2012.

### **1.02 ACTION AND INFORMATIONAL SUBMITTALS**

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

- .2 Submit [2] copies of WHMIS MSDS in accordance with Section [01 35 29.06 - Health and Safety Requirements] [01 35 43 - Environmental Procedures].
- .3 Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.
- .4 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.
- .5 Address topics at level of detail commensurate with environmental issue and required construction task.
- .6 Include in Environmental Protection Plan:
  - .1 Name[s] of person[s] responsible for ensuring adherence to Environmental Protection Plan.
  - .2 Name[s] and qualifications of person[s] responsible for manifesting hazardous waste to be removed from site.
  - .3 Name[s] and qualifications of person[s] responsible for training site personnel.
  - .4 Descriptions of environmental protection personnel training program.
  - .5 Erosion and sediment control plan identifying type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations [and EPA 832/R-92-005, Chapter 3].
  - .6 Drawings indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
  - .7 Traffic Control Plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather.
    - .1 Plans to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff.
  - .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.
    - .1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.
  - .9 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
  - .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
  - .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.
  - .12 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

- .13 Waste Water Management Plan identifying methods and procedures for management [and] [or] discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.
- .14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.
- .15 Pesticide treatment plan to be included and updated, as required.

### **1.03 FIRES**

- .1 Fires and burning of rubbish on site is not permitted.
- .2 Provide supervision, attendance and fire protection measures as directed.

### **1.04 POLLUTION CONTROL**

- .1 Maintain temporary erosion and pollution control features installed under this Contract.
- .2 Control emissions from equipment and plant in accordance with local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area.
  - .1 Provide temporary enclosures where [indicated] [directed by Departmental Representative.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

### **1.05 NOTIFICATION**

- .1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
- .2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
  - .1 Take action only after receipt of written approval by Departmental Representative.
- .3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.
- .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

**2 PRODUCTS**

**2.01 NOT USED**

- .1 Not Used.

**3 EXECUTION**

**3.01 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Bury rubbish and waste materials on site where directed after receipt of written approval from Departmental Representative.
- .3 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.
- .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**1 GENERAL**

**1.01 REFERENCES AND CODES**

- .1 Perform Work in accordance with National Building Code of Canada (NBC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
  - .1 Contract documents.
  - .2 Specified standards, codes and referenced documents.

**1.03 BUILDING SMOKING ENVIRONMENT**

- .1 Comply with smoking restrictions and municipal by-laws.

**2 PRODUCTS**

**2.01 NOT USED**

- .1 Not Used.

**3 EXECUTION**

**3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Canadian Construction Documents Committee (CCDC)
  - .1 CCDC 2-94, Stipulated Price Contract.

### **1.02 INSPECTION**

- .1 Refer to CCDC 2, GC 2.3.
- .2 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.
- .3 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.
- .4 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .5 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents.

### **1.03 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.

### **1.04 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.

### **1.05 REJECTED WORK**

- .1 Refer to CCDC, GC 2.4.

- .2 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.
- .3 Make good other Contractor's work damaged by such removals or replacements promptly.
- .4 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

#### **1.06 REPORTS**

- .1 Submit 4 copies of inspection and test reports to Departmental Representative.
- .2 Provide copies to subcontractor of work being inspected or tested.

#### **1.07 EQUIPMENT AND SYSTEMS**

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

### **2 PRODUCTS**

#### **2.01 NOT USED**

- .1 Not Used.

### **3 EXECUTION**

#### **3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 ACTION AND INFORMATIONAL SUBMITTALS**

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

### **1.02 INSTALLATION AND REMOVAL**

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

### **1.03 TEMPORARY HEATING AND VENTILATION**

- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.
- .3 Provide temporary heat and ventilation in enclosed areas as required to:
  - .1 Facilitate progress of Work.
  - .2 Protect Work and products against dampness and cold.
  - .3 Prevent moisture condensation on surfaces.
  - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
  - .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .4 Maintain temperatures of minimum 20 degrees C in areas where construction is in progress.
- .5 Ventilating:
  - .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
  - .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
  - .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
  - .4 Ventilate storage spaces containing hazardous or volatile materials.
  - .5 Ventilate temporary sanitary facilities.
  - .6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .6 Permanent heating system of building, to be used when available. Be responsible for damage to heating system if use is permitted.

- .7 Pay costs for maintaining temporary heat, when using permanent heating system. Departmental Representative will pay utility charges when temporary heat source is existing building equipment.
- .8 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
  - .1 Conform with applicable codes and standards.
  - .2 Enforce safe practices.
  - .3 Prevent abuse of services.
  - .4 Prevent damage to finishes.
  - .5 Vent direct-fired combustion units to outside.
- .9 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

#### **1.04 TEMPORARY POWER AND LIGHT**

- .1 Departmental Representative will pay for temporary power during construction for temporary lighting and operating of power tools, to a maximum supply of 230 volts 30 amps.
- .2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.
- .3 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.
- .4 Provide and maintain temporary lighting throughout project.

#### **1.05 FIRE PROTECTION**

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on site.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not Used.

**3 EXECUTION**

**3.01 NOT USED**

.1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Canadian Construction Documents Committee (CCDC)
  - .1 CCDC 2-1994, Stipulated Price Contract.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
  - .2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CSA-0121-M1978(R2003), Douglas Fir Plywood.
  - .3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.
  - .4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.
- .4 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.
- .5 U.S. Environmental Protection Agency (EPA) / Office of Water
  - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

### **1.02 ACTION AND INFORMATIONAL SUBMITTALS**

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

### **1.03 INSTALLATION AND REMOVAL**

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.
- .5 Remove from site all such work after use.

**1.04 SCAFFOLDING**

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, ladders, swing staging, platforms.

**1.05 SITE STORAGE/LOADING**

- .1 Refer to CCDC 2, GC 3.12.
- .2 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .3 Do not load or permit to load any part of Work with weight or force that will endanger Work.

**1.06 CONSTRUCTION PARKING**

- .1 Parking will be permitted on site provided it does not disrupt performance of Work.
- .2 Provide and maintain adequate access to project site.
- .3 Clean runways and taxi areas where used by Contractor's equipment.

**1.07 SECURITY**

- .1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

**1.08 EQUIPMENT, TOOL AND MATERIALS STORAGE**

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

**1.09 SANITARY FACILITIES**

- .1 Designated sanitary facilities for work force in accordance with governing regulations and ordinances shall be provided by Departmental Representative.

**1.10 CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or 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.

**2 PRODUCTS**

**2.01 NOT USED**

.1 Not Used.

**3 EXECUTION**

**3.01 NOT USED**

.1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Canadian Construction Documents Committee (CCDC)
  - .1 CCDC 2-94, Stipulated Price Contract.

### **1.02 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.
- .3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4 Provide on-site containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling.
- .6 Dispose of waste materials and debris at designated dumping areas off site.
- .7 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .8 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

### **1.03 FINAL CLEANING**

- .1 Refer to CCDC 2, GC 3.14.
- .2 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .3 Remove waste products and debris other than that caused by others, and leave Work clean

and suitable for occupancy.

- .4 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .5 Remove waste products and debris other than that caused by Owner or other Contractors.
- .6 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .7 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .9 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .10 Clean lighting reflectors, lenses, and other lighting surfaces.
- .11 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Clean and sweep roofs, gutters, areaways, and sunken wells.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not Used.

## **3 EXECUTION**

### **3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

## 1 GENERAL

### 1.01 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
  - .1 CCDC 2-2008, Stipulated Price Contract.
  - .2 DOC 14-2000, Design-Build Stipulated Price Contract.
  - .3 DOC 15-2000, Design-Builder/ Consultant Contract.

### 1.02 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
  - .1 Contractor's Inspection: Design-Builder: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
    - .1 Notify Departmental Representative in writing of satisfactory completion of Design-Builder's inspection and submit verification that corrections have been made.
    - .2 Request Departmental Representative inspection.
  - .2 Departmental Representative Inspection:
    - .1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
    - .2 Contractor to correct Work as directed.
  - .3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:
    - .1 Work: completed and inspected for compliance with Contract Documents.
    - .2 Defects: corrected and deficiencies completed.
    - .3 Equipment and systems: tested, adjusted and balanced and fully operational.
    - .4 Certificates required by Fire Commissioner: submitted.
    - .5 Operation of systems: demonstrated to Owner's personnel.
    - .6 Commissioning of mechanical systems.
    - .7 Work: complete and ready for final inspection.
  - .4 Final Inspection:
    - .1 When completion tasks are done, request final inspection of Work by Departmental Representative, and Contractor.
    - .2 When Work incomplete according to Owner and Departmental Representative, complete outstanding items and request re-inspection.
  - .5 Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.
  - .6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

- .7 Final Payment:
  - .1 When Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.
  - .2 Refer to CCDC 2: when Work deemed incomplete by Departmental Representative, complete outstanding items and request re-inspection.
- .8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

### **1.03 FINAL CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not Used.

## **3 EXECUTION**

### **3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Canadian Environmental Protection Act (CEPA)
  - .1 SOR/2008-197, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations.

### **1.02 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-warranty Meeting:
  - .1 Convene meeting one week prior to contract completion with contractor's representative and Departmental Representative to:
    - .1 Verify Project requirements.
  - .2 Departmental Representative to establish communication procedures for:
    - .1 Notifying construction warranty defects.
    - .2 Determine priorities for type of defects.
    - .3 Determine reasonable response time.
  - .3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
  - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

### **1.03 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of operating and maintenance manuals in English.
- .3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.
- .4 Provide evidence, if requested, for type, source and quality of products supplied.

### **1.04 FORMAT**

- .1 Organize data as 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.
  - .1 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 [systems,] [process flow,] under 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.
  - .1 Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on CD.

#### **1.05 CONTENTS - PROJECT RECORD DOCUMENTS**

- .1 Table of Contents for Each Volume: provide title of project;
  - .1 Date of submission; names.
  - .2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
  - .3 Schedule of products and systems, indexed to content of volume.
- .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 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.
  - .1 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 91 41 – Commissioning (Cx) Training.

#### **1.06 AS -BUILT DOCUMENTS AND SAMPLES**

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to 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.
  - .1 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.
  - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
  
- .4 Maintain record documents in clean, dry and legible condition.
  - .1 Do not use record documents for construction purposes.
  
- .5 Keep record documents and samples available for inspection by Departmental Representative.

#### **1.07 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS**

- .1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.
  
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
  
- .3 Record information concurrently with construction progress.
  - .1 Do not conceal Work until required information is recorded.
  
- .4 Contract Drawings and shop drawings: 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: 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, and field test records, required by individual specifications sections.

- .7 Provide digital photos, if requested, for site records.

## 1.08 EQUIPMENT AND SYSTEMS

- .1 For each item of equipment and each system include description of unit or system, and component parts.
  - .1 Give function, normal operation characteristics and limiting conditions.
  - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .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.
  - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
  - .2 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 co-ordination 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 13 - General Commissioning (Cx) Requirements.
- .15 Additional requirements: as specified in individual specification sections.

## **1.09 MATERIALS AND FINISHES**

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: as specified in individual specifications sections.

## **1.10 MAINTENANCE MATERIALS**

- .1 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 site as directed; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.
  - .5 Obtain receipt for delivered products and submit prior to final payment.
- .2 Extra Stock 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 site as directed; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.
  - .5 Obtain receipt for delivered products and submit prior to final payment.
- .3 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 site as directed; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.

## **1.11 DELIVERY, STORAGE AND HANDLING**

- .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 for review by Departmental Representative.

### **1.12 WARRANTIES AND BONDS**

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative approval.
- .3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
  - .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 applicable item of work.
  - .4 Verify that documents are in proper form, contain full information, and are notarized.
  - .5 Co-execute submittals when required.
  - .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .9 Include information contained in warranty management plan as follows:
  - .1 Roles and responsibilities of personnel associated with warranty process, including

- points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
- .2 Provide list for each warranted equipment, item, feature of construction or system indicating:
    - .1 Name of item.
    - .2 Model and serial numbers.
    - .3 Location where installed.
    - .4 Name and phone numbers of manufacturers or suppliers.
    - .5 Names, addresses and telephone numbers of sources of spare parts.
    - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
    - .7 Cross-reference to warranty certificates as applicable.
    - .8 Starting point and duration of warranty period.
    - .9 Summary of maintenance procedures required to continue warranty in force.
    - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
    - .11 Organization, names and phone numbers of persons to call for warranty service.
    - .12 Typical response time and repair time expected for various warranted equipment.
  - .3 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.
  - .4 Procedure and status of tagging of equipment covered by extended warranties.
  - .5 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
  - .11 Written verification to follow oral instructions.
    - .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

### **1.13 WARRANTY TAGS**

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by [Departmental Representative] [DCC Representative] [Consultant].
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
  - .1 Type of product/material.
  - .2 Model number.
  - .3 Serial number.

- .4 Contract number.
- .5 Warranty period.
- .6 Inspector's signature.
- .7 Construction Contractor.

**2 PRODUCTS**

**2.01 NOT USED**

- .1 Not Used.

**3 EXECUTION**

**3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**            **SUMMARY**

- .1      Section Includes
  - .1      General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2      Acronyms
  - .1      CxA – Commissioning Authority.
  - .2      Cx – Commissioning.
  - .3      Cx Plan – Commissioning Plan.
  - .4      EMCS – Energy Monitoring and Control Systems.
  - .5      O&M – Operation and Maintenance.
  - .6      PV – Performance Verification.
  - .7      TAB – Testing, Adjusting and Balancing.
  - .8      GC – General Contractor
  - .9      TSI – Technical Services Inspector
  - .10     LEED - Leadership in Energy and Environmental Design

**1.2**            **COMMISSIONING INTENT**

- .1      Undertake Cx to bring the facility to a fully operational state and free of deficiencies in the most effective and timely manner available.
- .2      Cx incorporates inspection and quality assurance activities as construction progresses, including start up and demonstration, performance verification, fine tuning, and operator training.
- .3      Bear all costs associated with the required personnel and test equipment as outlined in specification sections and all costs with organizing and managing the activities of the applicable subtrades as identified in this section.
- .4      Fully document all tests and inspections performed during the construction, at start up, and during performance verification and fine tuning. Incorporate into final commissioning documentation.
- .5      Provide direct training to designated staff responsible for the operation and maintenance of the building equipment and systems.

**1.3**            **RELATED SECTIONS**

- .1      Section 01 45 00 - Quality Control.
- .2      Section 01 77 00 - Closeout Procedures.

- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 91 33 - Commissioning (Cx) Forms.
- .5 Section 01 91 41 - Commissioning (Cx) Training.

#### 1.4 COMMISSIONING OVERVIEW

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is conducted in concert with activities performed during each stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include transfer of critical knowledge to facility operational personnel.
- .4 Complete inspection and verification activities as required by the specifications as construction progresses. This includes those activities that are necessary to ensure that the project is substantially complete to permit the execution of the commissioning process for the project.
- .5 Take responsibility to:
  - .1 Review the documentation manuals with the commissioning team.
  - .2 Complete all items as identified in these manuals. This includes work by subcontractors, test agencies, equipment representatives and manufacturer agents.
  - .3 Review Contract Documents and inspect the Work to ensure completeness of the Work and compliance with the Contract Documents.
  - .4 Correct contract deficiencies and execute change orders as directed by the Engineer/Architect.
  - .5 Test, adjust and balance equipment and systems identified in Divisions 2-16.
  - .6 Submit the completed manuals and project record documents as specified.
  - .7 Update the documentation manuals prior to each project meeting.
- .6 The Substantial Completion Certificate will not be issued until the commissioning process is completed and the final reports and commissioning documentation are received.
- .7 The Cx Plan provides direction for the Cx process during design and construction, provides resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals and coordination.

1.5 COMMISSIONING TEAM

- .1 The commissioning team shall consist of:
  - .1 Department Representative(s)
    - .1 Design Manager (DM)
    - .2 Construction Manager (CM)
    - .3 Project Coordinator (PC)
    - .4 Engineer/Architect/Consultant (AE)
    - .5 Technical Services Inspectors (TSI)
  - .2 User Representatives/Owner.
  - .3 General Contractor (GC)
  - .4 Mechanical Contractor
  - .5 Controls Contractor (CC)
  - .6 Electrical Contractor
  - .7 Fire Alarm Contractor
  - .8 Commissioning Authority (CxA)
  - .9 Manufacturer's Technicians.
  - .10 Testing Agencies.
  - .11 Building Manager (BM)
  - .12 A/E - Architect and Design Engineers
  
- .2 Roles of the commissioning team shall be as follows:
  - .1 CxA (Commissioning Authority):
    - .1 Produces Cx manual.
    - .2 Provides "Issued for Construction" Cx manual to CM.
    - .3 Clarifies Cx team responsibilities.
    - .4 Attends Cx kickoff meeting.
    - .5 Attends periodic Cx progress meetings.
    - .6 Attends verification/testing demonstrations.
    - .7 Attends owner training sessions.
    - .8 Reviews completed Cx manual.
    - .9 Issues final copy of Cx manual for Owner to CM.
  
  - .2 DM (Design Manager):
    - .1 Identifies Cx team.
    - .2 Reviews Cx manual.
    - .3 Attends Cx verification/testing demonstrations or provides representative
    - .4 CM (Construction Manager):
      1. Main contact for CxA during construction phase.
      2. Distributes "Issued for Construction" Cx Manual to GC.

3. Notifies CxA of any Cx related issues raised during construction.
  4. Provides times during any project meetings to discuss Cx with the entire team.
  5. Holds Cx kickoff meeting .
  6. Coordinates Cx schedule with GC and ensures all parties are available to witness testing.
  7. Ensures Cx Team is following/completing Cx Manual.
  8. Coordinates training schedules.
  9. Reviews project record documents.
  10. Ensures that O&M manuals, maintenance materials, as-built drawings and warranties have been submitted and reviewed.
  11. Provides CxA with reviewed as-builts, O&M manuals, and warranties.
- .3 BM (Building Manager):
- .1 Coordinates maintenance staff participation in Cx activities.
  - .2 Reviews O&M documentation and attends training.
- .4 GC (General Contractor):
- .1 Maintains as-built drawings on site during construction.
  - .2 Executes the Cx process ensuring that Subs trades perform their responsibilities and integrate Cx into the construction process.
  - .3 Ensures equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform startups.
  - .4 Coordinates and schedules Cx activities with CM.
  - .5 Provides written confirmation all systems are operational prior to verification/demonstration.
  - .6 Conducts installation and performance verification with CxA (or designated representative).
  - .7 Maintains an up to date version of the Cx manual on site with checklists completed on installed/operational systems.
  - .8 Provides CM with all appropriate training, O&M manuals, maintenance material and spare parts and warranties.
  - .9 Obtains occupancy approvals/permits.
- .5 PC (Project Coordinator):
- .1 Attends installation verification and performance verification demonstrations.
  - .2 Ensures Cx manual is on site and kept up to date by the GC.
  - .3 Verifies maintenance materials are provided by the GC as per the contract documents.
  - .4 Ensures GC is maintaining as-built drawings on site during construction.

- .6 TSI (Technical Services Inspector):
  - .1 Attends installation verification and performance verification for equipment within their discipline.
  - .2 Signs off on Cx checklists within their discipline.
- .7 Sub Trades:
  - .1 Demonstrates correct system performance.
- .8 A/E:
  - .1 Provides system descriptions, project narrative and reviews Cx process to meet the design intent.

**1.6 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS**

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Engineer/Architect, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor.

**1.7 CONFLICTS**

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

**1.8 SUBMITTALS**

- .1 Prior to starting Cx the Contractor shall provide a set of equipment and system submittals. These submittals are supplemented by the installation and start-up procedures, O&M data, performance data, control drawings and any changes that may affect commissioned systems.
- .2 Submit no later than 4 (four) weeks after award of Contract:
  - .1 Name of Contractor's Cx coordinator.
  - .2 Preliminary Cx schedule. Submit final Cx schedule to CxA for review prior to performance verification.
- .3 Ensure certified trades persons, certified testing agencies and/or factory authorized personnel participate in commissioning tasks.

- .4 Submit the names of all personnel for approval by the CxA. Designate who has managerial responsibilities for coordination of installation verification and performance verification.
- .5 Submit documentation to confirm personnel compliance with quality assurance provision.
- .6 Submit TAB report to CxA for review.
- .7 Submit start-up documentation to CxA for review.
- .8 Fifteen days prior to application for Substantial Completion:
  - .1 Submit 3 copies of final commissioning manual and applicable forms to the CM for review.
  - .2 Submit reports of performance verification postponed due to seasonal, climatic, occupancy, or other reasons beyond the Contractor's control, promptly after execution of those services.
  - .3 Ensure each form bears the required signatures as indicated on the form.
  - .4 Submit as-built drawings, schematics, O&M manuals, maintenance materials and warranties to CM for review.

**1.9**

**COMMISSIONING DOCUMENTATION/checklists**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms for requirements and instructions for use.
- .2 Checklists will be provided to the Contractor by the CM during the construction stage.
- .3 Installing subcontractors are to date and initial the checklists as construction and start-up is completed.
- .4 The general contractor is to submit completed checklists to the CxA for review and acceptance.
- .5 Once all documents have been reviewed and accepted the general contractor shall submit final commissioning documents in electronic form (PDF) and original signed copies.

**1.10**

**COMMISSIONING SCHEDULE**

- .1 Submit preliminary Cx schedule no later than 4 weeks after award of contract. Submit final Cx schedule in Gantt Chart format to CxA for review prior to performance verification.
- .2 Provide adequate time for Cx activities prescribed in technical sections, commissioning sections and the Cx manual including all on site activities as well as documentation procedures. Time should be allowed for re-verification should any system be rejected upon completion of initial verification.

- 
- .3 Provide adequate time for training.

### 1.11 COMMISSIONING MEETINGS

- .1 Commissioning Scope meeting:
  - .1 The CM will convene Cx scope meeting consisting of all members of the design, construction and operations teams to address building systems to be commissioned. Items to be discussed will include commissioning requirements, completion and start-up schedules, and roles and responsibilities.
  - .2 Commissioning Authority (CxA) to make necessary updates and changes to the Commissioning Manual and deliver to the CM who will distribute to all other parties as necessary.
  - .3 Convene Cx meetings following project meetings and as specified herein to resolve issues, monitor progress and identify deficiencies relating to Cx.
  - .4 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
  - .5 At 60% construction completion stage CM to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
    - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
    - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
  - .6 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
  - .7 Meeting will be chaired by the CM. Contractor will record minutes and submit to CM for review and approval. Approved minutes will be returned to the Contractor.
  - .8 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

### 1.12 STARTING AND TESTING

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

### 1.13 WITNESSING OF STARTING AND TESTING

- .1 Provide 21 days notice prior to commencement.
- .2 Owner's Representative to witness start-up and testing.
- .3 Contractor's Cx Coordinator to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

**1.14**      **MANUFACTURER'S INVOLVEMENT**

- .1      Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review Engineer/Architect.
  - .1      Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
  - .2      Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .2      Integrity of warranties:
  - .1      Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
  - .2      Verify with manufacturer that testing as specified will not void warranties.
- .3      Qualifications of manufacturer's personnel:
  - .1      Experienced in design, installation and operation of equipment and systems.
  - .2      Ability to interpret test results accurately.
  - .3      To report results in clear, concise, logical manner.

**1.15**      **PROCEDURES**

- .1      Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2      Conduct start-up and testing in following distinct phases:
  - .1      Included in delivery and installation:
    - .1      Verification of conformity to specification, approved shop drawings and completion of product information report forms.
    - .2      Visual inspection of quality of installation.
  - .2      Start-up: follow accepted start-up procedures.
  - .3      Operational testing: document equipment performance.
  - .4      System Performance Verification: include repetition of tests after correcting deficiencies.
  - .5      Post-substantial performance verification: to include fine-tuning.
- .3      Correct deficiencies and obtain approval from CxA after distinct phases have been completed and before commencing next phase.
- .4      Document required tests on approved performance verification forms.
- .5      Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by CxA . If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

- .1 Minor equipment/systems: implement corrective measures approved by CxA.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by CxA.
- .3 If evaluation report concludes that major damage has occurred, CxA shall reject equipment.
  - .1 Rejected equipment to be removed from site and replaced with new.
- .4 Subject new equipment/systems to specified start-up procedures.

**1.16**      **START-UP DOCUMENTATION**

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

**1.17**      **OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS**

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to CxA for approval before implementation.
- .3 Operate and maintain systems for minimum 21 days for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of Substantial Completion

**1.18**      **TEST RESULTS**

- .1 If start-up, testing and/or performance verification produce unacceptable results, repair, replace or repeat specified starting and/or performance verification procedures until acceptable results are achieved.
- .2 Provide personnel, resources and materials, assume all costs for re-verification.

**1.19**      **START OF COMMISSIONING**

- .1 Notify CxA at least 21 days prior to start of Cx.

- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.
- .3 Ensure all HVAC systems have been thoroughly cleaned.

**1.20 INSTRUMENTS / EQUIPMENT**

- .1 Submit to CxA for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide all required equipment to complete commissioning.

**1.21 FUNCTIONAL TEST & COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Conduct commissioning once identified pre-requisite activities are completed for a system and approved by the CxA.
- .2 CxA to issue a commissioning manual based on the complexity of building systems. Contractor to develop and implement a detailed schedule of commissioning related activities.
- .3 Test all building systems including architectural, structural, civil, mechanical and electrical components and operating procedures by challenging these systems to realistic operating conditions and train operational staff.
- .4 Run systems through all sequences of operation and verify response of components.
- .5 Notwithstanding all-inclusive requirements specified in this section, additional separate commissioning may be required at a later date for equipment and systems whose full operation is dependent on seasonal conditions. Job conditions for Peak Performance Verification are as follows: (1) Summer sequence commissioning to take place between June 1 and September 15 when outside ambient temperatures are at least 22°C; (2) Winter sequence commissioning to take place between November 1 and March 31 when outside ambient temperature is no greater than minus 10°C.
- .6 Carry out Cx:
  - .1 Under actual operating conditions, over entire operating range, in all modes.
  - .2 On independent systems and interacting systems.
- .7 Cx procedures to be repeatable and reported results are to be verifiable.
- .8 Follow equipment manufacturer's operating instructions.
- .9 EMCS trending to be available as supporting documentation for performance verification.

- .10 Contractor to obtain all documentation, including updated points list, controls sequences and setpoints, and submit documentation to commissioning authority for review. At completion of commissioning, scan completed manuals to electronic format on CD(s) in PDF format as required and submit to CxA.

#### 1.22 WITNESSING COMMISSIONING

- .1 CxA along with designated representatives to witness activities and verify results.

#### 1.23 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to CxA within 5 days of test and with Cx report.

#### 1.24 REPEAT VERIFICATIONS

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

#### 1.25 DEFICIENCIES, FAULTS, DEFECTS

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

#### 1.26 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to application for Substantial Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Engineer/Architect.
- .4 Contractor to compile a Final Commissioning Report summarizing all tasks, findings and documentation of the commissioning process. The Final

Commissioning Report is to incorporate all test reports by sub-contractors, manufacturer's and controlling authorities including:

- .1 Evaluation of operating condition of the systems at the time of functional test completion.
- .2 Deficiencies that were discovered and measures taken to correct them.
- .3 Functional test procedures and results.
- .4 Documentation of all commissioning field activities as they progressed.
- .5 Description and estimated schedule of required deferred testing.

**1.27 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

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

**1.28 TRAINING**

- .1 In accordance with Section 01 91 41 - Commissioning (Cx) – Training.

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

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

**1.30 OCCUPANCY**

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

**1.31 PERFORMANCE VERIFICATION TOLERANCES**

- .1 Application tolerances:
  - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 5 % of specified values.
- .2 Instrument accuracy tolerances:
  - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
  - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

**1.32 OWNER'S PERFORMANCE TESTING**

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

**PART 2**      **PRODUCTS (NOT APPLICABLE)**

**PART 3**      **EXECUTION**

**3.1**            **SCHEDULE**

- .1            Provide a detailed schedule for on-site verification activity by the commissioning team based on the commissioning plan provided by the CxA. Be responsible for resource allocation respecting the exact number and duration for personnel required to perform the tasks required.

**3.2**            **COMMISSIONING TASKS**

- .1            Refer to the Commissioning Manual provided by the CxA for a list of tasks to be conducted for the commissioning process. Further specifics are provided within applicable specification sections.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SECTION INCLUDES**

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

**1.2**      **RELATED SECTIONS**

- .1      Section 01 78 00 – Closeout Submittals.
- .2      Section 01 91 13 – Commissioning (Cx) Requirements.
- .3      Section 01 91 41 – Commissioning (Cx) Training.

**1.3**      **INSTALLATION VERIFICATION CHECK LISTS**

- .1      Prior to initiation of performance verification the CxA will develop and provide to the contractor the required project specific Commissioning plan and installation verification check lists.
- .2      Completed Commissioning forms to be submitted to Owner’s Representative for review and approval.
- .3      Include the following data:
  - .1      Product manufacturer's installation instructions and recommended checks.
  - .2      Special procedures as specified in relevant technical sections.
  - .3      Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .4      Equipment manufacturer's installation/start-up check lists are acceptable for use in conjunction with installation verification check lists forming part of the Cx manual. Manufacturer’s check sheets used must be attached to final document submittals.
- .5      Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Completed check lists to be included in Commissioning Manual submitted by the contractor at completion of project.
- .6      Use of check lists will be considered part of commissioning process.

**1.4**      **PERFORMANCE VERIFICATION CHECK LISTS**

- .1      The CxA will develop and provide to the Contractor the required project specific Commissioning plan and performance verification check lists.
- .2      Completed Commissioning forms to be submitted to Owner’s Representative for review and approval.

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- .3 Strategy for Use:
- .1 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
  - .2 Confirm operation as per design criteria and intent.
  - .3 Identify variances between design and operation and reasons for variances.
  - .4 Verify operation in specified normal and emergency modes and under specified load conditions.
  - .5 Record analytical and substantiating data.
  - .6 Verify reported results.
  - .7 Form to bear signatures of recording technician and reviewed and signed off by Owner's Representative as indicated on the forms.
  - .8 Reported results in true measured SI (metric) unit values.
  - .9 Maintain copy on site during start-up, testing and commissioning period.
  - .10 Forms to be both hard copy and electronic format.
  - .11 Upon completion of Performance Verification the contractor shall submit all completed forms to the Owner's Representative.
  - .12 Final submittal shall include all Installation Verification, Performance Verification check lists, training records, maintenance materials transmittals, written warranties and a list of all Cx activities postponed due to seasonal, climatic, occupancy, or other reasons beyond the contractor's control.

**PART 2      PRODUCTS (NOT APPLICABLE)**

**PART 3      EXECUTION (NOT APPLICABLE)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**            **SECTION INCLUDES:**

- .1      This Section specifies roles and responsibilities of Commissioning Training.

**1.2**            **RELATED SECTIONS:**

- .1      Section 01 78 00 – Closeout Submittals.
- .2      Section 01 91 13 – Commissioning (Cx) Requirements.
- .3      Section 01 91 33 – Commissioning (Cx) Forms.

**1.3**            **TRAINEES**

- .1      Trainees: personnel selected for operating and maintaining this facility including, but not limited to, Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.
- .2      Trainees may be available for training during any stage of construction.

**1.4**            **INSTRUCTORS**

- .1      The Cx Manual will contain:
  - .1      Descriptions of systems.
  - .2      Instruction on design philosophy, design criteria, and design intent.
- .2      Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
  - .1      Start-Up, operation, shut-down and maintenance of equipment, components and systems.
  - .2      Control features and reasons for, results of, implications on associated systems of adjustment of set points of control and safety devices.
  - .3      Instructions on servicing, maintenance and adjustment of systems, equipment and components.
  - .4      Training to be completed after Installation and Performance Verification are completed.

**1.5**            **TRAINING OBJECTIVES**

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

- 
- .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

**1.6 TRAINING MATERIALS**

- .1 Instructors to be responsible for content and quality. Provide copies for all those in attendance.
- .2 Training materials to include:
  - .1 "As-Built" Contract Documents.
  - .2 Operating Manual.
  - .3 Maintenance Manual.
  - .4 Testing, adjusting and balancing and performance verification reports where applicable.
- .3 Owner's Representative will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to the same degree of detail with or without the instructor.

**1.7 SCHEDULING**

- .1 Contractor to include in schedule time for training. Provide a detailed commissioning schedule indicating all Cx tasks and training.
- .2 Deliver training during regular working hours, training sessions to be determined in Commissioning meetings.
- .3 Training to be completed prior to Substantial Completion.

**1.8 RESPONSIBILITIES**

- .1 Be responsible for:
  - .1 Implementation of training activities,
  - .2 Coordination among instructors,
  - .3 Quality of training, training materials,
- .2 Owner's Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Owner's Representative. Include list of those in attendance.

**1.9 TRAINING CONTENT**

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
  - .1 Review of facility and occupancy profile.
  - .2 Functional requirements.
  - .3 System philosophy, limitations of systems and emergency procedures.

- 
- .4 Review of system layout, equipment, components and controls.
  - .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
  - .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
  - .7 Maintenance and servicing.
  - .8 Trouble-shooting diagnosis.
  - .9 Inter-Action among systems during integrated operation.
  - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

**PART 2**      **PRODUCTS (NOT APPLICABLE)**

**PART 3**      **EXECUTION (NOT APPLICABLE)**

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Definitions:
  - .1 Demolition: rapid destruction of building following removal of hazardous materials.
  - .2 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, may include but not limited to: asbestos PCB's, CFC's, HCFC's poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or well being or environment if handled improperly.
  - .3 Waste Audit (WA): detailed inventory of materials in building. Indicates quantities of reuse, recycling and landfill.
    - .1 Involves quantifying by volume/weight amounts of materials and wastes generated during construction, demolition, deconstruction, or renovation project.
    - .2 Indicates quantities of reuse, recycling and landfill.
  - .4 Waste Management Coordinator (WMC): contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.
  - .5 Waste Reduction Workplan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials. WRW is based on information acquired from WA.
- .2 Reference Standards:
  - .1 Canadian Council of Ministers of the Environment (CCME)
    - .1 PN1326, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.
  - .2 Canada Green Building Council (CaGBC)
    - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).
    - .2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
    - .3 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.
    - .4 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.
  - .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).
- .4 Transport Canada (TC)
  - .1 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

## **1.02 ADMINISTRATIVE REQUIREMENTS**

- .1 Site Meetings.
  - .1 Convene pre-demolition meeting one week prior to beginning work of this Section:
    - .1 Verify project requirements.
    - .2 Review installation [and substrate] conditions.
    - .3 Co-ordination with other building subtrades.
    - .4 Review [manufacturer's] installation instructions and warranty requirements.
  - .2 Arrange for site visit with Departmental Representative to examine existing site conditions adjacent to demolition work, prior to start of Work.
  - .3 Hold project meetings every month.

## **1.03 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Shop Drawings:
  - .1 Submit for approval drawings, diagrams or details showing sequence of demolition work and supporting structures and underpinning, where required by authorities having jurisdiction.
- .3 Hazardous Materials:
  - .1 Provide description of Hazardous Materials and Notification of Filing with proper authorities prior to beginning of Work as required.
- .4 Waste Reduction Workplan:
  - .1 Prior to beginning of Work on site submit detailed Waste Reduction Workplan and indicate:
    - .1 Descriptions of and anticipated quantities of materials to be salvaged reused, recycled and landfilled.
    - .2 Schedule of selective demolition.
    - .3 Number and location of dumpsters.
    - .4 Anticipated frequency of tipping.
    - .5 Name and address of waste receiving organizations.
- .5 Certificates:
  - .1 Submit copies of certified receipts from authorized disposal sites and reuse and recycling facilities for material removed from site upon request of Departmental Representative.
  - .2 Written authorization from Departmental Representative is required to deviate from facilities receiving organizations listed in Waste Reduction Workplan.

## **1.04 QUALITY ASSURANCE**

- .1 Regulatory Requirements: ensure Work is performed in compliance with [CEPA,] [CEAA,] [TDGA,] [and] [applicable Provincial/Territorial regulations].

## **1.05 SITE CONDITIONS**

- .1 Site Environmental Requirements.
  - .1 Perform work in accordance with Section 01 35 43 - Environmental Procedures.
  - .2 Ensure that selective demolition work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
  - .3 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.
    - .1 Ensure proper disposal procedures are maintained throughout the project.

## **2 PRODUCTS**

### **2.01 EQUIPMENT**

- .1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

## **3 EXECUTION**

### **3.01 PREPARATION**

- .1 Inspect site with Departmental Representative and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.
- .2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.
- .3 Notify and obtain approval of utility companies before starting demolition.
- .4 Disconnect and Cap Designated Mechanical Services as indicated.

### **3.02 REMOVAL OF HAZARDOUS WASTES**

- .1 Remove contaminated or dangerous materials defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

### **3.03 REMOVAL OPERATIONS**

- .1 Remove items as indicated.
- .2 Do not disturb items designated to remain in place.

### **3.04 RESTORATION**

- .1 Restore areas and existing works outside areas of demolition to conditions that existed prior to beginning of Work.

### **3.05 FIELD QUALITY CONTROL**

- .1 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Wood.
  - .8 Low-emitting materials.

### **3.06 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
  - .2 Remove debris, trim surfaces and leave work site clean, upon completion of Work
  - .3 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

### **3.07 PROTECTION**

- .1 Repair damage to adjacent materials or property caused by selective site demolition.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .2 Underwriter's Laboratories of Canada (ULC)
  - .1 ULC-S115-1995, Fire Tests of Fire stop Systems.

### **1.02 DEFINITIONS**

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
  - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

### **1.03 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .3 Shop Drawings:
  - .1 Submit shop drawings to show [location,] proposed material, reinforcement, anchorage, fastenings and method of installation.
  - .2 Construction details should accurately reflect actual job conditions.

- .4 Samples:
  - .1 Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.
  
- .5 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.
    - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
  - .4 Manufacturer's Field Reports: submit to manufacturer's written reports within [3] days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

#### **1.04 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: company specializing in fire stopping installations.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.
  
- .2 Storage and Protection:
  - .1 Store materials indoors or in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Replace defective or damaged materials with new.

### **2 PRODUCTS**

#### **2.01 MATERIALS**

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
  - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended [and conforming to specified special requirements described in PART 3].

- .2 Service penetration assemblies: systems tested to CAN-ULC-S115.
- .3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .10 Sealants for vertical joints: non-sagging.

### **3 EXECUTION**

#### **3.01 MANUFACTURER'S INSTRUCTIONS**

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

#### **3.02 PREPARATION**

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

### 3.03 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

### 3.04 SPECIAL REQUIREMENTS

- .1 Location of special requirements for fire stopping and smoke seal materials at openings and penetrations in fire resistant rated assemblies.

### 3.05 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by Departmental Representative.
- .2 Install floor fire stopping before interior partition erections.
- .3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.
- .4 Mechanical pipe insulation: certified fire stop system component.
  - .1 Ensure pipe insulation installation precedes fire stopping.

### 3.06 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY

ASSURANCE.

**3.07 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

**3.08 SCHEDULE**

- .1 Fire stop and smoke seal at:
  - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  - .2 Edge of floor slabs at curtain wall and precast concrete panels.
  - .3 Top of fire-resistance rated masonry and gypsum board partitions.
  - .4 Intersection of fire-resistance rated masonry and gypsum board partitions.
  - .5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  - .6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  - .7 Openings and sleeves installed for future use through fire separations.
  - .8 Around mechanical and electrical assemblies penetrating fire separations.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 02 41 99 – Demolition for Minor Works.
- .3      Section 01 78 00 - Closeout Submittals.

**1.2**      **SUBMITTALS**

- .1      Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Shop drawings; submit drawings stamped and signed for approval by Owner's Representative.
- .3      Shop drawings to show:
  - .1      Mounting arrangements.
  - .2      Operating and maintenance clearances.
- .4      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.
- .5      In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6      Closeout Submittals:
  - .1      Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2      Operation and maintenance manual approved by, and final copies deposited with, Owner's Representative before final inspection.
  - .3      Operation data to include:
    - .1      Control schematics for systems including environmental controls.
    - .2      Description of systems and their controls.
    - .3      Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4      Operation instruction for systems and component.

- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
  - .1 Submit 2 copies of draft Operation and Maintenance Manual to Owner's Representative for approval. Submission of individual data will not be accepted unless directed by Engineer / Architect.
  - .2 Make changes as required and re-submit as directed by Owner's Representative.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 Owner's Representative will provide 1 set of reproducible mechanical drawings or AutoCAD files. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour for each service.
  - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS

DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

- .3 Submit to Owner's Representative for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

### **1.3 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

### **1.4 MAINTENANCE**

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
  - .1 One glass for each gauge glass.
  - .2 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

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

- .1 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 All materials used on this project shall be new and CSA approved unless noted otherwise.

**PART 3**      **EXECUTION**

**3.1**      **PAINING, REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 99 – Painting for Minor Works.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

**3.2**      **CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

**3.3**      **FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
  - .1 Submit tests as specified in other sections of this specification.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.4**      **DEMONSTRATION**

- .1 Owner's Representative will use equipment and systems for test purposes prior to acceptance. Contractor to supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.

- .5 Owner's Representative may record these demonstrations on video tape for future reference.

**3.5**

**PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 02 41 99 – Demolition for Minor Works.
- .3      Section 01 78 00 - Closeout Submittals.

**1.2**      **SUBMITTALS**

- .1      Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Shop drawings; submit drawings stamped and signed for approval by Owner's Representative.
- .3      Shop drawings to show:
  - .1      Mounting arrangements.
  - .2      Operating and maintenance clearances.
- .4      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.
- .5      In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6      Closeout Submittals:
  - .1      Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2      Operation and maintenance manual approved by, and final copies deposited with, Owner's Representative before final inspection.
  - .3      Operation data to include:
    - .1      Control schematics for systems including environmental controls.
    - .2      Description of systems and their controls.
    - .3      Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4      Operation instruction for systems and component.

- .5 Description of actions to be taken in event of equipment failure.
- .6 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
  - .1 Submit 2 copies of draft Operation and Maintenance Manual to Owner's Representative for approval. Submission of individual data will not be accepted unless directed by Owner's Representative.
  - .2 Make changes as required and re-submit as directed by Owner's Representative.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 Owner's Representative will provide 1 set of reproducible mechanical drawings or AutoCAD files. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour for each service.
  - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

- .3 Submit to Owner's Representative for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

**1.3 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

**1.4 MAINTENANCE**

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
  - .1 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
  - .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

**1.5 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 02 41 99 – Demolition for Minor Works.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 All materials used on this project shall be new and CSA approved unless noted otherwise.

**PART 3 EXECUTION**

**3.1 PAINTING, REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 99 – Painting for Minor Works.
- .2 Prime and touch up marred finished paintwork to match original.

- .3 Restore to new condition, finishes which have been damaged.

### 3.2 CLEANING

- .1 Clean interior and exterior of all systems. Protect open ends of ducts, diffusers, grilles and registers during construction to prevent ingress of dust and dirt into interior of ducts. If dust or dirt is detected prior to startup, vacuum interior of all ducts and air handling units. Prior to vacuuming use video camera to record condition of ductwork. Also use video camera to record condition of ducts after cleaning.

### 3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
  - .1 Submit tests as specified in other sections of this specification.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### 3.4 DEMONSTRATION

- .1 Owner's Representative will use equipment and systems for test purposes prior to acceptance. Contractor to supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Owner's Representative may record these demonstrations on video tape for future reference.

**3.5**

**PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**            **SUMMARY**

- .1      Use of HVAC systems during construction.

**1.2**            **USE OF SYSTEMS**

- .1      Use of new and/or existing permanent heating and/or ventilating systems for supplying temporary heat or ventilation is permitted only under the following conditions: .
  - .1      Entire system is complete, pressure tested, cleaned, flushed out.
  - .2      Specified water treatment system has been commissioned, water treatment is being continuously monitored.
  - .3      Areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
  - .4      There is no possibility of damage from any cause.
  - .5      Supply ventilation systems are protected by 60 % filters, which shall be inspected daily, changed every week or more frequently as required.
  - .6      Return systems have approved filters over all openings, inlets, outlets.
  - .7      All systems will be:
    - .1      operated as per manufacturer's recommendations or instructions.
    - .2      operated by Contractor.
    - .3      monitored continuously by Contractor.
  - .8      Warranties and guarantees are not thereby relaxed.
  - .9      Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Owner's Representative.
  - .10     Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, and replace filters in air systems.
- .2      Filters specified in this section are over and above those specified in other sections of this project.
- .3      Exhaust systems are not included in any approvals for temporary heating ventilation.

**PART 2**      **PRODUCTS (NOT USED)**

**PART 3**      **EXECUTION (NOT USED)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes:
  - .1      Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
  - .2      Sustainable requirements for construction and verification.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 02 41 99 – Demolition for Minor Works.
- .3      Section 09 91 99 – Painting for Minor Works.

**1.3**      **REFERENCES**

- .1      Canadian Gas Association (CGA)
  - .1      CSA/CGA B149.1, Natural Gas and Propane Installation Code.
  - .2      CSAZ7396.1 Medical Gas pipeline Systems – Part 1: Pipelines for medical gases and vacuum.
- .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 Standpipe and Hose Systems.

**1.4**      **SUBMITTALS**

- .1      Product Data:
  - .1      Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .2      Product data to include paint colour chips, other products specified in this section.
  - .3      Samples:
    - .1      Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
    - .2      Samples to include nameplates, labels, tags, lists of proposed legends.

**1.5**            **QUALITY ASSURANCE**

- .1      Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.
- .2      Health and Safety:
  - .1      Do construction occupational health and safety in accordance with Section 01 35 29.06 – Health and Safety Requirements.

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

- .1      Packing, shipping, handling and unloading:
  - .1      Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
  - .2      Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2      Waste Management and Disposal:
  - .1      Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.
  - .2      Dispose of unused paint coating material at official hazardous material collections site approved by Engineer / Architect.
  - .3      Do not dispose of unused paint 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 to be raised or recessed.
- .3      Information to include, as appropriate:
  - .1      Equipment: Manufacturer's name, model, size, serial number, capacity.
  - .2      Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2**            **SYSTEM NAMEPLATES**

- .1      Colours:
  - .1      Hazardous: red letters, white background.

- .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
- .1 Conform to following table:
- | Size # mm | Sizes (mm) | No. of Lines | Height of Letters (mm) |
|-----------|------------|--------------|------------------------|
| 1         | 10 x 50    | 1            | 3                      |
| 2         | 13 x 75    | 1            | 5                      |
| 3         | 13 x 75    | 2            | 3                      |
| 4         | 20 x 100   | 1            | 8                      |
| 5         | 20 x 100   | 2            | 5                      |
| 6         | 20 x 200   | 1            | 8                      |
| 7         | 25 x 125   | 1            | 12                     |
| 8         | 25 x 125   | 2            | 8                      |
| 9         | 35 x 200   | 1            | 20                     |
- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
- .1 Terminal cabinets, control panels: Use size # 5.
- .2 Equipment in Mechanical Rooms: Use size # 9.

### 2.3 **EXISTING IDENTIFICATION SYSTEMS**

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Owner's Representative.

### 2.4 **IDENTIFICATION DUCTWORK SYSTEMS**

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify system : e.g. Supply AHU-1,Exhaust F-7.

**2.5**            **CONTROLS COMPONENTS IDENTIFICATION**

- .1        Identify all systems, equipment, components, controls, sensors with system nameplates specified in section 25 05 54 – EMCS: Identification. If no EMCS included in project, identification as per this section.
- .2        Inscriptions to include function and (where appropriate) fail-safe position, component ID name.

**2.6**            **LANGUAGE**

- .1        Identification to be 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 all painting specified in Section 09 91 99 Painting for Minor Works has been completed.

**3.3**            **INSTALLATION**

- .1        Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2        Provide ULC and/or CSA registration plates as required by respective agency.

**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 in any way.

### 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, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### 3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S"hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Owner's Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

**3.7**

**CLEANING**

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

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2      TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this Section.
- .3      Scope of work to include rebalancing/verification of existing AHU-4 and modified system and new RTAC-4A system including all associated VAV boxes.

**1.2**      **QUALIFICATIONS OF TAB PERSONNEL**

- .1      Submit names of personnel certified to AABC, NBC, NEBB or SMACNA to perform TAB to Owner's Representative within 90 days of award of contract.
- .2      Provide documentation confirming qualifications, successful experience. TAB contractor shall have a minimum of 5 (five) years experience to AABC, NBC, NEBB or SMACNA.
- .3      TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1      Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.
  - .2      National Balancing Council, (NBC) Certified Air Balancing Specifications and Certified Hydronic Balancing Specifications.
  - .3      National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
  - .4      Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems – Testing, Adjusting and Balancing.
- .4      Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5      Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6      Use TAB standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7      Where instrument manufacturer calibration recommendations are more stringent than those listed in the 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, NBC, NEBB, or SMACNA), requirements and recommendations contained in these procedures and requirements are mandatory.

### **1.3 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems 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 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.

### **1.5 CO-ORDINATION**

- .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 and confirm in writing to Owner's 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 Owner's 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 other Divisions.

**1.8**            **OPERATION OF SYSTEMS DURING TAB**

- .1      Operate systems for length of time required for TAB and as required by Owner's Representative for verification of TAB reports.

**1.9**            **START OF TAB**

- .1      Notify Owner's Representative 7 (seven) 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 weatherstripping, sealing, caulking.
  - .3      All pressure, leakage, other tests specified elsewhere in other Divisions.
  - .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.

**1.10**          **APPLICATION TOLERANCES**

- .1      Do TAB to following tolerances of design values:
  - .1      Laboratory HVAC systems: plus 10%, minus 0%.
  - .2      Other HVAC systems: plus 5%, minus 5%.
  - .3      Hydronic systems: plus or minus 10 %.
  - .4      Refrigeration 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 Owner's 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 (three) months of TAB. Provide certificate of calibration to Owner's Representative.
- .4        Use ultrasonic flow measurement when balancing valves or pete's plugs are not installed.

**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        Submit for checking and approval of Owner's 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 referenced standard.
- .2        TAB report to show results in SI units and to include:
  - .1        Project record drawings.
  - .2        System schematics.
- .3        Submit 3 (three) copies of TAB Report to Owner's Representative for verification and approval, in English in D-ring binders, complete with index tabs.

**1.16**            **VERIFICATION**

- .1        Reported results subject to verification by Owner's 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 Owner's Representative.
- .4        Bear costs to repeat TAB as required to satisfaction of Owner's Representative.

**1.17**            **SETTINGS**

- .1        After TAB is completed to satisfaction of Owner's 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 Owner's Representative.

**1.19**            **AIR SYSTEMS**

- .1        Standard: TAB to be to most stringent of this section or TAB standards of AABC, NBC or NEBB.
- .2        Do TAB of systems, equipment, components, controls specified in other Divisions.
- .3        Qualifications: personnel performing TAB to be qualified to standards of AABC, NBC or NEBB.
- .4        Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC, NBC or NEBB.
- .5        Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration, amperage and volts for each stage of electrical heating coils.
- .6        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.
- .7 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 POST- OCCUPANCY TAB**

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of areas designated by Owner's Representative.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 3 months of termination of Warranty Period.

**PART 2 PRODUCTS (NOT APPLICABLE)**

**PART 3 EXECUTION (NOT APPLICABLE)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3      Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .4      Section 23 05 53.01 – Mechanical Identification.

**1.2**      **REFERENCES**

- .1      American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1      ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2      American Society for Testing and Materials International, (ASTM)
  - .1      ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
  - .2      ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3      ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4      ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5      ASTM C547, Specification for Mineral Fiber Pipe Insulation.
  - .6      ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .7      ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .8      ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
  - .9      ASTM C921, Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .3      Canadian General Standards Board (CGSB)
  - .1      CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4      Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

- .5 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701, Thermal Insulation Polystyrene, Boards and Pipe Covering.
- .6 Model National Energy Code of Canada for Buildings (MNECB)

### 1.3 **DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
  - .1 CRD: Commercial Round Ductwork,
  - .2 CRF: Commercial Rectangular Finish.

### 1.4 **SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

### 1.5 **SAMPLES**

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

### 1.6 **MANUFACTURERS' INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Installation instructions to include procedures used and installation standards achieved.

**1.7**            **QUALIFICATIONS**

- .1        Installer: certified in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards of TIAC.

**1.8**            **DELIVERY, STORAGE AND HANDLING**

- .1        Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2        Protect from weather and construction traffic.
- .3        Protect against damage from any source.
- .4        Store at temperatures and conditions recommended by manufacturer.

**1.9**            **WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.
- .2        Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3        Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4        Divert unused metal materials from landfill to metal recycling facility approved by Owner's Representative.
- .5        Divert unused adhesive material from landfill to official hazardous material collections site approved by Owner's Representative.
- .6        Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

**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 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 C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553.

## 2.3

### JACKETS

- .1 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.
- .3 Aluminum:
  - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: 0.40 mm sheet.
  - .3 Finish: Stucco embossed or corrugated.
  - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .4 Stainless steel:
  - .1 Type: 304 or 316 where additional corrosion protection is required.
  - .2 Thickness: 0.25 mm sheet.
  - .3 Finish: Corrugated or stucco embossed.
  - .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick stainless steel.
- .5 Exterior insulation jacket:
  - .1 Exterior duct insulation to be made weatherproof by applying flexible weatherproofing jacket. Jacket to consist of a multi-ply embossed UV-resistant aluminum foil/polymer laminate to which is applied a layer of rubberized asphalt specially formulated for use on insulated duct and piping applications.
  - .2 Standard of Acceptance: Alumaguard.

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 ULC Listed Canvas Jacket:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .3
- .5 Outdoor Vapour Retarder Mastic:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

**PART 3**

**EXECUTION**

3.1

**PRE-INSTALLATION REQUIREMENTS**

- .1 Pressure testing of ductwork systems complete, witnessed and certified.  
Surfaces clean, dry, free from foreign material.

3.2

**INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .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.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.3

**DUCTWORK INSULATION SCHEDULE**

- .1 Insulation types and thicknesses: Conform to following Table:
- .2

|  | TIAC Code                         | Vapour Retarder | Thickness (mm) |
|--|-----------------------------------|-----------------|----------------|
| Rectangular cold and dual temperature supply air ducts (exposed)   | C-1                               | yes             | 50             |
| Round cold and dual temperature supply air ducts (concealed)       | C-2                               | yes             | 50             |
| Rectangular warm air ducts (exposed)                               | C-1                               | no              | 25             |
| Round warm air ducts (exposed)                                     | C-1                               | no              | 25             |
| Rectangular cold and dual temperature supply air ducts (concealed) | C-2                               | Yes             | 25             |
| Round cold and dual temperature supply air ducts (exposed)         | C-1                               | yes             | 50             |
| Rectangular warm air ducts (concealed)                             | C-2                               | No              | 25             |
| Round warm air ducts (concealed)                                   | C-2                               | No              | 25             |
| Supply, return and exhaust ducts exposed in space being served     |                                   |                 | none           |
| Outside air ducts to mixing plenum                                 | C-1                               | yes             | 50             |
| Mixing plenums   | C-1                               | yes             | 25             |
| Exhaust duct between dampers and louvers                           | C-1                               | no              | 50             |
| Rectangular ducts outside  | C-1                               | special         | 50             |
| Round ducts outside  | C-1                               | special         | 50             |
| Acoustically lined ducts   | See Section 23 33 53- Duct Liners |                 |                |

- .3 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
- .2 Finishes: Conform to following table:

|   | TIAC Code   |       |
|---|-------------|-------|
|   | Rectangular | Round |
| Indoor, concealed                         | None        | none  |
| Indoor, exposed within<br>mechanical room | CRF/1       | CRD/2 |
| Indoor, exposed elsewhere                 | CRF/2       | CRD/3 |
| Outdoor, exposed to<br>precipitation      | CRF/3       | CRD/4 |
| Outdoor, elsewhere                        | CRF/4       | CRD/5 |

- .3 Weatherproof exterior jacket as specified in Part 2 is acceptable on exterior duct applications provided insulation is rigid and faced.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section includes:
  - .1      Materials and installation of low-pressure metallic ductwork, joints and accessories.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 – Submittal Procedures.
- .2      Section 01 35 29.06 – Health and Safety Requirements
- .3      Section 02 41 99 – Demolition for Minor Works.
- .4      Section 01 91 13 – General Commissioning (Cx) Requirements.
- .5      Section 07 84 00 – Firestopping
- .6      Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

**1.3**      **REFERENCES**

- .1      American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2      American Society for Testing and Materials International, (ASTM).
  - .1      ASTM A 480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2      ASTM A 635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
  - .3      ASTM A 653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3      Department of Justice Canada (Jus).
  - .1      Canadian Environmental Protection Act (CEPA).
- .4      Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1      Material Safety Data Sheets (MSDS).
- .5      National Fire Protection Association (NFPA).
  - .1      NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

- .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual.
  - .3 IAQ Guideline for Occupied Buildings Under Construction, 1st Edition.
- .7 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA).

#### **1.4**      **SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets for the following:
  - .1 Sealants.
  - .2 Tape.
  - .3 Proprietary Joints.

#### **1.5**      **QUALITY ASSURANCE**

- .1 Certification of Ratings:
  - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
  - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

#### **1.6**      **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 02 41 99 – Demolition for Minor Works.

- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan.
- .5 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:

| Maximum Pressure Pa | SMACNA Seal Class |
|---------------------|-------------------|
| > 1000              | A                 |
| 750                 | B                 |
| 500                 | C                 |
| 250                 | C                 |
| 125                 | C                 |

- .2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
- .3 Class C: transverse joints and connections made air tight with gaskets, sealant tape or combination thereof. Longitudinal seams unsealed.

### **2.2**      **SEALANT**

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.

### **2.3**      **TAPE**

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

### **2.4**      **DUCT LEAKAGE**

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

2.5

**FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: Centreline radius: 1.5 times width of duct.
  - .2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45<sup>0</sup> entry on branch.
  - .2 Round main and branch: enter main duct at 45<sup>0</sup> with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with volume control damper.
- .5 Transitions:
  - .1 Diverging: 20<sup>0</sup> maximum included angle.
  - .2 Converging: 30<sup>0</sup> maximum included angle.
- .6 Offsets:
  - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.6

**FIRESTOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 – Firestopping.
- .2 Firestopping material and installation must not distort duct.

2.7

**GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

**2.8**            **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: 500 mm.
- .2      Hanger configuration: to SMACNA.
- .3      Hangers: galvanized steel angle with black steel rods to ASHRAE or SMACNA following table:

| Duct Size<br>(mm) | Angle Size<br>(mm) | Rod Size<br>(mm) |
|-------------------|--------------------|------------------|
| up to 750         | 25x25x3            | 6                |
| 751 to 1050       | 40x40x3            | 6                |
| 1051 to 1500      | 40x40x3            | 10               |
| 1501 to 2100      | 50x50x3            | 10               |
| 2101 to 2400      | 50x50x5            | 10               |
| 2401 and over     | 50 x 50 x 6        | 10               |

- .4      Upper hanger attachments:
  - .1      For concrete: manufactured concrete inserts.
    - .1      Acceptable Product: Myatt, Grinnell, Hunt.
  - .2      For steel joist: manufactured joist clamp steel plate washer.
    - .1      Acceptable Product: Myatt, Grinnell, Hunt.
  - .3      For steel beams: manufactured beam clamps:
    - .1      Acceptable Product: Myatt, Grinnell, Hunt.

**PART 3**            **EXECUTION**

**3.1**            **GENERAL**

- .1      Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2      Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3      Support risers in accordance with SMACNA.
- .4      Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.
- .5      Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6      Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

**3.2**            **HANGERS**

- .1        Strap hangers: install in accordance with SMACNA.
- .2        Angle hangers: complete with locking nuts and washers.
- .3        Hanger spacing: in accordance with SMACNA or as follows:

| Duct Size<br>(mm) | Spacing<br>(mm) |
|-------------------|-----------------|
| to 1500           | 3000            |
| 1501 and over     | 2500            |

**3.3**            **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. Sealant and tape to be applied to full perimeter of duct.

**3.4**            **LEAKAGE TESTS/COMMISSIONING**

- .1        In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2        Do leakage tests in sections.
- .3        Make trial leakage tests as instructed to demonstrate workmanship.
- .4        Install no additional ductwork until trial test has been passed.
- .5        Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .6        Complete test before insulation or concealment.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes:
  - .1      Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 – Submittal Procedures.
- .2      Section 01 35 29.06 – Health and Safety Requirements.
- .3      Section 01 45 00 – Quality Control.
- .4      Section 02 41 99 – Demolition for Minor Works.
- .5      Section 01 78 00 – Closeout Submittals.

**1.3**      **REFERENCES**

- .1      Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1      Material Safety Data Sheets (MSDS).
- .2      Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1      SMACNA – HVAC Duct Construction Standards – Metal and Flexible.

**1.4**      **SUBMITTALS**

- .1      Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2      Product Data:
  - .1      Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1      Flexible connections
    - .2      Duct access doors.
    - .3      Turning vanes.
    - .4      Instrument test ports.
  - .2      Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.
- .3      Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .7 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

## 1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
  - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
    - .1 Verify project requirements.
    - .2 Review installation and substrate conditions.
    - .3 Co-ordination with other building subtrades.
    - .4 Review manufacturer's installation instructions and warranty requirements.
  - .2 Health and Safety:
    - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 – Health and Safety Requirements.

## 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
  - .4 Separate for reuse and recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
  - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Owner's Representative.

**PART 2**      **PRODUCTS**

**2.1**      **GENERAL**

- .1      Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

**2.2**      **FLEXIBLE CONNECTIONS**

- .1      Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.
- .2      Material:
  - .1      Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40<sup>0</sup>C to plus 90<sup>0</sup>C, density of 1.3 kg/m<sup>2</sup>.

**2.3**      **ACCESS DOORS IN DUCTS**

- .1      Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2      Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3      Gaskets: neoprene.
- .4      Hardware:
  - .1      Hold open devices.
  - .2      300 x 300 mm glass viewing panels.
  - .3      Up to 300 x 300 mm: two sash locks complete with safety chain.
  - .4      301 to 450 mm: four sash locks complete with safety chain.
  - .5      451 to 1000 mm: piano hinge and minimum two sash locks.
  - .6      Doors over 1000 mm: piano hinge and two handles operable from both sides.
    - .1      Hold open devices.
    - .2      300 X 300 mm glass viewing panels.

**2.4**      **TURNING VANES**

- .1      Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

**2.5**      **INSTRUMENT TEST PORTS**

- .1      1.6 mm thick steel zinc plated after manufacture.

- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

## 2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

## PART 3 EXECUTION

### 3.1 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 Flexible connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access doors and viewing panels:
  - .1 Size:
    - .1 600 x 600 mm for person size entry.
    - .2 450 x 450 mm for servicing entry.
    - .3 300 x 300 mm for viewing.
    - .4 As indicated.
  - .2 Locations:

- .1 Fire and smoke dampers.
  - .2 Control dampers.
  - .3 Devices requiring maintenance.
  - .4 Required by code.
  - .5 Reheat coils.
  - .6 Elsewhere as indicated.
- .3 Instrument test ports.
- .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
    - .2 Locate to permit easy manipulation of instruments.
    - .3 Install insulation port extensions as required.
    - .4 Locations.
      - .1 For traverse readings:
        - .1 Ducted inlets to roof and wall exhausters.
        - .2 Inlets and outlets of other fan systems.
        - .3 Main and sub-main ducts.
        - .4 And as indicated.
      - .2 For temperature readings:
        - .1 At outside air intakes.
        - .2 In mixed air applications in locations as approved by Owner's Representative.
        - .3 At inlet and outlet of coils.
        - .4 Downstream of junctions of two converging air streams of different temperatures.
        - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### 3.3

#### **FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Have manufacturer's representative of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
  - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

- .3 Schedule site visits, to review Work, at stages listed:
  - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
  - .2 Twice during progress of Work at 25% and 60% complete.
  - .3 Upon completion of the Work, after cleaning is carried out.
- .4 Obtain reports, within 3 days of review, and submit, immediately, to Owner's Representative.

**3.4**      **CLEANING**

- .1 Perform cleaning operations as specified in Section 01 74 11 – Cleaning and in accordance with Manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes:
  - .1      Balancing dampers for mechanical forced air ventilation and air conditioning systems.

**1.2**      **RELATED SECTIONS:**

- .1      Section 01 33 00 – Submittal Procedures.
- .2      Section 01 35 29.06 – Health and Safety Requirements.
- .3      Section 01 45 00 – Quality Control.
- .4      Section 02 41 99 – Demolition for Minor Works.
- .5      Section 01 78 00 – Closeout Submittals.

**1.3**      **REFERENCES**

- .1      Sheet Metal and Air Conditioning National Association (SMACNA)
  - .1      SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2      Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1      Material Safety Data Sheets (MSDS).

**1.4**      **SUBMITTALS**

- .1      Product Data:
  - .1      Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1      Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 – Submittal Procedures.
    - .2      Indicate the following:
      - .1      Specifications.
  - .2      Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.

- .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: Submit manufacturer's installation instructions.

**1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 – Health and Safety Requirements.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.

**PART 2 PRODUCTS**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SINGLE BLADE DAMPERS**

- .1 Fabricate from same material as duct, 0.8 mm up to 450 mm wide, 1.6 mm maximum up to 1200 mm wide, V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**PART 3**      **EXECUTION**

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

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

**3.2**      **INSTALLATION**

- .1      Install where indicated.
- .2      Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3      For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .4      Runouts to registers and diffusers: located as close as possible to main ducts.
- .5      All dampers to be vibration free.
- .6      Ensure damper operators are observable and accessible.

**3.3**      **CLEANING**

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

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes:
  - .1      Fire and smoke dampers, and fire stop flaps.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 – Submittal Procedures.
- .2      Section 01 35 29.06 – Health and Safety Requirements.
- .3      Section 02 41 99 – Demolition for Minor Works.
- .4      Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

**1.3**      **REFERENCES**

- .1      American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
  - .1      ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2      Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1      Material Safety Data Sheets (MSDS).
- .3      Underwriters Laboratories of Canada (ULC)
  - .1      CAN4-S112, Fire Test of Fire Damper Assemblies.
  - .2      CAN4-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
  - .3      ULC-S505, Fusible Links for Fire Protection Service.

**1.4**      **SUBMITTALS**

- .1      Product Data:
  - .1      Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1      Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Smoke dampers.
  - .3 Fire stop flaps.
  - .4 Operators.
  - .5 Fusible links.
  - .6 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
  - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

## **1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.
  - .2 Provide the following:
    - .1 6 fusible links of each type.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

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

- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.

## **PART 2**      **PRODUCTS**

### **2.1**      **FIRE DAMPERS**

- .1 Fire dampers: arrangement Type B or C, blades out of air stream listed and bear label of ULC, meet requirements of provincial fire authority and ANSI/NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN4-S112. Minimum rating 1 ½ hours, dynamically rated.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset, round or square; multi-blade hinged or interlocking type; roll door type; or guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 Retaining angle iron frame, 40 x 40 x 3 mm, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed to prevent disruption of ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC and in manufacturer's instructions for fire dampers shall be followed.

### **2.2**      **SMOKE DAMPERS**

- .1 To be ULC or UL listed and labelled.

- .2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.
- .3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units mounted horizontally in vertical ducts.
- .4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.
- .5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 °C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

### **2.3 COMBINATION FIRE AND SMOKE DAMPERS**

- .1 Damper: similar in all respects to smoke dampers specified above.
- .2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

### **2.4 FIRE STOP FLAPS**

- .1 To be ULC listed and labelled and fire tested in accordance with CAN4-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .3 Flaps to be held open with fusible link conforming to ULC-S505 and close at 74 °C.

## **PART 3 EXECUTION**

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

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

### **3.2 INSTALLATION**

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.

- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Coordinate with installer of firestopping to Section 07 84 00 – Firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

### **3.3 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.

### **3.4 COMMISSIONING**

- .1 Commission in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes:
  - .1      Materials and installation of flexible ductwork, joints and accessories.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 – Submittal Procedures.
- .2      Section 01 35 29.06 – Health and Safety Requirements.
- .3      Section 02 41 99 – Demolition for Minor Works.
- .4      Section 01 91 13 – General Commissioning (Cx) Requirements.

**1.3**      **REFERENCES**

- .1      American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2      Department of Justice Canada (Jus).
  - .1      Canadian Environmental Protection Act (CEPA).
  - .2      Transportation of Dangerous Goods Act, (TDGA).
- .3      Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1      Material Safety Data Sheets (MSDS).
- .4      National Fire Protection Association (NFPA).
  - .1      NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2      NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5      Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
  - .1      SMACNA HVAC Duct Construction Standards - Metal and Flexible.
  - .2      SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .6      Underwriters' Laboratories Inc. (UL).
  - .1      UL 181, Standard for Factory-Made Air Ducts and Air Connectors.

- .7 Underwriters' Laboratories of Canada (ULC).
  - .1 CAN/ULC-S110, Fire Tests for Air Ducts.

#### **1.4** SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS for the following:
  - .1 Thermal properties.
  - .2 Friction loss.
  - .3 Acoustical loss.
  - .4 Leakage.
  - .5 Fire rating.
- .3 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

#### **1.5** QUALITY ASSURANCE

- .1 Certification of Ratings:
  - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

- .1 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 02 41 99 – Demolition for Minor Works.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
  - .4 Place materials defined as hazardous or toxic in designated containers.
  - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
  - .6 Ensure emptied containers are sealed and stored safely.

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

**1.7**      **INDOOR AIR QUALITY (IAQ)**

- .1 During construction, meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

**PART 2**      **PRODUCTS**

**2.1**      **GENERAL**

- .1 Factory fabricated to CAN/ULC S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

**2.2**      **METALLIC - UNINSULATED**

- .1 Type 1: spiral wound flexible aluminum.
- .2 Performance:
  - .1 Factory tested to 1000 Pa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.

**2.3**      **METALLIC - INSULATED**

- .1 Type 2: spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
  - .1 Factory tested to 1000 Pa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Thermal loss/gain: 1.3 W/m<sup>2</sup>.°C. mean.

**PART 3**      **EXECUTION**

**3.1**            **DUCT INSTALLATION**

- .1        Install in accordance with: NFPA 90A and NFPA 90B SMACNA.
- .2        Do leakage test in accordance with Section 23 05 94 - Pressure Testing of Ducted Air System.
- .3        Do trial test to demonstrate workmanship.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SECTION INCLUDES**

- .1      Materials and installation for acoustic duct lining.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 01 35 29.06 - Health and Safety Requirements.
- .3      Section 02 41 99 – Demolition for Minor Works.

**1.3**      **REFERENCES**

- .1      American Society for Testing and Materials International, (ASTM).
  - .1      ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - .2      ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
  - .3      ASTM C 1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - .4      ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
  - .5      ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2      Department of Justice Canada (Jus).
  - .1      Canadian Environmental Protection Act (CEPA).
- .3      Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1      Material Safety Data Sheets (MSDS).
- .4      National Fire Protection Association (NFPA).
  - .1      NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
  - .2      NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .5      Thermal Insulation Association of Canada(TIAC).
  - .1      National Insulation Standards.
- .6      Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

- .1 SMACNA, HVAC DCS HVAC, Duct Construction Standards, Metal and Flexible.
- .2 SMACNA IAQ Guideline for Occupied Buildings 95.
- .7 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .8 Underwriter's Laboratories of Canada (ULC).
  - .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

#### **1.4 SUBMITTALS**

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

#### **1.5 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

- .1 Protect on site stored or installed absorptive material from moisture damage.

#### **1.7 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA , Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

**PART 2**      **PRODUCTS**

**2.1**      **DUCT LINER**

.1      General:

- .1      Mineral Fibre duct liner: air surface coated mat facing.
- .2      Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A and NFPA 90B.
- .3      Fungi resistance: to ASTM C 1338, ASTM G 21.

.2      Rigid:

- .1      Use on flat surfaces where indicated
- .2      25 mm thick, to ASTM C 1071, Type 2, fibrous glass rigid board duct liner.
- .3      Density: 48 kg/m<sup>3</sup> minimum.
- .4      Thermal resistance to be minimum 0.76 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.15 (m<sup>2</sup>.degrees C)/W for 38 mm thickness, 1.53 (m<sup>2</sup>.degrees C)/W for 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
- .5      Maximum velocity on faced air side: 20.3 m/sec.
- .6      Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C 423.

.3      Flexible:

- .1      Use on round or oval surfaces.
- .2      25 mm thick, to ASTM C 1071 Type 1, fibrous glass blanket duct liner.
- .3      Density: 24 kg/m<sup>3</sup> minimum.
- .4      Thermal resistance to be minimum 0.37 (m<sup>2</sup>.degrees C)/W for 12 mm thickness, 0.74 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.11 (m<sup>2</sup>.degrees C)/W for 38 mm thickness, 1.41 (m<sup>2</sup>.degrees C)/W to 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
- .5      Maximum velocity on coated air side: 25.4 m/sec.
- .6      Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C 423.

**2.2**      **ADHESIVE**

- .1      Adhesive: to NFPA 90A and NFPA 90B, ASTM C916.
- .2      Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3      Water-based fire retardant type.

**2.3**            **FASTENERS**

- .1        Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

**2.4**            **JOINT TAPE**

- .1        Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

**2.5**            **SEALER**

- .1        Meet requirements of NFPA 90A and NFPA 90B.
- .2        Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

**PART 3**        **EXECUTION**

**3.1**            **GENERAL**

- .1        Do work in accordance with SMACNA HVAC DCS, NIAC, FGDLs and as indicated except as specified otherwise.
- .2        Line inside of ducts where indicated.
- .3        Duct dimensions, as indicated, are clear inside duct lining.

**3.2**            **DUCT LINER**

- .1        Install in accordance with manufacturer's recommendations, and as follows:
  - .1        Fasten to interior sheet metal surface with 100 % coverage of adhesive to ASTM C 916
    - .1        Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
  - .2        In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
    - .1        Spacing of mechanical fasteners in accordance with SMACNA HVAC, DCS, TIAC.
- .2        In systems, where air velocities exceed 20.3 m/sec, install galvanized sheet metal noising to leading edges of duct liner.

3.3

JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
  - .1 Bed tape in sealer.
  - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Owner's Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 American Gas Association (AGA)
- .2 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
  - .1 ANSI/AHRI 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
  - .2 ANSI/AHRI 270, Sound Rating of Outdoor Unitary Equipment.
- .3 CSA Group
  - .1 CSA B52, Mechanical Refrigeration Code.
  - .2 CSA C22.1, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
- .4 National Fire Protection Association (NFPA)
  - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5 Underwriters Laboratories (UL)
  - .1 UL 1995, Standard for Heating and Cooling Equipment.

### **1.02 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for outdoor HVAC equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Drawings to indicate project layout and dimensions; indicate:
    - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
    - .2 Piping, valves, fitting shipped loose showing final location in assembly.
    - .3 Control equipment shipped loose, showing final location in assembly.
    - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

- .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
  - .6 Fan performance curves.
  - .7 Details of vibration isolation.
  - .8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
  - .9 Type of refrigerant used.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
  - .6 Manufacturer's Field Reports:
    - .1 Submit manufacturer's field reports specified.

### **1.03 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for outdoor HVAC equipment for incorporation into manual.
  - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
  - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

### **1.04 DELIVERY, STORAGE AND HANDLING**

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

### **1.05 WARRANTY**

- .1 For Work of this Section 23 74 00 - Packaged Outdoor HVAC Equipment, 12 months warranty period is extended to 60 months.

- .2 Contractor hereby warrants that packaged rooftop HVAC units and refrigeration compressors will function and operate in accordance with CCDC 2 GC 24, but for 60 months.

## **2 PRODUCTS**

### **2.01 GENERAL**

- .1 Roof mounted, self-contained single zone unit with electric heating elements and DX refrigeration and bear label of CSA, FM and ULC.
- .2 Units to consist of cabinet and frame, supply fan, return fan heat exchanger, heater control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper, motorized gravity exhaust damper, power exhaust, BACnet controls.
- .3 Prefabricated roof curb to conform to requirements of National Roofing Contractors Association (NRCA), minimum height 450 mm.
- .4 Conform to ANSI/AHRI 210/240, rating for unit larger than 40 kW nominal.

### **2.02 CABINET**

- .1 Cabinets: weatherproofing tested and certified to AGA rain test standards and soundproofing tested to AHRI 270, dbA at 3m free field.
- .2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs [at top of unit].
- .3 Outer casing: weathertight 1.2mm thick galvanized steel with baked enamel finish, complete with [flashing].
- .4 Access: gasketed hinged doors or panels with locking door handle type screwdriver operated flush cam type fasteners.
- .5 Insulation: neoprene coated glass fiber on surfaces where conditioned air is handled, 50 mm thick, 32 kg/m<sup>3</sup> density.

### **2.03 FANS**

- .1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, rubber spring isolated hinge mounted motor fan and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95% efficiency.

## **2.04 AIR FILTERS**

- .1 50 mm thick, 85% efficiency, metal framed, replaceable media.
- .2 To meet NFPA 90A, air filter requirements type Class 1.

## **2.05 ELECTRIC HEATERS**

- .1 Nickel chromium electric resistant type capacity as per schedule.
- .2 Controls:
  - .1 Panel board with modulating SCR controller.
  - .2 Indicating light centre.
  - .3 Remote thermostat[s] as indicated.
  - .4 Fuse blocks (one per step unless otherwise specified).
  - .5 Built-in control transformer.
  - .6 Thermal cut outs: 9 manual reset disc types, one per circuit; one linear bulb type manual reset.
  - .7 Built-in fused disconnect switch.
  - .8 Elements control: accessible with protection against no air flow, short and grounds, and of self checking type.
  - .9 High limit temperature control: de-energize heating elements to protect against over heating.
  - .10 Supply fan: start before electric elements are energized and continue operating until bonnet temperature reaches minimum setting. Include switch for continuous fan operation.
  - .11 Conform to CSA C22.1, Canadian Electrical Code.

## **2.06 REFRIGERATION**

- .1 Conform to CSA B52 and UL 1995 requirements.
- .2 Compressor/Condenser Section:
  - .1 Semi-Hermetic compressor[s], vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and [automatic pump down system] with control to liquid line solenoid valve.
  - .2 Fan[s]: propeller type with single piece spun venturi outlets and zinc plated guards. Motor[s]: sequenced for head pressure control.
  - .3 Electrical system: complete with operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with [weatherproof, rain tight] disconnect.
  - .4 Include refrigerant piping with [automatic hot gas bypass], sight glass, filter and valves.
  - .5 Condenser: staggered copper tube aluminum fin coil assembly with sub-cooling rows to provide 15 degrees F sub-cooling.
  - .6 Capacity reduction: Provide fan control for head control for low ambient operation down to 0 degrees F ambient temperature.

- .7 Refrigerant: R410A.
- .3 Evaporator:
  - .1 Rated to ANSI/AHRI 210/240.
  - .2 Thermostatic expansion valve, with adjustable super heat and external equalizer .
  - .3 Coil: staggered seamless copper tubes expanded into aluminum fins, and insulated condensation pan.
  - .4 Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning. Drain connection: deep seal trap complete with trap seal primer.

## **2.07 CONTROLS**

- .1 In addition to combustion safety controls, provide [smoke sensors in return to NFPA standards, low limit on supply air.
- .2 Provide VAV controller c/w VFD and manual bypass c/w gateway to BACnet. Controller to include discharge air sensor, return air and outdoor air sensor.
- .3 Controls shall incorporate capability of maintaining supply air temperature from remote setpoint signal by modulating factory installed electric heat and 4 stages of DX cooling.

## **2.08 CAPACITY**

- .1 Fan capacity: 6000 cfm at 1.75 IWG external static pressure with 7.5 HP motor.
- .2 36 kW rated heating output when heated by electric heating elements.
- .3 188.2 MBH rated total cooling output with 80 degrees F db 67 degrees F wb air entering evaporator, 95 degrees F db condenser ambient air and 12.93 kW input.
- .4 Standard of Acceptance: York Series ZJ, Carrier, Trane.

## **3 EXECUTION**

### **3.01 EXAMINATION**

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

### **3.02 INSTALLATION**

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.

### **3.03 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its product[s], and submit written reports, in acceptable format, to verify compliance of work with Contract.
  - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
  - .3 Schedule site visits to review work at stages listed:
    - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
    - .2 Upon completion of work, after cleaning is carried out.
- .2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .3 Performance Verification:
  - .1 Rooftop Air Handling Units:
    - .1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that percentage of zone dampers to full heating.
    - .2 Set outside air and return air dampers for minimum outside air.
    - .3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.
    - .4 Check for smooth, vibration less correct rotation of supply fan impeller.
    - .5 Measure supply fan capacity.
    - .6 Adjust impeller speed as necessary and repeat measurement of fan capacity.
    - .7 Measure pressure drop each component of air handling unit.
    - .8 Set outside air and return air dampers for the percentage of outside air required by design and repeat measurements of fan capacity.
    - .9 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.
    - .10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.
    - .11 Reduce difference between fan capacity with F&BPD fully closed to

- bypass and fully open to bypass to less than 5%.
- .12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5%.
- .13 OAD: verify for proper stroking, interlock with RAD.
- .14 Measure DBT, WBT of SA, RA, EA.
- .15 Measure air cooled condenser discharge DBT.
- .16 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.
- .17 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.
- .18 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.
- .19 Simulate maximum heating load and:
  - .1 Verify temperature rise across heat exchanger.
  - .2 Perform flue gas analysis. Adjust for peak efficiency.
  - .3 Verify combustion air flow to heat exchanger.
  - .4 Simulate minimum heating load and repeat measurements.
- .20 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.
- .21 Verify operating control strategies, including:
  - .1 Heat exchanger operating and high limit.
  - .2 Early morning warm-up cycle.
  - .3 Freeze protection.
  - .4 Economizer cycle operation, temperature of change-over.
  - .5 Alarms.
  - .6 Voltage drop across thermostat wiring.
  - .7 Operation of remote panel including pilot lights, failure modes.
- .22 Set zone mixing dampers for full heating and repeat measurements.
- .23 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.
- .24 Measure return fan capacity.
- .25 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
- .26 Check capacity of heating unit.
- .27 Measure DX refrigeration system performance.
- .28 Refer to other sections of these specifications for PV procedures for other components.
- .3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .4 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

### **3.04 DEMONSTRATION**

- .1 Training: Training of O&M Personnel, supplemented as specified.

**3.05 CLEANING**

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

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
    - .1 Start-up testing and verification of systems
    - .2 Check-out demonstration or proper operation of components.
    - .3 On-site operational tests

**1.2**      **RELATED SECTIONS**

- .1 The contractor is to ensure that all related work is co-ordinated among all specification sections, as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 91 13 - General Commissioning (Cx) Requirements.
- .5 Section 01 91 41 - Commissioning (Cx) Training.
- .6 Section 25 05 01 - EMCS: General Requirements.

**1.3**      **DEFINITIONS**

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL (Average Effectiveness Level): ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  - .1 Outage of main power supply in excess of back-up power sources, provided that:
    - .1 Automatic initiation of back-up was accomplished.

- .2 Automatic shut-down and re-start of components was as specified.
- .2 Failure of communications link, provided that:
  - .1 Controller automatically and correctly operated in stand-alone mode.
  - .2 Failure was not due to failure of any specified EMCS equipment.
- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  - .1 System recorded said fault.
  - .2 Equipment defaulted to fail-safe mode.
  - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

#### 1.4 **DESIGN REQUIREMENTS**

- .1 Confirm with Owner's Representative that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

#### 1.5 **SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Final Report: submit report to Owner's Representative.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by Owner's Representative before commissioning is started.
  - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Owner's Representative in accordance with Section 01 78 00 - Closeout Submittals.
  - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

#### 1.6 **CLOSEOUT SUBMITTALS**

- .1 Provide documentation, O&M Manuals, and training materials of O&M personnel for review by Owner's Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals and Section 25 05 03 - EMCS: Project Record Documents.

**1.7**            **COMMISSIONING**

- .1        Do commissioning in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2        Carry out commissioning under direction of Owner’s Representative and in presence of Owner’s Representative and Commissioning Co-ordinator.
- .3        Inform, and obtain approval from, Owner’s Representative in writing at least 14 days prior to commissioning or each test. Indicate:
  - .1        Location and part of system to be tested or commissioned.
  - .2        Testing/commissioning procedures, anticipated results.
  - .3        Names of testing/commissioning personnel.
- .4        Correct deficiencies, re-test in presence of Owner’s Representative until satisfactory performance is obtained.
- .5        Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6        Load system with project software. Install software for access to EMCS via dial up modem at Owner’s designated site for use during commissioning and for their use afterwards. Where high speed internet is available, use web browser software, compatible with Windows Vista with access via Internet Explorer (latest edition).
- .7        Perform tests as required.

**1.8**            **COMPLETION OF COMMISSIONING**

- .1        Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Owner’s Representative and Commissioning Co-ordinator.

**1.9**            **ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

- .1        Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

**PART 2**        **PRODUCTS**

**2.1**            **EQUIPMENT**

- .1        Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

### **PART 3**      **EXECUTION**

#### **3.1**      **PROCEDURES**

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Commissioning Co-ordinator and/or Owner's Representative.
- .3 Commission integrated systems using procedures prescribed by Commissioning Co-ordinator and/or Owner's Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

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

- .1 Pre-Installation Testing.
  - .1 General: consists of field tests of equipment just prior to installation.
  - .2 Testing may be on site or at Contractor's premises as approved by Owner's Representative.
  - .3 Configure major components to be tested in same architecture as designed system. Include all required network and control components.
  - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
  - .5 Additional instruments to include:
    - .1 DP transmitters.
    - .2 VAV supply duct SP transmitters.
    - .3 DP switches used for dirty filter indication and fan status.

- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source.
  - .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
  - .8 Owner's Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".
  - .9 Transmitters above 0.5 % error will be rejected.
  - .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test operating software.
    - .8 Test application software and provide samples of logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug software.
    - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
    - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and Engineering units. This document will be used in final startup testing.
  - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Owner's Representative and Commissioning Co-ordinator and provide:
    - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
    - .2 Detailed daily schedule showing items to be tested and personnel available.

- .3 Owner's Representative's acceptance signature to be on executive and applications programs.
- .4 Commissioning to commence during final startup testing.
- .5 O&M personnel to assist in commissioning procedures as part of training.
- .6 Commissioning to be supervised by qualified supervisory personnel and Owner's Representative.
- .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
- .8 Operate systems as long as necessary to commission entire project.
- .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  - .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
  - .2 Test to last at least 30 consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.
- .5 Commissioning Co-ordinator and/or Owner's Representative to verify reported results.

**3.3**

**ADJUSTING**

- .1 Final adjusting: upon completion of commissioning as reviewed by Owner's Representative set and lock devices in final position and permanently mark settings.

**3.4**

**DEMONSTRATION**

- .1 Demonstrate to Commissioning Manager and/or Owner's Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes.
  - .1      Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 25 05 01 - EMCS: General Requirements.

**1.3**      **DEFINITIONS**

- .1      CDL - Control Description Logic.
- .2      For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements

**1.4**      **SUBMITTALS**

- .1      Submittals in accordance with Section 01 33 00 - Submittal Procedures and supplemented and modified by requirements of this Section.
- .2      Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Owner's Representative 30 days prior to anticipated date of beginning of training.
  - .1      List name of trainer, and type of visual and audio aids to be used.
  - .2      Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3      Submit reports within one week after completion of Phase 1 and Phase 2 training program that training has been satisfactorily completed.

**1.5**      **QUALITY ASSURANCE**

- .1      Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2      Owner's Representative reserves right to approve instructors.

**1.6**            **INSTRUCTIONS**

- .1        Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2        Training to be project-specific.

**1.7**            **TIME FOR INSTRUCTION**

- .1        Number of days of instruction to be as specified in this section (1 day = 7 hours including two 15 minute breaks and excluding lunch time).

**1.8**            **TRAINING MATERIALS**

- .1        Provide equipment, visual and audio aids, and materials for classroom training.
- .2        Supply manual for each trainee, describing in detail data included in each training program.
  - .1        Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

**1.9**            **TRAINING PROGRAM**

- .1        1/2 day program to begin at time mutually agreeable to Contractor, Owner's Representative and Commissioning Co-ordinator.
  - .1        Train O&M personnel in functional operations and procedures to be employed for system operation.
  - .2        Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .3        Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
  - .4        Identification of Control Components.
  - .5        Review of shop drawings for building.
  - .6        Detailed discussion of sequences of operation
  - .7        Walk through of mechanical systems.

**1.10**          **ADDITIONAL TRAINING**

- .1        List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

**1.11            MONITORING OF TRAINING**

- .1        Engineer/ Architect to monitor training program and may modify schedule and content.

**PART 2            PRODUCTS (NOT USED)**

**PART 3            EXECUTION (NOT USED)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**            **SUMMARY**

.1            Section Includes:

- .1            General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

**1.2**            **RELATED SECTIONS**

.1            The contractor is to ensure that all related work is co-ordinated among all specification sections, as well as between other Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

- .1            Section 01 33 00 – Submittal Procedures.
- .2            Section 01 35 29.06 – Health and Safety Requirements.
- .3            Section 02 41 99 – Demolition for Minor Works.
- .4            Section 01 91 13 – General Commissioning (Cx) Requirements.
- .5            Section 09 91 99 – Painting for Minor Works.
- .6            Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .7            Section 25 01 12 - EMCS: Training.
- .8            Section 25 05 02 - EMCS: Submittals and Review Process.
- .9            Section 25 05 03 - EMCS: Project Record Documents.
- .10          Section 25 05 54 - EMCS: Identification.
- .11          Section 25 30 02 - EMCS: Field Control Devices.

1.3

**REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA).
  - .2 Canadian Environmental Protection Act (CEPA).
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .8 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA).
- .9 National Electrical Manufacturers Association (NEMA)

1.4

**ACRONYMS, ABBREVIATIONS AND DEFINITIONS**

- .1 Acronyms used in EMCS.
  - .1 AEL - Average Effectiveness Level
  - .2 AI - Analog Input
  - .3 AO - Analog Output
  - .4 BACnet - Building Automation and Control Network
  - .5 BC(s) - Building Controller(s)
  - .6 BECC - Building Environmental Control Centre
  - .7 CAB - Canadian Automated Building (CAB) Protocol

- .8 CAD - Computer Aided Design
- .9 CDL - Control Description Logic
- .10 CDS - Control Design Schematic
- .11 COSV - Change of State or Value
- .12 CPU - Central Processing Unit
- .13 DI - Digital Input
- .14 DO - Digital Output
- .15 DP - Differential Pressure
- .16 ECU - Equipment Control Unit
- .17 EMCS - Energy Monitoring and Control System
- .18 HVAC - Heating, Ventilation, Air Conditioning
- .19 IDE - Interface Device Equipment
- .20 I/O - Input/Output
- .21 ISA - Industry Standard Architecture
- .22 LAN - Local Area Network
- .23 LCU - Local Control Unit
- .24 MCU - Master Control Unit
- .25 NC - Normally Closed
- .26 NO - Normally Open
- .27 OS - Operating System
- .28 O&M - Operation and Maintenance
- .29 OWS - Operator Work Station
- .30 PC - Personal Computer
- .31 PCI - Peripheral Control Interface
- .32 PCMCIA - Personal Computer Micro-Card Interface Adapter
- .33 PID - Proportional, Integral and Derivative.
- .34 RAM - Random Access Memory
- .35 ROM - Read Only Memory
- .36 SP - Static Pressure
- .37 TCU - Terminal Control Unit
- .38 USB - Universal Serial Bus
- .39 UPS - Uninterruptible Power Supply
- .40 WAN- Wide Area Network

## 1.5

### DEFINITIONS

- .1 Point: may be logical or physical.
  - .1 Logical points: values calculated by system such as setpoints, totals,

- counts, derived corrections and may include, but not limited to result of and statements in CDL's.
- .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction which related equipment (stop, start) and value or damper actuators.
  - .2 Point Name: composed of two parts, point identifier and point expansion.
    - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
      - .1 Area descriptor: building or part of building where point is located.
      - .2 System descriptor: system that point is located on.
      - .3 Point descriptor: physical logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
    - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system", and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
    - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
      - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
  - .3 Point Object Type: points fall into following object types:
    - .1 AI (analog input)
    - .2 AO (analog output)
    - .3 DI (digital input)
    - .4 DO (digital output)
    - .5 Pulse inputs
  - .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
    - .1 Printouts: to ANSI/IEEE 260.1.
    - .2 Refer also to Section 25 05 54 - EMCS: Identification.

## 1.6

### SYSTEM DESCRIPTION

- .1 This is a modification to an existing control system.

- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point summaries and/or shown on the control drawings.
  - .3 OWS
  - .4 Data communications equipment necessary to affect EMCS data transmission system.
  - .5 Field control devices.
  - .6 Software/Hardware complete with full documentation.
  - .7 Complete operating and maintenance manuals.
  - .8 Training of personnel.
  - .9 Acceptance tests, technical support during commissioning, full documentation.
  - .10 Wiring interface co-ordination of equipment supplied by others.
  - .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
  - .1 Ensure new control devices integrate seamlessly with the existing control system.
- .4 All wiring associated with the EMCS communication network as well as all control wiring and conduit associated with the EMCS at 50 volts or less. Wire and conduit above 50 volts by Electrical Division.
- .5 BACnet compliance: full compliance to the BACnet standard (ANSA/ASHRAE) 135, BACnet – A Data communication Protocol for Building Automation and Control Networks is mandatory. Down to the field device level, the EMCS system must meet BACnet standards for system architecture and administration, and use open communication protocols and user friendly programming and graphics. Install the EMCS installed to communicate at the supervisory layer to the WAN using the BACnet TCP/IP protocol implemented on Ethernet.

## 1.7

### SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.
- .2 Submit for review:
  - .1 Equipment list and systems manufacturers within 10 days after award of contract.

- .3 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 – EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by third party Engineer registered in Canada, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
  - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - .6 Permits and fees: in accordance with general conditions of contract.
  - .7 Existing devices intended for re-use: submit test report.

## 1.8 QUALITY ASSURANCE

- .1 Have local office for at least 5 years staffed by factory trained personnel capable of installing and providing instruction, routine maintenance and emergency service on systems.
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Ensure factory qualified supervisory personnel continuously direct and monitor work and attend site meetings.
- .5 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .6 Be able to provide factory trained personnel on site within 24 hours notice or provide instructions on maintenance and emergency service on system.
- .7 BACnet devices to bear BACnet testing laboratories BTL mark and listed on

BACnet manufacturers association web site.

**1.9 DELIVERY, STORAGE AND HANDLING**

- .1 Material Delivery Schedule: provide Owner's Representative with "Materials Delivery Schedule" within 2 weeks after award of contract.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 02 41 99 – Demolition for Minor Works.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
  - .4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.
  - .5 Place materials defined as hazardous or toxic in designated containers.
  - .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, Municipal, and Provincial regulations.
  - .7 Label location of salvaged material's storage areas and provide barriers and security devices.
  - .8 Ensure emptied containers are sealed and stored safely.
  - .9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative Owner's Representative.
  - .10 Fold up metal and plastic banding, flatten and place in designated area for recycling

**1.10 EXISTING CONDITIONS - CONTROL COMPONENTS**

- .1 Utilize existing control wiring and piping.
- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards and specifications.
  - .1 Do not modify original design of existing devices without written permission from Owner's Representative.
  - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
  - .1 Furnish test report to Owner's Representative within 40 days of award of

- contract listing each component to be re-used and indicating whether it is in good order or requires repair by Owner.
- .2 Failure to produce test report will constitute acceptance of existing devices by owner.
  - .4 Non-functioning items:
    - .1 Provide with report specification sheets or written functional requirements to support findings.
    - .2 Owner will repair or replace existing items judged defective yet deemed necessary for EMCS.
  - .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
  - .6 Assume responsibility for existing controls to be incorporated into EMCS after written receipt of approval from Owner's Representative.
    - .1 Be responsible for items repaired or replaced by Owner.
    - .2 Be responsible for repair costs due to negligence or abuse of equipment repaired or replaced by Owner.
    - .3 Responsibility for existing devices terminates upon final acceptance of EMCS or applicable portions of EMCS as approved by Owner's Representative.
  - .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed

## **PART 2**      **PRODUCTS**

### **2.1**      **ACCEPTABLE SYSTEMS, MANUFACTURERS**

- .1 **This facility is presently controlled by a Siemen's DDC system. This contractor shall include tying the new system into the existing DDC system utilizing a Siemen's DDC system.**
- .2 Proposed system to have communication capability utilizing BACnet Protocol.
- .3 Panel to be NEMA rated to suit environmental requirements.
- .4 Panels to have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.
- .5 Wiring within panels to be contained within properly sized rigid PVC slotted wall wire duct. All wiring within the wire duct to be concealed with a non-slip cover.
- .6 Terminations for the connection of power wiring, communication wiring and field mounted devices to be at properly identified terminal blocks mounted

within the control panel.

- .7 All control panels to be provided with an internally mounted 120 volt duplex power receptacle.
- .8 All control panels to be identified with permanently mounted Lamecoid tags to identify the control panel and the systems served by the control panel. Submit schedule of labels with shop drawing submission.
- .9 Provide low voltage transformers in panels or elsewhere as required.
- .10 Provide adaptors between metric and imperial components.

### **PART 3**      **EXECUTION**

#### **3.1**      **MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

#### **3.2**      **PAINING**

- .1 Painting to be in accordance with NEMA, supplemented as follows:
- .2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
- .3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.
- .4 Clean and prime exposed hangers, racks, fastenings, and other support components.
- .5 Paint all unfinished equipment installed indoors to NEMA.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process include review meetings for building Energy Monitoring and Control System (EMCS).

**1.2**      **RELATED SECTIONS**

- .1 The contractor is to ensure that all related work is co-ordinated among all specification sections as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.
  - .1 Section 01 33 00 - Submittal Procedures.
  - .2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
  - .3 Section 25 05 01 - EMCS: General Requirements.

**1.3**      **DEFINITIONS**

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

**1.4**      **DESIGN REQUIREMENTS**

- .1 Preliminary Design Review: to contain following contractor and systems information.
  - .1 Location of local office.
  - .2 Description and location of installing and servicing technical staff.
  - .3 Location and qualifications of programming design and programming support staff.
  - .4 List of spare parts.
  - .5 Location of spare parts stock.
  - .6 Names of sub-contractors and site-specific key personnel.
  - .7 Sketch of site-specific system architecture.
  - .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .9 Descriptive brochures.
  - .10 Sample CDL and graphics (systems schematics).
  - .11 Response time for each type of command and report.

- .12 Item-by-item statement of compliance.
- .13 Proof of demonstrated ability of system to communicate utilizing BACnet protocol.

## 1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 30 working days after contract award for review by Owner's Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in AutoCAD - latest version and Microsoft Word latest version format, or PDF structured using menu format for easy loading and retrieval on OWS.
- .6 Submittals shall consist of:
  - .1 Data sheets of all products.
  - .2 Wiring and piping interconnection diagrams including panel and device power, and sources.
  - .3 List of materials of all proposed devices and equipment.
  - .4 Software documentation:
  - .5 Sequence of operation, in text form.
  - .6 Application programs.
  - .7 Point Schedules
  - .8 Controls schematics and system diagrams.
  - .9 Project installation schedule.
  - .10 Names of subtrades working for EMCS contractor.
  - .11 Mounting support details for components installed in airflow, waterflow and steam systems.
- .7 Submit shop drawings in a package which contains the various schedules and drawings which completely describe the control system installed. At a minimum the shop drawing package to contain the following items described in Section 1.5.8 to 1.5.28 as follows:
- .8 Network drawing showing the network connection of all network control units, programmable control units, terminal control units and operator workstations to

indicate the location of each of these elements.

- .9 Schematic control diagram for each system being controlled. Where there are typical systems a drawing to be provided for each system. This drawing to be on a AB size sheet (11 x 17) and shall include a title block which includes as a minimum the drawing title, drawing number, project title, contractor's name, contractor's address, contractor's phone and fax numbers, contractor's project number and a section to provide a record for revision information.
- .10 The schematic control diagram to include a bill of materials which provides a list of all part numbers and descriptions for the control components on the drawing list to include field equipment as well as panel mounted components.
- .11 The schematic control diagram to include a complete wiring diagram for all electrical connections, including motor starters, heating coils, coiling coils etc.
- .12 The schematic control diagram to include a layout of the control panels for each system. This layout to show the mounting of all panel equipment, including transformers, power supplies, controllers, transducers, sensors, relays, contactors and any other panel mounted equipment.
- .13 The contractor to include with the shop drawing submittal drawings, showing all wiring details for the connections of sensors, transducers, relays and contactors these details to show terminal numbers and be referenced to the appropriate schedules and drawings.
- .14 The contractor to supply with the shop drawing package a complete point schedule to show every point connected to the system. This schedule to be in tabular format and provide the point identification, point type, wire tag, termination details reference, referenced drawings, device mounting location and device code numbers.
- .15 The point schedule to provide at a minimum the following information on the software attributes of the point:
  - .1 Tag name – ex. EPT-1
  - .2 Point type – ex. AO-3
  - .3 System name – ex. A/C-1
  - .4 Object name – H-VLV.
  - .5 Expanded ID- Heating control valve
  - .6 Units of measurement - %.
- .16 The point schedule to provide at a minimum the following information on the digital controller to which the point is connected:
  - .1 Controller type – ex. Unitary controller
  - .2 Controller address ex. 256.
  - .3 Cable destination – the termination at the controller, ex. AO-1.

- .4 Terminal numbers – the termination at the controller.
- .17 The point schedule to provide at minimum the following information on the control panel:
  - .1 Panel identification
  - .2 Panel location
  - .3 Reference drawing
- .18 The point schedule to provide at a minimum the following information on any intermediate device which may be associated with the point:
  - .1 Type of wiring or tubing used
  - .2 Device part number
  - .3 Location of the device.
  - .4 Reference details.
- .19 The point schedule to provide at a minimum the following information on any field device which may be associated with the point;
  - .1 Type of wiring or tubing used
  - .2 Device part number
  - .3 Location of the devices
  - .4 Reference details
- .20 The contractor to supply with the shop drawing package a complete room schedule, to show the equipment associated with the room controls. Schedule to be in tabular format and provide the room number and location, terminal unit number, part numbers for the terminal unit controller, sensors and actuators. Included on this schedule terminal unit type, size, minimum flow and maximum flow.
- .21 Sequence of operation for each system controlled. Sequence to be in complete conformance with the sequence of operations included with this specification. Any changes require the approval of the Owner's Representative in writing. Sequence to include all modes of operation including fail safe, emergency and fire modes.
- .22 Valve schedule including design flow, CV, size, type, actuator, pressure drop and maximum shut off pressure differential for each control valve.
- .23 Damper schedule including design air flow, size, type actuator and torque requirements for each control damper.
- .24 Provide one permanent, not fading, as built copy of each control drawing, enclosed by an aluminium frame with glass cover, or sealed by plastic laminate in rigid metal bound frame. To be installed at each respective control panel location.

- .25 Catalogue cut sheets of all equipment used. This includes, but is not limited to DDC panels, peripherals, sensors, actuators, dampers, control air system components, etc.
- .26 Range and scale information for all transmitters and sensors. This sheet to clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.
- .27 Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.
- .28 Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth for

## 1.6

### **PRELIMINARY SHOP DRAWING REVIEW**

- .1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
  - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
  - .2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.
  - .3 Spare point capacity of each controller by number and type.
  - .4 Controller locations.
  - .5 Auxiliary control cabinet locations.
  - .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
  - .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
  - .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
  - .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate,

manufacturer, model and range of velocity transmitter.

- .10 Compressor schematic and sizing data.

## 1.7

### DETAIL SHOP DRAWING REVIEW

- .1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
  - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
  - .2 Wiring diagrams.
  - .3 Piping diagrams and hook-ups.
  - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
  - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
    - .1 Sensing element type and location.
    - .2 Transmitter type and range.
    - .3 Associated field wiring schematics, schedules and terminations.
    - .4 Pneumatic schematics and schedules.
    - .5 Complete Point Name Lists.
    - .6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
    - .7 Software and programming details associated with each point.
    - .8 Manufacturer's recommended installation instructions and procedures.
    - .9 Input and output signal levels or pressures where new systems ties into existing control equipment.
  - .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
  - .7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
  - .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
  - .9 Listing of and example of specified reports.
  - .10 Listing of time of day schedules.
  - .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
  - .12 Type and size of memory with statement of spare memory capacity.
  - .13 Full description of software programs provided.

- .14 Sample of "Operating Instructions Manual" to be used for training purposes.
- .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 – EMCS: Start-up, Verification and Commissioning.

**1.8**      **QUALITY ASSURANCE**

- .1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
  - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
  - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
  - .3 Review interface requirements of materials supplied by others.
  - .4 Review "Sequence of Operations".
- .2 Contractor's factory trained programmer to attend meeting.
- .3 Owner's Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Owner.

**PART 2**      **PRODUCTS (NOT USED)**

**PART 3**      **EXECUTION (NOT USED)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes.
  - .1      Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 78 00 - Closeout Submittals.
- .2      Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .3      Section 25 05 01 - EMCS: General Requirements.
- .4      Section 25 05 02 - EMCS: Submittals and Review Process.

**1.3**      **DEFINITIONS**

- .1      BECC - Building Environmental Control Centre.
- .2      OWS - Operator Work Station.
- .3      For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements

**1.4**      **SUBMITTALS**

- .1      Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2      Submit Record Documents, As-built drawings, Operation and Maintenance Manual to Owner's Representative in English.
- .3      Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
  - .1      Binders to be 2/3 maximum full.
  - .2      Provide index to full volume in each binder.
  - .3      Identify contents of each manual on cover and spine.
  - .4      Provide Table of Contents in each manual.
  - .5      Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

**1.5**      **AS-BUILTS**

- .1      Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1      Changes to contract documents as well as addenda and contract extras.
  - .2      Changes to interface wiring.
  - .3      Routing of conduit, wiring and control air lines associated with EMCS installation.
  - .4      Locations of obscure devices to be indicated on drawings.
  - .5      Listing of alarm messages.
  - .6      Panel/circuit breaker number for sources of normal/emergency power.
  - .7      Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
  - .8      Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
  - .9      Basic system design and full documentation on system configuration.
- .2      Submit for final review by Owner's Representative.
- .3      Provide before acceptance 4 hard and 1 soft copy incorporating changes made during final review.

**1.6**      **O&M MANUALS**

- .1      Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2      Provide 2 complete sets of hard and soft copies prior to system or equipment tests.
- .3      Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4      Functional description to include:
  - .1      Functional description of theory of operation.
  - .2      Design philosophy.
  - .3      Specific functions of design philosophy and system.
  - .4      Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

- .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
- .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
- .5 System operation to include:
  - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
  - .2 Operation of computer peripherals, input and output formats.
  - .3 Emergency, alarm and failure recovery.
  - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 Software to include:
  - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - .2 Detailed descriptions of program requirements and capabilities.
  - .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
  - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
  - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
  - .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
  - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

- .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

**PART 2      PRODUCTS (NOT USED)**

**PART 3      EXECUTION (NOT USED)**

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **SUMMARY**

- .1      Section Includes.
  - .1      Requirements and procedures for identification of devices, sensors, wiring, tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates, materials, colours and lettering sizes.

**1.2**      **RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 25 05 01 - EMCS: General Requirements.

**1.3**      **REFERENCES**

- .1      Canadian Standards Association (CSA International).
  - .1      CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

**1.4**      **DEFINITIONS**

- .1      For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.5**      **SYSTEM DESCRIPTION**

- .1      Language Operating Requirements: provide identification for control items in English.

**1.6**      **SUBMITTALS**

- .1      Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process supplemented and modified by requirements of this Section.
- .2      Submit to Owner’s Representative for approval samples of nameplates, identification tags and list of proposed wording.

**PART 2**      **PRODUCTS**

**2.1**      **NAMEPLATES FOR PANELS**

- .1 Identify by plastic laminate, 3 mm thick melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core, mechanically attached with self-tapping screws.
- .2 Sizes: 25 x 67 mm minimum.
- .3 Lettering: minimum 7 mm high, black.
- .4 Inscriptions: machine engraved to identify function.

**2.2**      **NAMEPLATES FOR FIELD DEVICES**

- .1 Identify by plastic encased cards attached by plastic tie.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address, make, model number.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

**2.3**      **NAMEPLATES FOR ROOM SENSORS**

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Owner's Representative.
- .3 Letter size: to suit, clearly legible.

**2.4**      **WARNING SIGNS**

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Owner's Representative.

**2.5**      **WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

**2.6**            **CONDUIT**

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Owner's Representative during "Preliminary Design Review".

**PART 3**        **EXECUTION**

**3.1**            **NAMEPLATES AND LABELS**

- .1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

**3.2**            **EXISTING PANELS**

- .1 Correct existing nameplates and legends to reflect changes made during work.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**      **RELATED SECTIONS**

- .1      Section 25 05 02 - EMCS: Submittals and Review Process.
- .2      Section 25 05 03 - EMCS: Project Records Documents.

**1.2**      **REFERENCES**

- .1      American National Standards Institute (ANSI)
  - .1      ANSI C12.7, Requirements for Watthour Meter Sockets.
  - .2      ANSI/IEEE C57.13, Requirements for Instrument Transformers.
- .2      Canadian Standards Association
  - .1      CSA Type 1 Enclosure
  - .2      CSA Type 4X Enclosures
  - .3      CSA Type 12 Enclosures

**1.3**      **SUBMITTALS**

- .1      Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals 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 Owner's Representative, 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 CSA 4X 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**      **TEMPERATURE SENSORS**

- .1 Existing temperature sensors to remain or be relocated as indicated. Contractor shall confirm proper operation of existing temperatures sensor, prior to completion of project.

**2.3**      **ELECTRICAL RELAYS**

- .1 Requirements:
  - .1 Double voltage, DPDT, plug-in type with termination base.
  - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
  - .3 Contacts: rated at 5 amps at 120 V AC.
  - .4 Relay to have visual status indication

**2.4**      **SOLID STATE RELAYS**

- .1 Requirements:
  - .1 CSA approved.
  - .2 Suitable to the application as recommended by manufacturer.
  - .3 Voltage range: 75-265 VAC
  - .4 Panel mounting.

- .5 Suitable for AC or DC loads.
- .6 Output surge absorbing element for inductive on/off loads.
- .7 Input capacitor/resistor circuit for pulse noise absorption.
- .8 For input inductive noise use twisted-pair wires for electromagnetic noise and shielded cable for static noise.

## 2.5 CURRENT TRANSDUCERS

- .1 Requirements:
  - .1 Range: in accordance with Equipment Schedules.
  - .2 Purpose: measure line current and produce proportional signal in one of following ranges:
    - .1 4-20 mA DC.
    - .2 0-5 volt DC.
    - .3 0-10 volts DC.
    - .4 2-10 volts DC.
  - .3 Frequency insensitive from 10 - 80 hz.
  - .4 Accuracy to 0.5% full scale.
  - .5 Zero and span adjustments. Field adjustable range to suit motor applications.
  - .6 Adjustable mounting bracket to allow for secure/safe mounting inside the MCC or starter enclosure.

## 2.6 CURRENT SENSING RELAYS

- .1 Requirements:
  - .1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.
  - .2 Suitable for single or 3 phase metering into single relay.
  - .3 To have adjustable latch level, adjustable delay on latch and minimum differential of 10 % of latch setting between latch level and release level.
  - .4 3-Phase application: provide for discrimination between phases.
  - .5 To have adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be acceptable from auxiliary cabinet.
  - .6 Relay contacts: capable of handling 10 amps at 240 V AC.

## 2.7 SURFACE WATER DETECTORS

- .1 Requirements:
  - .1 Provide alarm on presence of water in drain pan.
  - .2 Expendable cartridge sensor.

- .3 Internal waterproof switch.
- .4 One set of dry contacts 2 amps at 24 V.
- .5 Unaffected by moisture in air.
- .6 Self-powered.

## 2.8 PANELS

- .1 Either free-standing or wall mounted enameled steel cabinets with hinged and key-locked front door.
- .2 To be modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by Owner's Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

## PART 3 EXECUTION.

### 3.1 INSTALLATION

- .1 Install field control devices, conduit and wire in accordance with manufacturers recommended methods, procedures and instructions. Wiring and conduit above 50 volts by electrical Division. Coordinate requirements with Electrical Contactor.
- .2 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in CSA 2 enclosures or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.
- .3 Support field-mounted transmitters, sensors on pipe stands or channel brackets.
- .4 Install wall mounted devices on plywood panel properly attached to wall.

### 3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by stainless steel shields.
  - .2 Install in CSA 4X enclosures.
- .4 Duct installations
  - .1 Do not mount in dead air space.
  - .2 Location to be within sensor vibration and velocity limits.

- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports so as to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors:
  - .1 Sensor length to be not less than 1000 mm per square metre of duct cross-sectional area.
  - .2 Use multiple sensors where single sensor does not meet minimum length ratio. Wire multiple sensors in series for freeze protection applications.
  - .3 Wire multiple sensors separately for temperature measurement.
  - .4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.
- .6 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.

### 3.3 **PANELS**

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).
- .3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .4 Identify wiring and conduit clearly.

### 3.4 **IDENTIFICATION**

- .1 Identify field devices properly.
- .2 Refer to Section 25 05 54 - EMCS: Identification.

### 3.5 **TESTING**

- .1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Owner's Representative for approval. Owner's Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.

**3.6**

**COMMISSIONING**

- .1 Refer to Section 25 01 11 – EMCS: Start-up, Verification and Commissioning.

**END OF SECTION**

## PART 1 - GENERAL

- 1.1 References .1 Canadian Standards Association (CSA International)
- .1 Do complete installation in accordance with CSA C22.1-06, Canadian Electrical Code, Part 1 (latest Edition), Safety Standard for Electrical Installations, except where specified otherwise.
  - .2 Comply with CSA Certification Standards and Electrical Bulletins in force at time of Tender submission.
  - .3 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
- .1 IEEE SP1147, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- 1.2 Definitions .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1147.
- 1.3 Design Requirements .1 Operating voltages: to CAN3-C235.
- .2 Motors, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.
- 1.4 Submittals .1 Submittals: in accordance with Section 01 33 00 -Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 01 35 28 - Health & Safety Requirements.
- .3 Shop drawings:
- .1 Submit shop drawings, product data and samples in accordance with Section 01 33 00.
  - .2 Submit drawings to be stamped and signed by professional engineer.
-

- 1.4 Submittals (Cont'd)
- .3 Shop drawings:(Cont'd)
    - .3 Where applicable, submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
    - .4 Where applicable, identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
    - .5 Where applicable, indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
    - .6 If changes are required, notify Engineer of these changes before they are made.
  - .4 Quality Control: in accordance with Section 01 11 00 -. Summary of Work.
    - .1 Provide CSA certified equipment and material.
    - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
    - .3 Submit test results of installed electrical systems and instrumentation.
    - .4 Permits and fees: in accordance with General Conditions of contract.
    - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
    - .6 Submit certificate of acceptance from Electrical Inspection Department upon completion of work to Engineer.
- 1.5 Quality Assurance
- .1 Quality Assurance: in accordance with Section 01 11 00 -Summary of Work.
  - .2 Qualifications: Electrical Work to be carried out by qualified, licensed journeymen electricians or apprentices in accordance with authorities having jurisdiction
    - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
    - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
  - .3 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 28 - Health and Safety Requirements.
-

- 1.6 Delivery, Storage and Handling
- .1 Material Delivery Schedule: provide Engineer with schedule within 2 weeks after award of Contract.
- 1.7 System Startup
- .1 Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.
  - .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
  - .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.
- 1.8 Operating Instructions
- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .4 Post instructions where directed.
  - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
  - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
- 1.9 Operation and Maintenance Data
- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual specified in Section 01 33 00.
  - .2 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.
-

- 1.9 Operation and Maintenance Data (Cont'd) .2 (Cont'd)
- .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
  - .3 Wiring and schematic diagrams and performance curves.
  - .4 Names and addresses of local suppliers for items included in maintenance manuals.
  - .5 Copy of reviewed shop drawings.
- 1.10 Permits, Fees and Inspections .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
  - .3 Engineer will provide drawings and specifications required by the Electrical Inspection Department and Supply Authority at no cost.
  - .4 Notify Engineer of changes required by Electrical Inspection Department prior to making changes.
  - .5 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Engineer.
- 1.11 Contract Drawings .1 The Drawings for the Electrical work are diagrammatic performance Drawings only, intended to convey the scope of work and indicate the general arrangement and approximate location of apparatus and fixtures, and the approximate sizes and locations of equipment and outlets. The Drawings do not intend to show Architectural, Mechanical or Structural details.
- .2 Do not scale or measure Drawings, but obtain information regarding accurate dimensions, from the dimensions shown on the Architectural Drawings, or by site measurements. Follow the Electrical Drawings for laying out the work.
  - .3 Refer to the other Division's Coordination Drawings, to become familiar with all conditions affecting the work, and verify suitable spaces exist, in which the equipment will be installed.
  - .4 Make, at no additional cost, any changes or additions to materials and equipment necessary to accommodate Structural conditions (offsets around beams, columns, etc.).
  - .5 Alter at no additional cost, the location of materials and/or equipment as directed, provided that the changes are made before installation, and do not necessitate additional materials.
-

- 1.11 Contract Drawings (Cont'd)
- .6 Leave space clear, and install equipment to accommodate future materials and/or equipment as indicated or specified, or to accommodate equipment and/or materials supplied by other Contractors.
  - .7 Verify that the spaces in which the equipment is to be installed is sufficient and install all equipment to maintain head room and clearances, to conserve space, comply with codes, and to ensure adequate space for future servicing.
  - .8 Confirm at the site, the exact location of equipment, outlets and fixtures, and the location of outlets for equipment supplied by other Contractors, before installation.
- 1.12 As-Built Drawings
- .1 Provide As-Built Drawings of the installation from the Record Drawings.
- 1.13 Completion of Contract
- .1 All the equipment must be cleaned and tested, before final acceptance by the Consultant.
  - .2 From the date of issuance of a "Certificate of Substantial Performance", all equipment, materials and workmanship, must be unconditionally warranted for not less than 1 (one) year.
  - .3 Defects and deficiencies which originate or become evident during the warranty period must be repaired or replaced, at no cost.
  - .4 If, during the warranty period, transformers or other noise and vibration producing equipment are considered by the Consultant to exceed acceptable standards, then these must be replaced without delay or additional cost to the Owner. All work relating to the replacement of defective items must be carried out after normal working hours and at a time which is acceptable to the Owner.
- 1.14 Existing Conditions
- .1 Visit the site and examine existing conditions affecting the work of this Division.
  - .2 No claim for extra payment shall be made for extra work made necessary by circumstances encountered due to conditions which were visible upon, or reasonably inferable from an examination of the site prior to submission of the bid.
-

## PART 2 - PRODUCTS

- 2.1 Materials and Equipment
- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
  - .2 Factory assemble control panels and component assemblies.
- 2.2 Electric Motors, Equipment and Controls
- .1 Supplier and installer responsibility is indicated on the Drawings and in the Motor Control Schedule. Mechanical responsibility is indicated on the Mechanical Drawings and in the Mechanical Specification.
  - .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.
- 2.3 Warning Signs
- .1 Warning Signs: in accordance with requirements of authority having jurisdiction inspection authorities and Engineer.
  - .2 Decal signs, minimum size 175 x 250 mm.
- 2.4 Wiring Terminations
- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.
- 2.5 Equipment Identification
- .1 Identify electrical equipment with nameplates and labels as follows:
    - .1 Nameplates: lamicoïd 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core, self adhesive unless specified otherwise.
    - .2 Sizes as follows:

### NAMEPLATE SIZES

|        |            |          |          |
|--------|------------|----------|----------|
| Size 1 | 10 x 50 mm | 1 line   | 3mm high |
| Size 2 | 12 x 70 mm | 1 line   | 5mm high |
| Size 3 | 12 x 70 mm | 2 lines  | 3mm high |
| Size 4 | 20 x 90 mm | 1 line   | 8mm high |
| Size 5 | 20 x 90 mm | 2 lines  | 5mm high |
| Size 6 | 25 x 100mm | 1 line 1 | 2mm high |
| Size 7 | 24 x 100mm | 2 lines  | 6mm high |

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2.5 Equipment  
Identification  
(Cont'd)

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Engineer 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 and starters: indicate equipment being controlled and voltage.
- .7 Pull boxes: indicate system and voltage.

2.6 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.

2.7 Conduit and  
Cable  
Identification

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

|                | <u>Prime</u> | <u>Auxiliary</u> |
|----------------|--------------|------------------|
| up to 250 V    | Yellow       |                  |
| up to 600 V    | Yellow       | Green            |
| up to 5 kV     | Yellow       | Blue             |
| control wiring | Green        | Blue             |

2.8 Finishes

- .1 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel.
    - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y-1-1-1955.
    - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1-1958.
-

- 2.9 Standard of Acceptance
- .1 Means that item named meets specifications in all respects regarding performance, quality of material and workmanship, and is acceptable to Engineer without qualification. Equipment proposed shall meet same standards and must be approved ten (10) days prior to tender closing.
  - .2 Requests for approvals will only be accepted from manufacturers or their representatives.
  - .3 "Approved Equals" will be acceptable as a base bid item.
  - .4 "Approved Alternates" will be indicated with the tender on the form supplied, indicating price increase or decrease to the bid, should the alternate be accepted.

### PART 3 - EXECUTION

- 3.1 Installation
- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

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

- 3.3 Conduit and Cable Installation
- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

- 3.4 Location of Outlets
- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings, where indicated on the Drawings.
  - .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
  - .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

- 3.5 Mounting Heights
- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
  - .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
-

- 3.5 Mounting Heights (Cont'd) .3 Install electrical equipment at following heights unless indicated otherwise.
- .1 Wall receptacles:
    - .1 In mechanical rooms: 1400 mm.
- 3.6 Co-ordination of Protective Devices .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- 3.7 Field Quality Control .1 Load Balance:
- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
- .1 Circuits originating from branch distribution panels.
  - .2 Motors and associated control equipment including sequenced operation of systems where applicable.
  - .3 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Engineer.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- 3.8 Cleaning .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
-

- 3.9 Protection .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.
- 3.10 Fireproofing .1 Where cables or conduits pass through non fire-rated floors, walls or roof, provide internal and external sealing thereto.
- .2 Retain the service of a specialty sealant contractor for the work required.
- .3 Comply with manufacturer's installation instructions for all sealant applications.
- .4 For non fire-rated locations, sealant shall be silicone that meets the requirements of CGSB 19-GP-23, for the size of the joint required, and the types of materials being bonded.
- .5 For fire rated locations, the fire stop shall meet the requirements of ULC with regards to the type of assembly and the fire separation.
- 3.11 Co-ordination of Protective Devices .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.
- 3.12 Cutting and Patching .1 All cutting and patching shall be provided by the General Contractor.
- .2 This Contractor to provide layout drawings for all openings required for the completion of their work.
- 3.13 Demolition .1 All demolition shall be the responsibility of the General Contractor.
- 3.14 Noise and Vibration .1 Electrical equipment is to operate without objectionable noise or vibration. If, in the opinion of the Consultant, the equipment operates with excessive noise or vibration, then the equipment must be replaced or noise or vibration eliminated.
-

3.14 Noise and  
Vibration  
(Cont'd)

- .2 Connections to noise-producing and vibrating equipment (i.e. transformers) must be made with flexible conduit. Use a minimum of 1m of flexible cable at each device, formed into a 360 deg. loop.
- .3 Vibration isolators are to be provided where indicated or required.

## PART 1 - GENERAL

- 1.1 Section Includes .1 Materials and installation for wire and box connectors.
- 1.2 References .1 Canadian Standards Association (CSA International)  
.1 CAN/CSA-C22.2 No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.  
.2 CSA C22.2 No.65-93(R1999), Wire Connectors.  
.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)  
.1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).  
.3 National Electrical Manufacturers Association (NEMA)
- 1.3 Waste Management and Disposal .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.  
.2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.  
.3 Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer.

## PART 2 - PRODUCTS

- 2.1 Materials .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.  
.2 Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.  
.3 Bushing stud connectors: to EEMAC 1Y-2 to suit conductor.  
.4 Clamps or connectors for armoured cable and flexible conduit as required to: CAN/CSA-C22.2 No.18.
-

PART 3 - EXECUTION

- 3.1 Installation .1 Remove insulation carefully from ends of conductors and:
- .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .3 Install fixture type connectors and tighten. Replace insulating cap.
  - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.
  - .5 Install crimp type connectors with snap-on nylon caps on splices and joints in branch circuits.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- 1.2 References .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.  
.2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.
- 1.3 Product Data .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 Waste Management and Disposal .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.  
.2 Fold up metal banding, flatten and place in designated area for recycling.
- 1.5 Wiring Methods .1 Wiring methods used shall be in accordance with the Canadian Electrical Code, Part 1, CSA Standard C22.1 - latest edition and the requirements of the Electrical Inspection Department of Prince Edward Island. The standards of this specification shall not be reduced to the minimum safety standards of the above.  
.2 All conductors shall be copper; aluminum is not acceptable.  
.3 Branch feeders from the subdistribution equipment to major equipment, etc. shall be sized as indicated on the drawings. Conductors in conduit shall be used unless otherwise indicated.  
.4 Branch circuit wiring and control wiring shall be conductors in EMT conduit or as identified on drawings E1, E2 and E3 only.
-

## PART 2 - PRODUCTS

- 2.1 Building Wires
- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG, solid.
  - .2 Copper conductors: size as indicated, with 600V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.
- 2.2 TECK Cable
- .1 Cable: to CAN/CSA-C22.2 No. 131.
  - .2 Conductors:
    - .1 Grounding conductor: copper.
    - .2 Circuit conductors: copper, size as indicated.
  - .3 Insulation:
    - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.
  - .4 Inner jacket: polyvinyl chloride material.
  - .5 Armour: interlocking aluminum.
  - .6 Overall covering: polyvinyl chloride material, Firex II rating.
  - .7 Fastenings:
    - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
    - .2 Channel type supports for two or more cables at 1000 mm centers, or at spacing required to suit loading.
    - .3 Threaded rods: 6 mm dia. to support suspended channels.
  - .8 Connectors:
    - .1 Watertight. Approved for TECK cable and environmental application (i.e., wet areas - watertight).
- 2.3 Control Cables
- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket, and fire rated FT4.
  - .2 Low energy 300 V control cable: annealed copper conductors sized as indicated, with PVC insulation type TW or TWH and shielding over each conductor and overall PVC jacket, fire rated FT4.
-

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.

3.2 Installation of TECK Cable 0 -1000 V

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

3.3 Installation of Control Cables

- .1 Install control cables as indicated on drawings.
- .2 Ground control cable shield.

3.4 Installation of Cables and Voltage Drop

- .1 Any wire or group of wires shall be sized according to the following chart. The voltage drop calculations are based on a 12 amp load on a 15 amp 120 volt circuit as per CEC C22.1 8-102.

| Size of Wire | Distance       |
|--------------|----------------|
| #12 AWG      | 0 m to 25 m    |
| #10 AWG      | 25 m to 40 m   |
| # 8 AWG      | 40 m to 63 m   |
| # 6 AWG      | 63 m to 100 m  |
| # 4 AWG      | 100 m to 155 m |

## PART 1 - GENERAL

- 1.1 Related Sections .1 Section 26 05 00 - Common Work Results for Electrical.
- 1.2 References .1 Canadian Standards Association, (CSA International).  
.1 Grounding and bonding equipment to: CSA C22.2 No. 41 - M1987(R1993).
- 1.3 Waste Management and Disposal .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.  
.2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.  
.3 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.  
.4 Fold up metal banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

- 2.1 Equipment .1 Grounding conductors: bare stranded copper, un-tinned, soft annealed, unarmoured, size as indicated.  
.2 Insulated grounding and bonding conductors: green, type as per Section 26 05 21.  
.3 Non-corroding accessories necessary for grounding and bonding system, type, size, material as indicated, including but not necessarily limited to:  
.1 Grounding and bonding bushings.  
.2 Protective type clamps.  
.3 Bolted type conductor connectors.  
.4 Bonding jumpers, straps.  
.5 Pressure wire connectors.
-

2.2 Manufacturers .1 Standard of Acceptance: Burndy Corp., McGraw-Edison (Canada) Ltd.

### PART 3 - EXECUTION

3.1 Installation .1 Install complete permanent, continuous grounding and bonding systems including, conductors, connectors, accessories. Where EMT is used, run ground or bond wire in conduit. Installation should conform to the requirements of the Engineer and Local Authorities having jurisdiction over the installation.  
General

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding and bonding conductors from mechanical injury.

.4 Use mechanical connectors for grounding and bonding connections to equipment provided with lugs.

.5 Soldered joints not permitted.

.6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.7 Make grounding and bonding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.8 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.2 Equipment .1 Install grounding connections to typical equipment included in, but not necessarily limited to the following list. Frames of motors, starters, control panels, and distribution panels.  
Grounding

3.3 Field Quality .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.  
Control

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and Local Authority having jurisdiction over installation. Provide a written report of results to the Engineer.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

## PART 1 - GENERAL

- 1.1 Waste Management and Disposal
- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
  - .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
  - .3 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
  - .4 Fold up metal banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

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

## PART 3 - EXECUTION

- 3.1 Installation
- .1 Secure equipment to hollow or solid masonry, tile and plaster surfaces with anchors to suit.
  - .2 Secure equipment to poured concrete with expandable inserts.
  - .3 Secure equipment to hollow masonry walls with toggle bolts.
  - .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
  - .5 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.
  - .6 Suspended support systems.
    - .1 Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
    - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
-

3.1 Installation  
(Cont'd)

- .7 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

### PART 1 - GENERAL

- |  |    |  |
|--|----|--|
| <u>1.1 Waste Management and Disposal</u> | .1 | Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan. |
|  | .2 | Fold up metal banding, flatten and place in designated area for recycling.                                       |

### PART 2 - PRODUCTS

- |                                    |    |  |
|------------------------------------|----|--|
| <u>2.1 Junction and Pull Boxes</u> | .1 | Welded steel construction with screw-on flat covers for surface mounting.                  |
|                                    | .2 | Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes. |

### PART 3 - EXECUTION

- |   |    |   |
|---|----|---|
| <u>3.1 Junction and Pull Box Installation</u> | .1 | Install pull boxes in inconspicuous but accessible locations.   |
|   | .2 | Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes. |
| <u>3.2 Identification</u>                     | .1 | Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.                      |
|   | .2 | Install size 2 identification labels indicating system name, voltage and phase, as applicable.                                  |

## PART 1 - GENERAL

- 1.1 References .1 CSA C22.1-1998, Canadian Electrical Code, Part 1.
- 1.2 Waste Management and Disposal .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

## PART 2 - PRODUCTS

- 2.1 Outlet and Conduit Boxes General .1 Size boxes in accordance with CSA C22.1.
- 2.2 Sheet Steel Outlet Boxes .1 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- 2.3 Fittings - General .1 Bushing and connectors with nylon insulated throats.  
.2 Knock-out fillers to prevent entry of debris.  
.3 Conduit outlet boxes for conduit up to 32 mm and pull boxes for larger conduits.  
.4 Double locknuts and insulated bushings on sheet metal boxes.

## PART 3 - EXECUTION

- 3.1 Installation .1 Support boxes independently of connecting conduits.  
.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.  
.3 Provide correct size of openings in boxes for conduit connections. Reducing washers are not allowed.

## PART 1 - GENERAL

- 1.1 References .1 Canadian Standards Association (CSA)
- .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
  - .2 CSA C22.2 No. 45-M1981(R1992), Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56-1977(R1999), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83-M1985(R1999), Electrical Metallic Tubing.
  - .5 CAN/CSA C22.2 No. 227.3-M91(R1999), Flexible Nonmetallic Tubing.
- 1.2 Waste Management and Disposal .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
  - .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- 1.3 Location of Conduit .1 Drawings do not indicate all conduits. Those indicated are in diagrammatic form only.

## PART 2 - PRODUCTS

- 2.1 Conduits .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel, threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with steel set screw couplings and connectors.
  - .3 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.
- 2.2 Conduit Fastenings .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
  - .3 Channel type supports for two or more conduits at 1.5 m oc.
  - .4 Threaded rods, 6 mm dia., to support suspended channels.
-

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

- 2.4 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 except in mechanical and electrical service rooms and in unfinished areas.
  - .3 Use rigid galvanized steel threaded conduit where subject to mechanical damage; where indicated; and where not specified or indicated otherwise.
  - .4 Use electrical metallic tubing (EMT) except in cast concrete for feeders and branch circuits above 2.4 m and below where not subject to mechanical injury.
  - .5 Use flexible metal conduit for connection to motors in dry areas.
  - .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
  - .7 Minimum conduit size for power circuits: 16 mm.
  - .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
  - .9 Mechanically bend steel conduit over 19 mm dia.
  - .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
  - .11 Install fish cord in empty conduits.
  - .12 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
  - .13 Dry conduits out before installing wire.
-

- 3.2 Surface Conduits
- .1 Run parallel or perpendicular to building lines.
  - .2 Run conduits in flanged portion of structural steel.
  - .3 Group conduits wherever possible on suspended or surface channels.
  - .4 Do not pass conduits through structural members except as indicated.
  - .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- 3.3 Concealed Conduits
- .1 Run parallel or perpendicular to building lines.

## PART 1 - GENERAL

### 1.1 Related Sections

- .1 Section 26 05 01 - Common Work Results - Electrical.

### 1.2 References

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No.248.12-94, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).

### 1.3 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit fuse performance data characteristics for each fuse type and size above 200 A. Performance data to include: average melting time-current characteristics.

### 1.4 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
  - .1 Place materials defined as hazardous or toxic waste in designated containers.
  - .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
  - .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

### 1.5 Delivery and Storage

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in moisture free location.

### 1.6 Maintenance Materials

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Three spare fuses of each type and size installed above 600 A.
  - .3 Six spare fuses of each type and size installed up to and including 600 A.
-

## PART 2 - PRODUCTS

### 2.1 Fuses General

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer for entire project.

### 2.2 Fuse Types

- .1 Class L fuses (formerly HRC-L ).
  - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type L2, fast acting.
- .2 Class J fuses (formerly HRCI- J).
  - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type J2, fast acting.
- .3 Class R -R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and its' peak let-through values not to exceed limits of UL 198E-1982, table 10.2.
  - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class -C fuses (formerly HRCII- C).
- .5 Visual indication of open fuse.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
  - .1 Install Class R rejection clips for HRCI-R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

PART 1 - GENERAL

- 1.1 Section Includes .1 Materials and installation for fuse and non-fused disconnect switches.
- 1.2 Related Sections .1 Section 01 33 00 - Submittal Procedures.  
.2 Section 01 35 28 - Health and Safety Requirements.  
.3 Section 26 05 00 - Common Work Results for Electrical.  
.4 Section 26 28 14 - Fuses - Low Voltage.
- 1.3 References .1 Canadian Standards Association (CSA International).  
.1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.  
.2 CSA C22.2 No. 39-M89 (R2003), Fuseholder Assemblies.
- 1.4 Submittals .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.5 Health and Safety .1 Do construction occupational health and safety in accordance with Section 01 35 28 - Health and Safety Requirements.
- 1.6 Waste Management and Disposal .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.  
.2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.  
.3 Separate for reuse and recycling and place in designated containers metal and plastic waste in accordance with Waste Management Plan.  
.4 Fold up metal banding, flatten and place in designated area for recycling.
-

## PART 2 - PRODUCTS

- 2.1 Disconnect Switches .1 Fusible, Non-fusible and horsepower rated disconnect switches in CSA Enclosures, to CAN/CSA C22.2 No.4, size as indicated.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.
- 2.2 Equipment Identification .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.
- 2.3 Manufacturers .1 Acceptable manufacturers: Siemens or approved equal.

## PART 3 - EXECUTION

- 3.1 Installation .1 Install disconnect switches complete with fuses if applicable.