

**SOLAR WALLS MODIFICATIONS  
PRESCOTT, ONTARIO  
PWGSC PROJECT NO. R.087682.002**

**SPECIFICATIONS  
Issued for 100% Review**

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END OF SECTION

PART 1 - GENERAL

1.1 Not Used

- .1 Consultant for Building Code Review: Jim Gordon, P.Eng., Goodkey, Weedmark & Associates Limited, Ottawa, ON.

PART 2 - PRODUCTS

2.1 Not Used

- .1 Not Used

PART 3 - EXECUTION

3.1 Not Used

- .1 Not Used



END OF SECTION

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- .1 Precedence
- .2 Work Covered by Contract Documents
- .3 Contract Method
- .4 Cost Breakdown
- .5 Contractor Use of Premises
- .6 Owner Occupancy

### 1.2 PRECEDENCE

- .1 For Federal Government projects, Division 01 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

### 1.3 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract consist of the upgrading and updating of the existing solar make-up air prewarming system.
- .2 Work includes the removal of an existing make-up air unit, providing a new rooftop make-up air unit, providing four new ceiling suspended make-up air unit, repair of the existing control system and integration into the existing welding exhaust system through controls interlocking.

### 1.4 CONTRACT METHOD

- .1 Construct work under lump sum contract.

### 1.5 COST BREAKDOWN

- .1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract price.
- .2 Within 48 hours of acceptance of bid submit a list of subcontractors.

### 1.6 CONTRACTOR USE OF PREMISES

- .1 Contractor shall limit use of premises for Work, to allow;
  - .1 Owner occupancy.
- .2 Coordinate use of premises under direction of Departmental Representative.

- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

1.7 OWNER OCCUPANCY

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ACCESS AND EGRESS

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

### 1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.

### 1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to occupants, public and normal use of premises. Arrange with Departmental Representative to facilitate execution of work.

### 1.4 EXISTING SERVICES

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel and vehicular traffic.

### 1.5 SPECIAL REQUIREMENTS

- .1 Carry out noise generating Work Monday to Friday from 18:00 to 07:00 hour.
- .2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .3 Keep within limits of work and avenues of ingress and egress.
- .4 Deliver materials outside of peak traffic hours 17:00 to 07:00 unless otherwise approved by Departmental Representative.

## 1.6 SECURITY

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Security clearances:
  - .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.
  - .2 Obtain requisite clearance, as instructed, for each individual required to enter premises.
  - .3 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.
- .3 Security escort:
  - .1 Personnel employed on this project must be escorted when executing work in non-public areas during normal working hours. Personnel must be escorted in all areas after normal working hours.
  - .2 Submit an escort request to Departmental Representative at least 14 days before service is needed. For requests submitted within time noted above, costs of security escort will be paid for by Departmental Representative. Cost incurred by late request will be Contractor's responsibility.
  - .3 Any escort request may be cancelled free of charge if notification of cancellation is given at least 4 hours before scheduled time of escort. Cost incurred by late request will be Contractor's responsibility.
  - .4 Calculation of costs will be based on average hourly rate of security officer for minimum of 8 hours per day for late service request and of 4 hours for late cancellations.

## 1.7 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions. Smoking is not permitted.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

- .1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCE STANDARDS

- .1 Owner/Contractor Agreement.
- .2 Standard Acquisition Clauses and Conditions (SACC).

### 1.2 APPLICATIONS FOR PROGRESS PAYMENT

- .1 SACC.
- .2 Make applications for payment on account monthly as Work progresses.
- .3 Date applications for payment last day of agreed monthly payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.
- .4 Submit to Departmental Representative, at least 14 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

### 1.3 SCHEDULE OF VALUES

- .1 SACC.
- .2 Provide schedule of values supported by evidence as Consultant may reasonably direct and when accepted by Departmental Representative, be used as basis for applications for payment.
- .3 Include statement based on schedule of values with each application for payment.
- .4 Support claims for products delivered to Place of Work but not yet incorporated into Work by such evidence as Departmental Representative may reasonably require to establish value and delivery of products.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

- .1 Not Used.

END OF SECTION



## PART 1 - GENERAL

### 1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
- .9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

### 1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Submit to Departmental Representative within 7 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.

#### 1.4 MASTER PLAN

- .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
- .2 Departmental Representative will review and return revised schedules within 5 working days.
- .3 Revise impractical schedule and resubmit within 5 working days.
- .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

#### 1.5 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
  - .1 Award.
  - .2 Shop Drawings, Samples.
  - .3 Permits.
  - .4 Mobilization.
  - .5 Shop drawings.
  - .6 Equipment delivery.
  - .7 Installation.
  - .8 Programming.
  - .9 Commissioning.
  - .10 Operator Training.
  - .11 Completion.

#### 1.6 PROJECT SCHEDULE REPORTING

- .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

### PART 2 - PRODUCTS

#### 2.1 NOT USED

- .1 Not used.

### PART 3 - EXECUTION

#### 3.1 NOT USED

- .1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 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.

### 1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Allow 7 days for Departmental Representative's review of each submission.
- .4 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.
- .5 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.

- .6 Accompany submissions with transmittal letter, 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.
- .7 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.
- .8 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request. Hard copy submittals will not be reviewed.
- .9 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.
- .10 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.
- .11 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.
- .12 Submit electronic copies of manufacturers 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.

- .13 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .14 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .15 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Delete information not applicable to project.
- .17 Supplement standard information to provide details applicable to project.
- .18 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.
- .19 The review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general concept.
  - .1 This review shall not mean that Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
  - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

### 1.3 CERTIFICATES AND TRANSCRIPTS

- .1 Immediately after award of Contract, submit WSIB's status.
- .2 Submit transcription of insurance immediately after award of Contract.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

- .1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 Canadian Standards Association (CSA): Canada
  - .1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.
- .2 National Building Code 2015 (NBC):
  - .1 NBC 2015, Division B, Part 8 Safety Measures at Construction and Demolition Sites.
- .3 National Fire Code 2015 (NFC):
  - .1 NFC 2015, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.
- .4 Province of Ontario:
  - .1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
  - .2 O. Reg. 490/09, Designated Substances.
  - .3 Workplace Safety and Insurance Act, 1997.
  - .4 Municipal statutes and authorities.
- .5 Treasury Board of Canada Secretariat (TBS):
  - .1 Treasury Board, Fire Protection Standard April 1, 2010 [www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=17316&section=text](http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=17316&section=text).

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
  - .1 Results of site specific safety hazard assessment.
  - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
  - .3 Measures and controls to be implemented to address identified safety hazards and risks.
- .3 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.1.3 prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing Facility Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will provide Facility Emergency Procedures and Evacuation Plan. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.
- .4 Contractor's and Sub-contractors' Safety Communication Plan.
- .5 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing Facility Emergency Response requirements and procedures provided by Departmental Representative.
- .6 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 14 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 7 days after receipt of comments from Departmental Representative.

- .7 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .8 Submit names of personnel and alternates responsible for site safety and health.
- .9 Submit records of Contractor's Health and Safety meetings when requested.
- .10 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative weekly.
- .11 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.
- .12 Submit copies of incident and accident reports.
- .13 Submit Material Safety Data Sheets (MSDS).
- .14 Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report.

### 1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to commencement of Work.

### 1.4 WORK PERMIT

- .1 Obtain building permits related to project prior to commencement of Work.
- .2 Obtain 'Permit to Work Form' from Departmental Representative.

### 1.5 SAFETY ASSESSMENT

- .1 Perform site specific safety hazard assessment related to project.

### 1.6 MEETINGS

- .1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

### 1.7 REGULATORY REQUIREMENTS

- .1 Comply with the Acts and regulations of the Province of Ontario.
- .2 Comply with specified standards and regulations to ensure safe operations at site.

### 1.8 PROJECT/SITE CONDITIONS

- .1 Work at site will involve contact with:
  - .1 Silica in concrete.

- .2 Mercury in thermostats.
  - .3 HCFC-22 air conditioning unit.
  - .4 Open water.
  - .5 Working at heights.
  - .6 Craning and hoisting.
- .2 Confined spaces in attic and crawl space.

#### 1.9 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.
- .3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

#### 1.10 COMPLIANCE REQUIREMENTS

- .1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter O.1, as amended.

#### 1.11 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
- .3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act and Regulations for Construction Projects for the Province of Ontario.

#### 1.12 UNFORESEEN HAZARDS

- .1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing.
- .2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.



#### 1.13 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator.  
Health and Safety Co-ordinator must:
  - .1 Have working knowledge of occupational safety and health regulations.
  - .2 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
  - .3 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
  - .4 Be on site during execution of Work.

#### 1.14 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.
  - .1 Contractor's Safety Policy.
  - .2 Constructor's Name.
  - .3 Notice of Project.
  - .4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).
  - .5 Ministry of Labour Orders and reports.
  - .6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.
  - .7 Address and phone number of nearest Ministry of Labour office.
  - .8 Material Safety Data Sheets.
  - .9 Written Emergency Response Plan.
  - .10 Site Specific Safety Plan.
  - .11 Valid certificate of first aider on duty.
  - .12 WSIB "In Case of Injury At Work" poster.
  - .13 Location of toilet and cleanup facilities.

#### 1.15 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

#### 1.16 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
- .2 Assign responsibility and obligation to Competent Supervisor to stop or start Work when, at Competent Supervisor's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.2 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 Indicate use of supplemental or other staging area.
- .3 Provide construction facilities in order to execute work expeditiously.
- .4 Remove from site all such work after use.

### 1.3 SITE STORAGE/LOADING

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

### 1.4 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.

### 1.5 SECURITY

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

### 1.6 OFFICES

- .1 Provide marked and fully stocked first-aid case in a readily available location.
- .2 Provide private washroom facilities adjacent to office complete with flush or chemical type toilet, lavatory and mirror and maintain supply of paper towels and toilet tissue.
- .3 Maintain in clean condition.

1.7 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.

1.8 SANITARY FACILITIES

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.9 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Store materials resulting from demolition activities that are salvageable.
- .3 Stack stored new or salvaged material not in construction facilities.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

## PART 1 - GENERAL

### 1.1 REFERENCE STANDARDS

- .1 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .2 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .3 Cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

### 1.2 QUALITY

- .1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.
- .3 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .4 Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

### 1.3 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

- .5 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

#### 1.4 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.

#### 1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative will establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

#### 1.6 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

#### 1.7 CO-ORDINATION

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

#### 1.8 CONCEALMENT

- .1 In finished areas conceal wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

#### 1.9 REMEDIAL WORK

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

#### 1.10 LOCATION OF FIXTURES

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Departmental Representative of conflicting installation. Install as directed.

#### 1.11 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

#### 1.12 FASTENINGS - EQUIPMENT

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

#### 1.13 PROTECTION OF WORK IN PROGRESS

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Departmental Representative.

1.14 EXISTING UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and building occupants.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION



## PART 1 - GENERAL

### 1.1 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner.
- .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 and use marked separate bins for recycling. Refer to Section 01 74 20.
- .5 Dispose of waste materials and debris off site.
- .6 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .9 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

### 1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris other than that caused by Owner or other Contractors.
- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish stainless steel, chrome, and mechanical fixtures. Replace broken, scratched or disfigured glass.
- .8 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 CONSTRUCTION & DEMOLITION WASTE

- .1 Carefully deconstruct and source separate materials/equipment and divert, from D&C waste destined for landfill to maximum extent possible. Target for this project is 50% diversion from landfill. Reuse, recycle, compost, anaerobic digest or sell material for reuse except where indicated otherwise. On site sales are not permitted.
- .2 Source separate waste and maintain waste audits in accordance with the Environmental Protection Act, Ontario Regulation 102/94 and Ontario Regulation 103/94.
  - .1 Provide facilities for collection, handling and storage of source separated wastes.
  - .2 Source separate the following waste:
    - .1 Brick and portland cement concrete.
    - .2 Corrugated cardboard.
    - .3 Wood, not including painted or treated wood or laminated wood.
    - .4 Gypsum board, unpainted.
    - .5 Steel.
- .3 Submit proof that all waste is being disposed of at a licensed land fill site or waste transfer site. A copy of the disposal/waste transfer site's license and a letter verifying that said landfill site will accept the waste must be supplied to Departmental Representative prior to removal of waste from the demolition site.

### 1.2 WASTE PROCESSING SITES

- .1 Province of: Ontario.
  - .1 Ministry of Environment and Energy, 135 St. Clair Avenue West, Toronto, ON, M4V 1P5.
  - .2 Telephone: 800-565-4923 or 416-323-4321.
  - .3 Fax: 416-323-4682.
- .2 Recycling Council of Ontario: 215 Spadina Avenue, #225, Toronto, ON, M5T 2C7.
  - .1 Telephone: 416-657-2797 or 1-888-501-9637.
  - .2 Fax: 416-960-8053.
  - .3 Email: [rco@rco.on.ca](mailto:rco@rco.on.ca).
  - .4 Internet: <http://www.rco.on.ca/>.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT

.1 Government Chief Responsibility for the Environment.

Province	Address	General Faxquiries
Ontario	Ministry of Environment and Energy 135 St Clair Avenue West Toronto, ON M4V 1P5	(416) 3(416)-323-4682 (800) 565-4923
	Environment Canada Toronto, ON	(416) 734-4494

END OF SECTION

## PART 1 - GENERAL

### 1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
  - .1 Contractor's Inspection: 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 Contractor'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 Operation of systems: demonstrated to Owner's personnel.
    - .5 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 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.

### 1.2 FINAL CLEANING

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

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

- .1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.2 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, 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.

### 1.3 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.

### 1.4 AS -BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, at site for Departmental Representative one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.

- .3 Addenda and amendments.
- .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.

#### 1.5 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.

## 1.6 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 location 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 location 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 location as directed; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

- .1 Not Used.

END OF SECTION



## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 Section Includes:
  - .1 General requirements 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 AFD - Alternate Forms of Delivery, service provider.
  - .2 BMM - Building Management Manual.
  - .3 Cx - Commissioning.
  - .4 EMCS - Energy Monitoring and Control Systems.
  - .5 O&M - Operation and Maintenance.
  - .6 PI - Product Information.
  - .7 PV - Performance Verification.
  - .8 TAB - Testing, Adjusting and Balancing.

### 1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
  - .2 Ensure appropriate documentation is compiled into the BMM.
  - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
  - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

### 1.3 COMMISSIONING OVERVIEW

- .1 Cx to be a line item of Contractor's cost breakdown.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.

- .3 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .4 Departmental Representative will issue Interim Acceptance Certificate when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M training has been completed.

#### 1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

#### 1.5 PRE-CX REVIEW

- .1 Before Construction:
  - .1 Review Contract Documents, confirm by writing to Departmental Representative.
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
  - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
  - .1 Have completed Cx Plan up-to-date.
  - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
  - .3 Fully understand Cx requirements and procedures.
  - .4 Have Cx documentation shelf-ready.
  - .5 Understand completely design criteria and intent and special features.
  - .6 Submit complete start-up documentation to Departmental Representative.
  - .7 Have Cx schedules up-to-date.
  - .8 Ensure systems have been cleaned thoroughly.
  - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
  - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

#### 1.6 CONFLICTS

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

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

#### 1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
  - .1 Submit no later than 2 weeks after award of Contract:
    - .1 Name of Contractor's Cx agent.
    - .2 Draft Cx documentation.
    - .3 Preliminary Cx schedule.
  - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 2 weeks prior to start of Cx.
  - .3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 2 weeks prior to start of Cx.
  - .4 Provide additional documentation relating to Cx process required by Departmental Representative.

#### 1.8 COMMISSIONING DOCUMENTATION

- .1 Departmental Representative to review and approve Cx documentation.
- .2 Provide completed and approved Cx documentation to Departmental Representative.

#### 1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule Section 01 32 16.07.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
  - .1 Approval of Cx reports.
  - .2 Verification of reported results.
  - .3 Repairs, retesting, re-commissioning, re-verification.
  - .4 Training.

#### 1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16.07 and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Section 01 32 16.07. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
  - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
  - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

- .6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

#### 1.11 STARTING AND TESTING

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

#### 1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

#### 1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
  - .1 Coordinate time and location of testing.
  - .2 Provide testing documentation for approval by Departmental Representative.
  - .3 Arrange for Departmental Representative to witness tests.
  - .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative
  - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
  - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 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.
- .4 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.

#### 1.14 PROCEDURES

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

- .2 Conduct start-up and testing in following distinct phases:
  - .1 Included in delivery and installation:
    - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
    - .2 Visual inspection of quality of installation.
  - .2 Start-up: follow accepted start-up procedures.
  - .3 Operational testing: document equipment performance.
  - .4 System PV: include repetition of tests after correcting deficiencies.
  - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.

#### 1.15 START-UP DOCUMENTATION

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

#### 1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

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

#### 1.17 TEST RESULTS

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

#### 1.18 START OF COMMISSIONING

- .1 Notify Departmental Representative at least 14 days prior to start of Cx.

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

#### 1.19 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
  - .1 Under actual operating conditions, over entire operating range, in all modes.
  - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

#### 1.20 WITNESSING COMMISSIONING

- .1 Departmental Representative to witness activities and verify results.

#### 1.21 AUTHORITIES HAVING JURISDICTION

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

#### 1.22 REPEAT VERIFICATIONS

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

#### 1.23 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

#### 1.24 DEFICIENCIES, FAULTS, DEFECTS

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

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

#### 1.25 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

#### 1.26 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.

#### 1.27 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

#### 1.28 OCCUPANCY

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

#### 1.29 OWNER'S PERFORMANCE TESTING

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

### PART 2 - PRODUCTS

#### 2.1 NOT USED

- .1 Not Used.

### PART 3 - EXECUTION

#### 3.1 NOT USED

- .1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province Territory, Canada.
  - .2 Indicate on drawings:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances.
  - .3 Shop drawings and product data accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify current model production.
    - .5 Certification of compliance to applicable codes.
  - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

### 1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
  - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .2 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for systems and component.
    - .5 Description of actions to be taken in event of equipment failure.
    - .6 Valves schedule and flow diagram.
    - .7 Colour coding chart.
  - .3 Maintenance data to include:
    - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
    - .2 Data to include schedules of tasks, frequency, tools required and task time.
  - .4 Performance data to include:
    - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.



- .2 Equipment performance verification test results.
- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93.
- .5 Approvals:
  - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

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

#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse.

## PART 2 - PRODUCTS

### 2.1 NOT USED

- .1 Not used.

## PART 3 - EXECUTION

### 3.1 PAINTING REPAIRS AND RESTORATION

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

### 3.2 SYSTEM CLEANING

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

### 3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

### 3.4 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct 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 Departmental Representative will record these demonstrations on video tape for future reference.

### 3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### 3.6 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 Related Requirements
  - .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-16, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. 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.
  - .2 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Quality Control: i
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00.

### 1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.

## 1.5 DELIVERY, STORAGE, AND HANDLING

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

### 2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 575 V, unless otherwise indicated.

### 2.3 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00.

### PART 3 - EXECUTION

#### 3.1 MANUFACTURER'S INSTRUCTIONS

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

#### 3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

#### 3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

#### 3.4 CLEANING

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
  - .2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
  - .1 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit data for valves specified in this Section.

### 1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- .1 Valves:
  - .1 Except for specialty valves, to be single manufacturer.
  - .2 Products to have CRN registration numbers.

- .2 End Connections:
  - .1 Connection into adjacent piping/tubing:
    - .1 Steel pipe systems: screwed ends to ASME B1.20.1.
    - .2 Copper tube systems: solder ends to ASME B16.18.
- .3 Ball Valves:
  - .1 NPS 2 and under:
    - .1 Body and cap: cast high tensile bronze to ASTM B62.
    - .2 Pressure rating: Class 125 , 860 kPa steam.
    - .3 Connections: screwed ends to ASME B1.20.1 and with hexagonal shoulders.
    - .4 Stem: tamperproof ball drive.
    - .5 Stem packing nut: external to body.
    - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
    - .7 Stem seal: TFE with external packing nut.
    - .8 Operator: removable lever handle.
- .4 Butterfly Valves:
  - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
    - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
    - .2 Disc: elastomer coated ductile iron with integrally cast stem.
    - .3 Operator: lever.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

#### 3.2 CLEANING

- .1 Clean in accordance with Section 01 74 11.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

END OF SECTION



## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 ASTM International
  - .1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307-14e1, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-15, Standard Specification for Carbon and Alloy Steel Nuts.
- .2 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design, Selection, Manufacture, Application and Installation.
- .3 National Research Council Canada (NRC)
  - .1 National Plumbing Code of Canada 2015 (NPC).
- .4 Underwriter's Laboratories of Canada (ULC)

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
  - .2 Submit shop drawings for:
    - .1 Bases, hangers and supports.
    - .2 Connections to equipment and structure.
    - .3 Structural assemblies.
- .4 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:
  - .1 Provide manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

#### 1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove in accordance with Section 01 74 20.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
  - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
  - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
  - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP 58.
- .2 Performance Requirements:
  - .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified.

#### 2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58 and ANSI B31.1.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

#### 2.3 PIPE HANGERS

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized after manufacture.
  - .2 Use hot dipped galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are copper plated .

- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, to MSS-SP 58 and MSS-SP 69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, to MSS SP 69.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP 69.
- .5 Hanger rods: threaded rod material to MSS SP 58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 22 mm or 28 mm rod.
- .6 Pipe attachments: material to MSS SP 58:
  - .1 Attachments for steel piping: carbon steel black.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP 69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.
- .9 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion epoxy coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

#### 2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP 58, type 42.
- .2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

## 2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.

## 2.6 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

## 2.7 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.

## 2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

## 2.9 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel.
- .2 Submit structural calculations with shop drawings.

### PART 3 - EXECUTION

#### 3.1 MANUFACTURER'S INSTRUCTIONS

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

#### 3.2 INSTALLATION

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to industry standards.
  - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
  - .1 Vertical movement of pipework is 13 mm or more,
  - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 Variation in supporting effect does not exceed 25 % of total load.

#### 3.3 HANGER SPACING

- .1 Plumbing piping: to National Plumbing Code of Canada (NPC).
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1¼	2.4 m	1.8 m
1½	3.0 m	2.4 m
2	3.0 m	2.4 m
2½	3.7 m	3.0 m
3	3.7 m	3.0 m
3½	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 Pipework greater than NPS 12: to MSS SP 69.

### 3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

### 3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

### 3.7 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### 3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 Section Includes:
  - .1 Vibration isolation materials and components, seismic control measures and their installation.
- .2 Related Requirements
  - .1 Section 23 05 00 - Common Work Results for HVAC.
  - .2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. 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.
- .2 Submit shop drawings in accordance with Section 01 33 00.
  - .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
  - .2 Provide system shop drawings complete with performance and product data.
  - .3 Provide detailed drawings of seismic control measures for equipment and piping.
- .3 Quality assurance submittals:
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
  - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

### 1.4 QUALITY ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.



## 1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 20.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

### 2.2 ELASTOMERIC MOUNTS

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

### 2.3 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Colour code springs.

### 2.4 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

## 2.5 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

## 2.6 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

## 2.7 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

## 2.8 ROOF CURB ISOLATION RAILS

- .1 General: complete factory assembled without need for sub-base.
- .2 Lower member: continuous rectangular steel tube.
- .3 Upper member: continuous rectangular steel tube to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind and seismic forces.
- .4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.
- .5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly. Material: closed cell neoprene.
- .6 Weatherproofing: continuous flexible counter flashing to curb and providing access to springs. Material: neoprene.
- .7 Hardware: cadmium plated or galvanized.

## 2.9 SEISMIC CONTROL MEASURES

- .1 General:
  - .1 Seismic control systems to work in every direction.
  - .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
  - .3 Drilled or power driven anchors and fasteners not permitted.
  - .4 No equipment, equipment supports or mounts to fail before failure of structure.
  - .5 Supports of cast iron or threaded pipe not permitted.
  - .6 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
  - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended equipment:
    - .1 Use one or more of following methods depending upon site conditions:
      - .1 Install tight to structure.
      - .2 Cross brace in every direction.
      - .3 Brace back to structure.
      - .4 Cable restraint system.
  - .3 Seismic restraints:
    - .1 Cushioning action gentle and steady.
    - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
  - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
  - .3 As indicated.
- .4 Piping systems:
  - .1 Fire protection systems: to NFPA 13.
  - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
  - .3 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
  - .1 Approved by Departmental Representative.
  - .2 Structural angles or channels.
  - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

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

### 3.2 INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.

- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
  - .1 Up to NPS4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first 6 points of support.
  - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

### 3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
  - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
  - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
    - .1 After delivery and storage of Products.
    - .2 After preparatory work is complete but before installation commences.
    - .3 Twice during the installation, at 25% and 60% completion stages.
    - .4 Upon completion of installation.
  - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
  - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
  - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93.
  - .2 Provide Departmental Representative with notice 24 hours in advance of commencement of tests.
  - .3 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
  - .4 Submit complete report of test results including sound curves.

### 3.4 CLEANING

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

## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 Related Requirements
  - .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA)
  - .1 CSA B149.1-15, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00.
- .3 Product data to include paint colour chips, other products specified in this section.

### 1.4 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 20.
  - .2 Dispose of unused paint coating material at official hazardous material collections site approved by Departmental Representative.
  - .3 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

### 2.2 SYSTEM NAMEPLATES

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
  - .1 Conform to following table:

Size #mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20
  - .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
  - .1 Terminal cabinets, control panels: use size # 5.
  - .2 Equipment in Mechanical Rooms: use size # 9.

### 2.3 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
  - .1 Natural gas: to CSA B149.1.

## 2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB-24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
  - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Departmental Representative .
  - .2 Colours for legends, arrows: to following table:
  - .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Natural gas	to Codes	

## 2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

## 2.6 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## 2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

## 2.8 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for each language.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

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

### 3.2 TIMING

- .1 Provide identification only after painting has been completed.

### 3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and 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.

### 3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.



- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### 3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Number valves in each system consecutively.

### 3.7 CLEANING

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

### 1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Departmental Representative within 14 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
  - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

### 1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

#### 1.4 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

#### 1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

#### 1.6 PRE-TAB REVIEW

- .1 Review Contract Documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

#### 1.7 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

#### 1.8 OPERATION OF SYSTEMS DURING TAB

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

#### 1.9 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.

- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Access doors, installed, closed.
    - .7 Outlets installed, volume control dampers open.

#### 1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 5%, minus 5%.

#### 1.11 ACCURACY TOLERANCES

- .1 Measured values accurate to within plus or minus 2 % of actual values.

#### 1.12 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

#### 1.13 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

#### 1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.
  - .4 Summaries.

#### 1.15 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

#### 1.16 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 50% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative

#### 1.17 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

#### 1.18 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

#### 1.19 AIR SYSTEMS

- .1 Standard: TAB to most stringent of TAB standards of AABC or ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Division 23.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.

- .6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

#### 1.20 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.

#### PART 2 - PRODUCTS

##### 2.1 NOT USED

- .1 Not used.

#### PART 3 - EXECUTION

##### 3.1 NOT USED

- .1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 ASTM International Inc.
  - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
  - .2 ASTM C335/C335M-17, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .3 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .5 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .6 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .4 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

### 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" - means "not concealed" as previously defined.
  - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
  - .1 CRD: Code Round Ductwork,
  - .2 CRF: Code Rectangular Finish.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.

- .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed.
- .4 Manufacturers' Instructions:
  - .1 Provide manufacturer's written duct insulation jointing recommendations.

#### 1.5 QUALITY ASSURANCE

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse in accordance with Section 01 74 20.

### PART 2 - PRODUCTS

#### 2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

#### 2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335/C335M.
- .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: 0.50 mm sheet.
  - .3 Finish: Stucco embossed.
  - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

## 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.
- .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 stainless steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

## PART 3 - EXECUTION

### 3.1 APPLICATION

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

### 3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

### 3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

### 3.4 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour	Thickness
Rectangular war air ducts	C-1	no	25
Round ducts outside	C-1	special	50

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:
  - .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
  - .1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4

### 3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect electric and electronic control systems from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse as specified in Section 01 74 20.

## PART 2 - PRODUCTS

### 2.1 THERMOSTAT (LOW VOLTAGE)

- .1 Low voltage wall thermostat:
  - .1 For use on 24 V circuit at 1.5 A capacity.
  - .2 With heat anticipator adjustable 0.1 to 1.2 A.
  - .3 Temperature setting range: 10 degrees C to 25 degrees C.
  - .4 With sub-base.

### 2.2 THERMOSTAT GUARDS

- .1 Thermostat guards: lockable, plastic cast metal. Slots for air circulation to thermostat.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 INSTALLATION

- .1 Install control devices.
- .2 On outside wall, mount thermostats on bracket or insulated pad 25 mm from exterior wall.
- .3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

#### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 Related Requirements
  - .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.5-2017, Pipe Flanges and Flanged Fittings.
  - .2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4 ASME B18.2.1-2012, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A47/A47M-99(2014), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM B837-10, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA W47.1-09 (R2014), Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)
  - .1 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code Handbook.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
  - .2 Indicate on manufacturers catalogue literature following: valves.
  - .3 Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00.

#### 1.4 QUALITY ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.

### PART 2 - PRODUCTS

#### 2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
  - .1 NPS 1/2 to 2, screwed.
  - .2 NPS 2-1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

#### 2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

#### 2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
  - .1 Malleable iron: screwed, banded, Class 150.
  - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
  - .3 Welding: butt-welding fittings.
  - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
  - .5 Bolts and nuts: to ASME B18.2.1.
  - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
  - .1 Cast copper fittings: to ASME B16.18.
  - .2 Wrought copper fittings: to ASME B16.22.

#### 2.4 VALVES

- .1 Provincial Code approved, lubricated plug type.

### 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 PIPING

- .1 Install in accordance with CAN/CSA-B149.1, supplemented as specified.
- .2 Install drip points:
  - .1 At low points in piping system.
  - .2 At connections to equipment.

#### 3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

#### 3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA-B149.1 and requirements of authorities having jurisdiction.
- .2 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 products, 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.
- .3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.

#### 3.5 ADJUSTING

- .1 Purging: purge after pressure test in accordance with CAN/CSA-B149.1.
- .2 Pre-Start-Up Inspections:
  - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
  - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6      CLEANING

- .1      Cleaning: in accordance with CAN/CSA-B149.1, supplemented as specified.

END OF SECTION



## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

### 1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA 016-2012, HVAC Air Duct Leakage Test Manual, 2nd Edition
  - .2 SMACNA 1966-2005, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Replace defective or damaged materials with new.

## PART 2 - PRODUCTS

### 2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C

- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant .
- .3 Class C: transverse joints and connections made air tight with sealant tape. Longitudinal seams unsealed.
- .4 Unsealed seams and joints.

## 2.2 SEALANT

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

## 2.3 TAPE

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

## 2.4 DUCT LEAKAGE

- .1 In accordance with SMACNA 016.

## 2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: short radius with single thickness turning vanes.
  - .2 Round: smooth radius, 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.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Full radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## 2.6 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

## 2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA:
  - .4 Upper hanger attachments:
    - .1 For concrete: manufactured concrete inserts.
    - .2 For steel joist: manufactured joist clamp.
    - .3 For steel beams: manufactured beam clamps:

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 GENERAL

- .1 Do work in accordance with ASHRAE and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.

### 3.3 HANGERS

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

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

### 3.4 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

### 3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA 1966-2005, HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 DELIVERY, STORAGE AND HANDLING

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Manufacture in accordance with SMACNA 1966.

### 2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.5 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<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 Up to 300 x 300 mm: two sash locks complete with safety chain.

- .2 301 to 450 mm: four sash locks complete with safety chain.
- .3 451 to 1000 mm: piano hinge and minimum two sash locks.
- .4 Hold open devices.

#### 2.4 TURNING VANES

- .1 Factory or shop fabricated single thickness, to recommendations of SMACNA and as indicated.

#### 2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

#### 2.6 SPIN-IN COLLARS

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

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 INSTALLATION

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.

- .2 Ensure slack material in flexible connection.
- .2 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
    - .2 Locate to permit easy manipulation of instruments.
    - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Departmental Representative.
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
      - .5 And as indicated.
- .3 Turning Vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
  - .1 SMACNA 1966-2005, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 DELIVERY, STORAGE AND HANDLING

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Manufacture to SMACNA standards.

### 2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.



### 2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage : 2% at 250 Pa.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

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

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.
- .2 Section 23 33 00 - Air Duct Accessories.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.3 CLOSEOUT SUBMITTALS

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

### 1.4 DELIVERY, STORAGE AND HANDLING

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

## PART 2 - PRODUCTS

### 2.1 MULTI-LEAF DAMPERS

- .1 Parallel blade type as indicated.
- .2 Structurally formed steel, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Performance:
  - .1 Leakage: in closed position less than 2% of rated air flow at 250 Pa differential across damper.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### 3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00.
- .5 Ensure dampers are observable and accessible.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11.
  - .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.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results for HVAC.

### 1.2 REFERENCE STANDARDS

- .1 ASTM International
  - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM A755/A755M-16e1, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 DELIVERY, STORAGE AND HANDLING

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

## PART 2 - PRODUCTS

### 2.1 COLLECTOR

- .1 Perforated, unglazed, transpired solar collector with metal standoffs and internal framing system to balance air flow.
- .2 Panel Profile Type: match existing:
  - .1 Mounting Location: wall.
  - .2 Heating Stages: single.
  - .3 Metal: Galvanized steel, 26 gauge, ASTM A653/A653M and ASTM A755/A755M.
  - .4 Configuration: Standard roll-formed corrugated metal panels with high & low flats.
  - .5 Standard Finish: Silicon modified polyester (SMP) with inorganic and ceramic pigmentation. Colour to match existing.

## 2.2 ACCESSORIES

- .1 Stand-Off Components: Provide galvanized steel components to support the panels in a manner as recommended by the manufacturer.
- .2 Flashing: Provide flashing materials to match the metal and finish of the panels.
- .3 Fasteners: Provide corrosion resistant self-drilling screws and rivets as recommended by the manufacturer. Exposed fasteners must be finished to match the panels.

## 2.3 FABRICATION

- .1 Factory Finishing:
  - .1 Silicon modified polyester (SMP) with inorganic and ceramic pigmentation.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalogue
- .2 Ensure piping or ductwork connections do not transmit stress to panel.
- .3 Protect panels from sunlight until system is completed.
- .4 Touch-up galvanized steel with "zinc rich" conductive paint coating on bare edges and where required after assembly.

### 3.3 EXAMINATION

- .1 Site Verification of Conditions: Verify existing installed equipment. New system to match existing.

### 3.4 PREPARATION

- .1 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.5 PROTECTION

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- .1 Unit start-up and customer training shall be the responsibility of the equipment supplier. All other labour and materials required to install the unit shall be the responsibility of the success installation contractor. Equipment supplier is responsible to supply extra set of drives for final air flow balancing
- .2 Equipment supplier shall be responsible of delivering the unit to jobsite without unloading. Required unit delivery time shall be no more than 6 weeks from the shop drawing approval.

### 1.2 REFERENCE STANDARDS

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
  - .1 AHRI 430-2014, Performance Rating of Central Station Air-Handling Units.
- .2 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 52.1-1992, Gravimetric and Dust-Spot Procedures for testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
  - .2 ASHRE 52.2-2017, Method of Testing General ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181-99, Ready Mixed Organic Zinc Rich Coating.
- .4 National Electrical Manufacturers Association (NEMA).

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data.
- .2 Indicate following: fan, fan curves showing point of operation, motor drive, filters, heating capacities, controls; include performance data.

### 1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual.
- .2 Include following: approved shop drawing.

### 1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility.
- .3 Divert unused paint material from landfill to official hazardous material collections site.

- .4 Do not dispose of unused paint materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

## 1.6 EXTRA MATERIALS

- .1 Provide one spare sets of filters for each piece of equipment.
- .2 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .3 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Factory assembled components to form units supplying air at designed conditions, as indicated.
- .2 Horizontal type, as indicated, having air tight modular components, consisting of casing, supply fan section with motor and drive, return fan section with motor and drive, filter section, dampers, burner and controls.
- .3 Contractor to confirm unit orientation, control cabinet location, gas and electrical connection requirements on site prior to ordering equipment.
- .4 Each air handling unit is to be provided with all required starters and local disconnects.
- .5 Performance: refer to mechanical equipment schedules.
- .6 Acceptable material: Engineered Air, Bousquet, ICE Western.

### 2.2 CASINGS

- .1 Galvanized steel 1.3 mm thickness reinforced and braced for rigidity.
  - .1 Inspection doors: provide access for maintenance of internal parts including but not limited to fans, motors, filters, dampers, operators, access plenums, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Access doors shall be hinged with gasket, sully lined and a minimum of 2 lever locking handles which are operable from both sides.
  - .2 Paint steel parts, where not galvanized, with corrosion resistant paint to CAN/CGSB-1.181M.
- .2 All units to be internally insulated 25mm thick with neoprene coated glass fibre insulation having a minimum density of 24 kg/cu.m.
- .3 Indoor suspended units shall be provided with ½" (13 mm) holes in the base channels to accommodate outdoor unit shall be built to fit on existi roof curb without the use of a curb adaptor.

## 2.3 FANS

- .1 Free standing AMCA rated for sound and performance centrifugal fans with forward curved wheels, selected to operate in stable part of performance curve at times and service self aligning greaseable pillow block bearings.
  - .1 Provide internally mounted motor on a rigid structural steel frame and as indicated complete with adjustable V belt drive and guard.
  - .2 Motor: size as indicated in schedules.
- .2 Maximum sound power levels, as indicated.
- .3 Internally mounted motor and fan.
- .4 Motor to be Super E ODP
- .5 All fans shall be dynamically balanced during factory run test.
- .6 Fan shafts shall be selected for stable operation at least 20% below the first critical RPM.
- .7 Fan shafts shall be provided with a rust inhibiting coating.
- .8 Motor drives shall be fixed and be provided with rust inhibiting coating. Air Balancing contractor to provide drive changes as required during air balancing.

## 2.4 VIBRATION ISOLATION

- .1 Flexible connections at inlet and outlet of fan section.
- .2 Vibration isolators on fan motor assemblies. Isolators shall be bolted to steel channel welded to unit floor, which is to be welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 230 mm to 380 mm diameters forward curved fans. All other fans shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 25 mm static deflection designed to achieve high isolation efficiency.

## 2.5 DIRECT FIRED HEATING SECTION

- .1 Units shall have a direct fired heating section and be ETL approved as a complete package including accessories and controls for both sea level and high altitude areas.
- .2 Operating natural gas pressure at the units manifold shall be 1750 Pa.
- .3 Burner assembly shall be in-line type with a modulating turn down ratio of 25:1.
- .4 The assembly shall be constructed in a draw through arrangement.
- .5 All burner combustion air openings shall be located in stainless steel burner plates to maintain design combustion air requirements at all inputs.
- .6 Gas burner connection size shall be 38mm to ensure full turndown performance.



- .7 Burner assembly and piping to include modulating flow ratio valve, fail-safe shut off valve(s), main and pilot pressure regulators, manual shut off valves and electric pilot valve. Flame surveillance shall be with a solid-state programmed flame relay complete with flame rod. The gas train shall be in a cabinet enclosure.
- .8 Units shall have insulation between the outer cabinet and inner heat reflective galvanized steel liner downstream of profile plate in addition to neoprene-faced insulation in inlet section.

## 2.6      FILTERS

- .1 Filtre sections shall be provided with adequately sized access doors to allow easy removal of filters. Filtre removal shall be from one side.
- .2 For units with filtre banks up to 1825 mm high, the filtre modules shall be designed to slide out of the unit. Side removal 25 mm or 50 mm filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- .3 For units with filtre banks 1854 mm high and larger, the filters shall be lift out from an access plenum upstream of the filters. Lift out 50 mm filters shall fit into a horizontal track from which they are lifted up and out.
- .4 50 mm Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fibre media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filtre media shall have a minimum efficiency of 20-25% on ASHRAE 52.1, and a minimum of MERV 6 per ASHRAE 52.2. Rated U.L. Class 2.
- .5 Filtre media shall meet UL Class 2 standards.

## 2.7      DAMPERS

- .1 Damper frames shall be galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 13mm aluminum shall turn in nylon or bronze bushings.
- .2 Blades shall be galvanized metal rigid reinforcement. Damper edges shall interlock. Maximum length of damper between supports shall be 1219 mm. Damper linkage brackets shall be constructed of galvanized metal.
- .3 Dampers shall be standard construction and include blade ends sealed with an adhesive backed foamed polyurethane gasket. Outdoor air dampers also include an all weather PVC seal fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers are interlocked from the centre.
- .4 Two position inlet dampers shall be parallel blade type.
- .5 Motorized relief dampers shall be parallel blade type.
- .6 Makeup Air Inlet Damper Control shall provide a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.

## 2.8 CONTROLS

- .1 Direct fired burners shall be equipped with a programmed logic controller to provide discharge air temperature control and burner management function.
- .2 Controllers shall have the following features:
  - .1 A built in discharge air setpoint adjustment to allow discharge air setpoint between 8.3°C and 71.1°C.
  - .2 Self-checking of discharge air sensor to identify out of range or fault conditions.
  - .3 Built in auto by-pass low limit with alarm contact.
  - .4 Flame relay monitoring.
  - .5 Air sensor self test.
  - .6 Air flow monitoring.
  - .7 Optical isolation on BMS input.
  - .8 LED indicator lights for status indication of different status functions including but not limited to: burner status, flame status, fan status, low limit and operation status
- .3 Provide unit mounted ambient lockout thermostat to lock out heat at 18 deg C and supply fan.
- .4 Controller shall be able to modulate the gas valve to maintain setpoint with a discharge air sensor.
- .5 An adjustable discharge air temperature selector is to be mounted in the remote control panel. Remote control panel also comes complete with unit on/off switch and light and burner on/off switch and light.
- .6 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices and relays.
- .7 Unit shall have high limit.
- .8 Unit to contain factory installed and wired non-fused disconnect switch in CEMA/NEMA 3 configuration.
- .9 Automatic controls shall be housed in a control panel mounted in or on the air handling unit.
- .10 Provide a discharge airflow limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.
- .11 Refer to equipment schedules for additional controls requirements.

## 2.9 TESTING

- .1 Factory test the final assembled unit just prior to shipping to site. Tests shall be performed in accordance with the equipment standard to which the gas heating section is certified.
- .2 Provide a copy of factory test report to Departmental Representative prior to shipping the units.
- .3 Factory test to include at a minimum the following:
  - .1 Burner shall be clocked with a dedicated calibrated gas meter to insure proper set up of the gas manifold to match the required flow rate.
  - .2 The blowers flow rate shall be set to the design airflow conditions.
  - .3 The controls shall be checked and set to ensure proper operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 01 00 10 - General Instructions.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 61 00 - Common Products Requirements.
- .5 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .6 Section 01 78 00 - Closeout Submittals.
- .7 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .8 Section 28 31 00.01 - Multiplex Fire Alarm System.

### **1.2 REFERENCES**

- .1 Reference Standards:
  - .1 CSA Group
    - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

### **1.3 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with project general requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit 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.
  - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

- .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .4 Submit drawings and product data to authority having jurisdiction.
- .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .6 Submit seismic restraint shop drawings, stamped by professional engineer.
- .4 Certificates:
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction 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 authority having jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Submit power shutdown schedule 15 days prior to service interruptions and obtain return approval from the Departmental Representative to do so including completing the de-energizing and re-energizing forms.
- .7 Apply and obtain ESA permit.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with project requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with project requirements.

#### 1.6 DESIGNATED CONTRACTOR

- .1 Hire the services of Chubb Edwards fire alarm system manufacturer to provide proprietary fire alarm modifications, including equipment, modules, programming and verification labour.

## **PART 2 - PRODUCTS**

### **2.1 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English and French.
- .4 Use one nameplate or label for each language.

### **2.2 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with project requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

### **2.3 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

### **2.4 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicoïd 3 mm thick plastic engraving sheet, matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:

#### **NAMEPLATE SIZE**

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

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.

- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with labels engraved as directed by Departmental Representative. Red for fire alarm & emergency system, black for others.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.
- .10 Identification to be English and French.

## 2.5 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## 2.6 CONDUIT AND CABLE IDENTIFICATION

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

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
Other Communication Systems	Green	Blue

## 2.7 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

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

### **3.2 INSTALLATION**

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

### **3.3 NAMEPLATES AND LABELS**

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

### **3.4 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 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.6 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL 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 project requirements.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.



- .3 Lighting and its control.
- .4 Motors, heaters and associated control equipment including sequence operation of systems where applicable.
- .5 Systems: fire alarm.
- .6 Insulation resistance testing:
  - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
  - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
  - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

### 3.7 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

### 3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with project requirements.
  - .1 Leave Work area clean at end each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with project requirements.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with project requirements.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA-C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CAN/CSA-C22.2 No. 65-13, Wire Connectors (Tri-National) Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 National Electrical Manufacturers Association (NEMA)

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No. 65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No. 65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, 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 cables and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
  - .2 Install fixture type connectors and tighten to CAN/CSA-C22.2 No. 65. Replace insulating cap.
  - .3 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

## **PART 2 - PRODUCTS**

### **2.1 BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE.

### **2.2 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: anti short connectors.

## **PART 3 - EXECUTION**

### **3.1 GENERAL CABLE INSTALLATION**

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .6 Branch circuit wiring to be 2-wire + G circuits only, i.e. common neutrals not permitted.

### 3.2 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### 3.3 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible on channels.
- .2 Armoured cable to be used for final connection only, and not to exceed 2.5 metres.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT**

- .1 Insulated grounding conductors: green, copper conductors, size as required.
- .2 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Bonding jumpers, straps.
  - .5 Pressure wire connectors.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION GENERAL**

- .1 Install permanent, continuous grounding system including, conductors, connectors, accessories and as required by code. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Loops are not permitted.

### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment as required by code.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 NOT USED**

- .1 Not used.

## **PART 2 - PRODUCTS**

### **2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 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.
- .5 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm diameter thread rod and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rods where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

## **PART 2 - PRODUCTS**

### **2.1 JUNCTION AND PULL BOXES**

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat covers.

## **PART 3 - EXECUTION**

### **3.1 JUNCTION AND PULL BOXES INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Provide additional pull boxes as required by CSA C22.1.

### **3.2 IDENTIFICATION**

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name voltage and phase or as indicated.

END OF SECTION



## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.

## **PART 2 - PRODUCTS**

### **2.1 CONDUITS**

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .2 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.
  - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

### **2.3 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
  - .1 Set-screws are not acceptable.

### **2.4 FISH CORD**

- .1 Polypropylene.

## **PART 3 - EXECUTION**

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

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

### **3.2 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Use electrical metallic tubing (EMT) except in cast concrete.
- .4 Use flexible metal conduit for connection to motors in dry areas.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Length not to exceed 2.5 metres.
- .6 Minimum conduit size for lighting and power circuits: 19 mm.
- .7 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .8 Mechanically bend steel conduit over 19 mm diameter.
- .9 Install fish cord and nylon bushing at each end in empty conduits.
- .10 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .11 Dry conduits out before installing wire.
- .12 Communication (Telephone/Data) and Television conduit infrastructure to be installed in accordance with ANSI/EIA/TIA569-C. All wiring by others.

### **3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on channels.
- .5 Do not pass conduits through structural members except as indicated.

- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

#### 3.4 CONCEALED CONDUITS

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

END OF SECTION

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No. 5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2013).

## **PART 2 - PRODUCTS**

### **2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient to match existing system.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.

### **2.2 THERMAL MAGNETIC BREAKERS**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.

END OF SECTION