



**Mechanical**  
Specifications



**Electrical**  
Specifications

**END OF SECTION**

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**Part 1 General**

**1.1 NOT USED**

.1 Not Used

DRAWING NO.	DESCRIPTION	[REVISION NO].
MECHANICAL DRAWINGS		
R.067978.001 – M01	MECHANICAL SERVICES TITLE DRAWING	
R.067978.001 – M02	MECHANICAL SERVICES LEGEND DRAWING	
R.067978.001 – M03A	MECHANICAL VENTILATION PHASING SCHEMATIC 1 OF 2	
R.067978.001 – M03B	MECHANICAL VENTILATION PHASING SCHEMATIC 2 OF 2	
R.067978.001 – M04	EXISTING MECHANICAL VENTILATION PHASED STRIPOUT LAYOUT 1 OF 2	
R.067978.001 – M05	EXISTING MECHANICAL VENTILATION PHASED STRIPOUT LAYOUT 2 OF 2	
R.067978.001 – M06	EXISTING CHILLED WATER SERVICES PHASED STRIPOUT LAYOUT	
R.067978.001 – M07	EXISTING LTHW HEATING PHASED STRIPOUT LAYOUT	
R.067978.001 – M08	EXISTING GAS PHASED STRIPOUT LAYOUT	
R.067978.001 – M10	PROPOSED MECHANICAL VENTILATION PLANT SCHEMATIC	
R.067978.001 – M11	PROPOSED PLANT ROOM MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M12	PROPOSED PLANT ROOM MECHANICAL VENTILATION SECTIONS	
R.067978.001 – M13	PROPOSED STORAGE VAULTS MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M14	PROPOSED STORAGE VAULTS MECHANICAL VENTILATION SECTIONS	
R.067978.001 – M20	PROPOSED PHASE 1 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M21	PROPOSED PHASE 2 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M22	PROPOSED PHASE 3 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M23	PROPOSED PHASE 4 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M24	PROPOSED PHASE 5 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M25	PROPOSED PHASE 6 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M26	PROPOSED PHASE 7 MECHANICAL VENTILATION LAYOUT	
R.067978.001 – M27	PROPOSED PHASE 8 MECHANICAL VENTILATION LAYOUT	

R.067978.001 – M30	PROPOSED CHILLED WATER PLANT SCHEMATIC	
R.067978.001 – M31	PROPOSED PLANT ROOM CHILLED WATER SERVICES LAYOUT	
R.067978.001 – M40	PROPOSED LTHW HEATING SCHEMATIC	
R.067978.001 – M41	PROPOSED PLANT ROOM LTHW HEATING LAYOUT	
R.067978.001 – M50	PROPOSED BAS CONTROLS SCHEMATIC	
R.067978.001 – M51	PROPOSED HUMIDITY CONTROL SCHEMATIC	
R.067978.001 – M60	MECHANICAL SCHEDULES	
ELECTRICAL DRAWINGS		
R.067978.001 – E01	ELECTRICAL KEYPLAN AND LIGHTING SCHEDULE (EXISTING AS BUILT INFO)	
R.067978.001 – E01A	ELECTRICAL SERVICES LEGEND DRAWING	
R.067978.001 – E02	LIGHTING AND FIRE ALARM LAYOUT	
R.067978.001 – E03	EXISTING POWER SYSTEMS – DEMOLITION WORKS	
R.067978.001 – E04	PROPOSED POWER SYSTEMS LAYOUT	
R.067978.001 – E05	SINGLE LINE DIAGRAM DEMOLITION	
R.067978.001 – E06	SINGLE LINE DIAGRAM NEW WORK	

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used

**END OF SECTION**

**Part 1 General**

**1.1 TAXES**

- .1 Pay all taxes properly levied by law (including Federal, Provincial and Municipal).

**1.2 FEES, PERMITS and CERTIFICATES**

- .1 Pay all fees and obtain all permits. Provide authorities with plans and information for acceptance certificates. Provide inspection certificates as evidence that work conforms to requirements of Authority having jurisdiction.

**1.3 REGULATORY REQUIREMENTS**

- .1 References and Codes:
  - .1 Materials shall be new and work shall conform to the minimum applicable standards of the "References" indicated in the specification sections, the National Building Code of Canada 2015 (NBC) and all applicable Provincial and Municipal codes. In the case of conflict or discrepancy the most stringent requirement shall apply.
  - .2 COVID -19  
The contractor shall comply with all health advise in Ottawa, Ontario to ensure that all national and local regulations are followed to ensure that all contractor activities are recorded entering / leaving the site, all socially distance requirements are followed including the use of face coverings as required, The Departmental representative shall be informed of any suspected or confirmed case of Covid-19, for information and follow ups such as cleaning / disinfecting of work areas and tools
- .2 Building Smoking Environment:
  - .1 Smoking is not permitted in the Building. Obey smoking restrictions on building property.
- .3 Hazardous Material Discovery:
  - .1 Stop work immediately when material resembling spray or trowel-applied asbestos, Polychlorinated Biphenyl (PCB), mould or other designated substance is encountered during demolition work.
    - .1 Take preventative measure and promptly notify Departmental Representative.
    - .2 Do not proceed until written instructions have been received from Departmental Representative.

**1.4 FIRE SAFETY REQUIREMENTS**

- .1 Comply with both the National Building Code of Canada 2015 and the National Fire Code of Canada 2015 for safety of persons in buildings in the event of a fire and the protection of buildings from the effects of fire, as follows;
  - .1 The National Building Code (NBC): for fire safety and fire protection features that are required to be incorporated in a building during construction.
  - .2 The National Fire Code (NFC):
    - .1 The on-going maintenance and use of the fire safety and fire protection features incorporated in buildings.

- .2 The conduct of activities that might cause fire hazards in and around buildings.
  - .3 Limitations on hazardous contents in and around buildings.
  - .4 The establishment of fire safety plans.
  - .5 Fire safety at construction and demolition sites.
- .2 Welding and cutting:
  - .1 Before welding, soldering, grinding and/or cutting work, obtain a permit as directed by the Departmental Representative. Store flammable liquids in approved CSA containers.
  - .2 At least one week prior to commencing cutting, welding or soldering procedure, provide to Departmental Representative:
    - .1 Notice of intent, indicating devices affected, time and duration of isolation or bypass.
    - .2 Completed welding permit as defined in NFC.
    - .3 Return welding permit to Departmental Representative immediately upon completion of procedures for which permit was issued.
  - .3 "Fire Watchers" as described in NFC shall be assigned when welding or cutting operations are carried out in areas where combustible materials within 15m may be ignited by conduction or radiation.
- .3 Where work requires interruption or cause activation of fire alarms or fire suppression, extinguishing or protection systems:
  - .1 Retain services of manufacturer for fire protection systems on daily basis or as approved by Departmental Representative, to isolate and protect all devices relating to:
    - .1 modification of fire alarms, fire suppression, extinguishing or protection systems; and/or
    - .2 cutting, welding, soldering or other construction activities that might activate fire protection systems.
  - .2 Immediately upon completion of work, restore fire protection systems to normal operation and verify that all devices are fully operational.
  - .3 Inform fire alarm system monitoring agency and local Fire Department immediately prior to isolation and immediately upon restoration of normal operation.

## **1.5 HAZARDOUS MATERIALS**

- .1 Hazardous Materials: product, substance, or organism that may cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.
- .2 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and the provision of Material Safety Data Sheets (MSDS).
- .3 For work in occupied buildings, give the Department Representative one week notice for work involving designated substances (Ontario Bill 208), hazardous substances, and before painting, caulking, installing carpet or using adhesives and other materials, that cause off gassing.

## **1.6 TEMPORARY UTILITIES**

- .1 Existing services required for work may be used by the Contractor without charge. Ensure capacity is adequate prior to imposing additional loads. Connect and disconnect at own expense and responsibility.
- .2 Notify the Departmental Representative and utility companies of intended interruption of services and obtain requisite permission.
- .3 Give the Departmental Representative two weeks notice related to each necessary interruption of any mechanical or electrical service throughout the course of the work. Keep duration of these interruptions to a minimum. Carry out all interruptions after normal working hours of the occupants, preferably on weekends.

## **1.7 CONSTRUCTION FACILITIES**

- .1 Site Storage:
  - .1 The Departmental Representative will assign storage space that shall be equipped and maintained by the Contractor.
  - .2 Do not unreasonably encumber site with materials or equipment.
  - .3 Move stored products or equipment that interfere with operations of Departmental Representative or other contractors.
  - .4 Obtain and pay for use of additional storage or work areas needed for operations.
  - .5 Do not load or permit to load any part of work with weight or force that will endanger work.
- .2 Where security is reduced by work provide temporary means to maintain security.
- .3 Signage:
  - .1 Provide common-use signs related to traffic control, information, instruction, use of equipment, public safety devices, etcetera, in both official languages or by the use of commonly understood graphic symbols and to approval of the Departmental Representative.
  - .2 No advertising will be permitted on this project.

## **1.8 TEMPORARY BARRIERS AND ENCLOSURES**

- .1 Maintain existing services to building and provide for personnel and vehicle access.
- .2 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.
- .3 Protection:
  - .1 Protect work against damage until take-over.
  - .2 Protect adjacent work against the spread of dust and dirt beyond the work areas.
  - .3 Protect operatives and other users of site from all hazards.
- .4 Work zones:
  - .1 Work zone locations include: The mechanical room, externally to the facility adjacent the chillers, the main storage vault corridor and the acclimatization vault corridor.

- .2 The contractor shall agree to install proper site separation and identification in order to maintain "Time and Space" at all times throughout the life of the project. When Building Operations staff requires access to equipment in order to operate the building, proper coordination and communication must exist between all parties involved."

## **1.9 COMMON PRODUCT REQUIREMENTS**

- .1 Quality of Work:
  - .1 Carry out work using qualified licenced workers or apprentices in accordance with Provincial Act respecting manpower vocational training and qualification.
  - .2 Permit employees registered in Provincial apprenticeship program to perform specific tasks only if under direct supervision of qualified licenced workers.
  - .3 Determine permitted activities and tasks by apprentices, based on level of training attended and demonstration of ability to perform specific duties.
- .2 Storage, Handling and Protection:
  - .1 Handle and store products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions.
  - .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove packaging or bundling until required in work.

## **1.10 EXAMINATION and PREPARATION**

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

## **1.11 EXECUTION**

- .1 Cut, Patch and Make Good:
  - .1 Cut existing surfaces as required to accommodate new work.
  - .2 Remove all items so shown or specified.
  - .3 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture.
- .2 Firestop and smoke seal systems: in accordance with CAN-ULC-S115-05 – Standard Method of Fire Test of Firestop Systems. Install around pipe, ductwork, cables, and other objects penetrating fire separations to provide fire resistance not less than the fire resistance rating of surrounding floor, ceiling, and wall assembly.
- .3 Sleeves, Hangers and Inserts: co-ordinate setting and packing of sleeves and supply and installation of hangers and inserts. Obtain Departmental Representative's approval before cutting into structure.
- .4 Unless otherwise specified, materials for removal become the Contractor's property and shall be taken from site.

## **1.12 WASTE MANAGEMENT**

- .1 Comply with Environmental Protection Act, Ontario Regulations: O. Reg. 102/94 – Waste Audits and Waste Reduction Work Plans; and O. Reg. 103/94 – Industrial, Commercial and Institutional Source Separation Programs; for waste management on construction and demolition projects.

**1.13 CLEANING**

- .1 Clean up as work progresses. At the end of each work period, and more often if ordered by the Departmental Representative, remove debris from site, neatly stack material for use, and clean up generally.
- .2 Upon completion remove scaffolding, temporary protection and surplus materials. Make good defects noted at this stage.
- .3 Clean areas under contract to a condition equal to what previously existed and to approval of Departmental Representative.

**1.14 SECURITY CHECK**

- .1 All personnel employed on this project will be subject to security check. Obtain requisite clearance, as instructed, for each individual required to enter the premises. This shall include all direct company employees and sub contractors, all details shall be provided a minimum of 7 working days before the planned start on site
- .2 Personnel will be checked daily at start of work shift and given a pass, which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

**1.15 SECURITY ESCORT**

- .1 All personnel employed on this project shall be escorted when executing work in non-public areas during normal working hours. Personnel shall be escorted in all areas after normal working hours.

**1.16 PRECEDENCE**

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

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

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

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

**1.4 EXISTING SERVICES**

- .1 Notify Departmental Representative 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. The Departmental Representative shall confirm that the requested shut down is acceptable based on weather conditions and the length of the proposed shut down period to the Contractor, prior to the proposed shut down period.
- .3 Provide a schedule of proposed shut downs in accordance with Section 01 32 16.19 – Construction Progress Schedule – Bar (GANTT) Chart.

**1.5 SPECIAL REQUIREMENTS**

- .1 Carry out noise generating Work Monday to Friday during normal working hours, including but not limited to:
  - .1 Making holes through solid walls
  - .2 Breaking up existing plinths / groundworks.
  - .3 Cutting of pipework / ductwork with power tools.
- .2 Submit schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.



- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Deliver materials inside normal working hours unless otherwise approved by Departmental Representative.
- .6 The contractor shall make allowance within the site boundary for three car parking spaces for Departmental Representative use during the works. Should these spaces be located on soft ground / lawn area, the area shall be made good at project completion.
- .7 Ingress and egress of Contractor vehicles at site is limited to the car parking facilities available on site, with allowance of the parking requirements of the Departmental Representative as stated previously.
- .8 The loading bay shall be available for intermittent use by the Contractor. The loading bay shall be used strictly for deliveries / removals from site and shall always be maintained dust free and tidy.
- .9 The Departmental Representative shall have access to the loading bay when required. The Departmental Representative shall give 48 hours notice to the Contractor when access is required to the facility to withdraw or deposit media.

## **1.6 SECURITY**

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Security clearances:
  - .1 Daytime site access is provided to personnel employees on this project when executing work in all areas of the facility with the exception of the vaults. Personnel must be escorted in all areas after normal working hours.
  - .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.
  - .4 Contractor's personnel will require satisfactory RCMP initiated security screening in order to complete Work in premises and on site.
- .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 5 business 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 24 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 4 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            SECTION INCLUDES**

- .1        This Section clarifies Contractor's responsibilities and obligations to review the information provided in the "Designated Substances Report (DSR)", pertaining to the Site located at 3701 Carling Avenue, Ottawa, ON, prepared by Custodial Health and Safety Unit, PSPC dated February 2020.
- .2        This Section is to be read in conjunction with the Site specific DSR February 20<sup>th</sup>, 2020.
  - .1        A copy of the Site specific DSR February 20<sup>th</sup>, 2020 is attached at the end of this section.

**1.2            GENERAL REQUIREMENTS**

- .1        Should the contractor find designated substances, they shall inform the Departmental Representative and cease all works until further instruction from the Departmental Representative.

**Part 2            Products**

**2.1            NOT USED**

- .1        NOT USED

**Part 3            Execution**

**3.1            NOT USED**

- .1        NOT USED

**END OF SECTION**



Kostyantyn Frolov  
Real Property Services,  
Public Services and Procurement Canada  
Ottawa, Ontario

February 20<sup>th</sup>, 2020

**SUBJECT: Designated Substance Report, HVAC Modifications – Nitrate Building at 3701 Carling Avenue, Ottawa, ON**

On February 7<sup>th</sup>, 2020, the Custodial Health and Safety Unit (CHSU) of Real Property Services (RPS) at Public Services and Procurement Canada (PSPC) was contacted to prepare a Designated Substance Report for a project involving the reconstruction of the HVAC system in the Nitrate Building at 3701 Carling Avenue, Ottawa, ON.

A Designated Substance Report serves to inform workers of designated substances that are present in the workplace, to meet the requirements of Section 30 of the *Ontario Occupational Health and Safety Act (Act)*, as well as Sections 124 and 125 of Part II of the *Canada Labour Code*.

The only designated substance likely to be disturbed during this project is silica contained in concrete, cinder block, and mortar. Two paint samples were taken during the site visit; one white paint sample from the men's washroom, and one grey sample from the mechanical room; each of which were found to contain less than the minimum detectable limit and are therefore considered non-lead containing. Other designated substances, as identified in the Act, were either not identified or will not be disturbed during this project.

Precautions should be taken to reduce the risk of generating airborne silica dust when performing work involving the disturbance of silica-containing materials. In order to do so, the project should be implemented following the document entitled "Guideline: Silica on Construction Projects" published by the Occupational Health and Safety Branch of the Ontario Ministry of Labour. This document recommends work procedures and respiratory protection to reduce the risk of silica exposure.

The project may also impact Halocarbons. All work involving halocarbons is to be done following the requirements of the Federal Halocarbon Regulations, 2003, SOR/2003-289.

Although the scope of work does not include the removal of fluorescent lighting, it should be noted that fluorescent lighting and certain thermostats contain small amounts of mercury and if these items are to be removed, all applicable federal and provincial regulations, guidelines, and best practices should be followed regarding their removal and disposal.

Should any other suspected hazardous materials be identified during the course of the work, or if the scope of work changes and other designated substances are likely to be disturbed, the Departmental Representative shall contact the CHSU to determine if an additional designated substance investigation is required.

Sincerely,

A handwritten signature in dark ink, appearing to read "Nick Tobin". The signature is fluid and cursive, with the first name "Nick" and last name "Tobin" clearly distinguishable.

Nick Tobin  
Environmental Officer  
Custodial Health and Safety Unit  
Public Services and Procurement Canada

**Part 1            General**

**1.1            ADMINISTRATIVE**

- .1    Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2    Prepare agenda for meetings.
- .3    Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.
- .4    Provide physical space and make arrangements for meetings with dedicated site cabins for this purpose (not to be located within the facility).
- .5    Preside at meetings.
- .6    Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7    Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and, Departmental Representative.
- .8    Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

**1.2            PRECONSTRUCTION MEETING**

- .1    Within 10 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2    Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3    Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4    Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5    Agenda to include:
  - .1    Appointment of official representative of participants in the Work.
  - .2    Schedule of Work: in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
  - .3    Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .4    Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
  - .5    Delivery schedule of specified equipment in accordance with Section 01 14 00 – Work Restrictions.
  - .6    Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
  - .7    Departmental Representative provided products.

- .8 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .9 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Monthly progress claims, administrative procedures, photographs, hold backs.
- .12 Appointment of inspection and testing agencies or firms.
- .13 Insurances, transcript of policies.
- .14 Health and safety.

### **1.3 PROGRESS MEETINGS**

- .1 During course of Work and from the beginning of the project, schedule progress meetings bi-weekly.
- .2 Contractor, major Subcontractors involved in Work, Departmental Representative are to be in attendance.
- .3 Notify parties minimum 5 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 3 days after meeting.
- .5 Agenda to include the following:
  - .1 Review, approval of minutes of previous meeting.
  - .2 Review of Work progress since previous meeting.
  - .3 Field observations, problems, conflicts.
  - .4 Problems which impede construction schedule.
  - .5 Review of off-site fabrication delivery schedules.
  - .6 Corrective measures and procedures to regain projected schedule.
  - .7 Revision to construction schedule.
  - .8 Progress schedule, during succeeding work period.
  - .9 Review submittal schedules: expedite as required.
  - .10 Maintenance of quality standards.
  - .11 Review proposed changes for affect on construction schedule and on completion date.
  - .12 Health and safety.
  - .13 Other business.

## **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 - Submittal Procedures.
- .2 Submit to Departmental Representative within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
- .3 Submit Project Schedule to Departmental Representative within 5 working days of receipt of acceptance of Master Plan.

**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 Services Isolations
  - .6 Strip out works
  - .7 Plumbing.
  - .8 Lighting.
  - .9 Electrical.
  - .10 Piping.
  - .11 Controls.
  - .12 Heating, Ventilating, and Air Conditioning.
  - .13 Soak test periods
  - .14 Fire Systems.
  - .15 Testing and Commissioning.
  - .16 Supplied equipment long delivery items.
  - .17 Engineer supplied equipment required dates.
  - .18 Completion of each phase of the works proposed.

- .3 Where down time of the systems that serve the facility is required as part of the works, a schedule of proposed shut down periods shall be produced alongside the project programme and shall be continually updated by the Contractor to keep the Departmental Representative informed of all planned shut down periods.

#### **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.

#### **1.7 PROJECT MEETINGS**

- .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.
- .2 Unforeseeable weather related delays with their remedial measures will be discussed and negotiated.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not used.

### **Part 3 Execution**

#### **3.1 PROJECT PHASING**

- .1 The project shall be phased to ensure the facility is able to remain operational wherever possible, to maintain design conditions within the vaults. The phasing is outlined within the following specification clauses and shall be adopted by the contractor at appointment, to review, amend as necessary and produce their own phasing strategy and programme for issue to the Departmental Representative.
- .2 The phasing breakdown is intended to minimize the impact on the Departmental Representatives collection, should any of the works from the tender package contradict or be omitted from the phasing breakdown or vice versa, the contractor shall inform the Departmental Representative and await further instruction.
- .3 The contractor shall allow to undertake all the below phasing items within their tender return.
- .4 The contractor shall perform commissioning activities as described within the phasing breakdown at the end of the respective phase for the Departmental Representatives approval, prior to continuing to the next phase.

- .5 Any enabling activities for the next phase that can be undertaken without impacting the temperature and humidity control of the facility shall be undertaken when the contractor is awaiting approval to proceed to the next phase of the project, to avoid unnecessary delay.

### **3.2 PHASE 1**

- .1 Ventilation
  - .1 New supply and exhaust ventilation headers shall be installed within the vault corridors to terminate with capped connections for future connection to the existing vault ductwork, as indicated on the drawings.
  - .2 The main headers shall be terminated within the mechanical room for future connection to the ventilation system also.
  - .3 There shall be no shut down of the existing system within this phase.
- .2 Chilled water services
  - .1 No works required within this phase.
- .3 Heating services
  - .1 No works required within this phase.
- .4 Gas services
  - .1 No works required within this phase.
- .5 Control Systems
  - .1 No works required within this phase.

### **3.3 PHASE 2**

- .1 Ventilation
  - .1 The supply and exhaust headers installed within phase 1 shall be connected to the existing ventilation system within the mechanical room as indicated on the drawings.
  - .2 A phased approach shall be adopted by the contractor to switch over a number of vaults per day (for tender purposes assume 3No. per day) to the new supply and exhaust ductwork headers, installed in phase 1.
  - .3 At the end of each day where a number of vaults have been switched to the new supply / exhaust headers, the contractor shall balance the headers to ensure each vault is supplied with conditioned air to maintain design conditions.
  - .4 The contractor shall modify the existing ventilation exhaust ductwork from the vault corridors as indicated on the drawings.
  - .5 The contractor shall isolate the existing acclimatization vault supply and exhaust ductwork from the existing system, as indicated on the drawings.
- .2 Chilled water services
  - .1 No works required within this phase.
- .3 Heating services

.1 No works required within this phase.

.4 Gas services

.1 No works required within this phase.

.5 Control Systems

.1 No works required within this phase.

### 3.4 PHASE 3

.1 Ventilation

.1 Blanking plates and shut off dampers shall be installed within the mechanical room to provide means of isolation of certain parts of the existing system to accommodate future phase works, as indicated on the drawings.

.2 Chilled water services

.1 The existing chillers shall be replaced with new in a phased manner, to ensure the facility remains operational wherever possible. The new chillers shall be installed in the same location as the existing, with local modifications required to the existing concrete bases.

.2 New primary pump-sets shall be installed that serve the new chillers within the mechanical room, as indicated on the drawings.

.3 A new dry air cooler shall be installed externally, adjacent to the existing chiller serving 103-AH3.

.4 The existing buffer vessel flow and return headers shall be extended from the existing isolation valves with new connections for the proposed new dry air cooler and air handling units installed in a future phase.

.5 Commissioning of the new dry air cooler and chillers shall take place within this phase to ensure the new equipment is able to temporarily serve the existing facility.

.3 Heating services

.1 No works required within this phase.

.4 Gas services

.1 No works required within this phase.

.5 Control Systems

.1 Existing control systems shall be modified and adapted for the installation of the new chillers and dry air cooler.

.2 Commissioning activities associated with the new chillers and dry air cooler shall take place.

### 3.5 PHASE 4

.1 Ventilation

.1 Blanking plates and shut off dampers installed in phase 3 shall be used to isolate the existing air handling plant ready for strip out. Air handling plant 103AH2, 103-AH2-ERV, 103-AH2-RF and its associated ductwork, accessories and ancillaries

- shall be stripped out as indicated on the drawings, ensuring the remaining ventilation plant remains operational throughout the demolition works.
- .2 Concrete bases shall be modified to suit the installation of new plant to replace the stripped out plant.
- .3 Louvre connections shall be blanked where left open to avoid any risk of snow ingress to the mechanical room.
- .2 Chilled water services
  - .1 Isolation and strip out of the existing chilled water coil and associated pipework serving the existing air handling plant back to existing isolation valves.
- .3 Heating services
  - .1 Isolation and strip out of the existing heating coil and associated pipework serving the existing air handling plant back to existing isolation valves.
- .4 Gas services
  - .1 Isolation, purge and strip out of existing gas pipework serving the existing air handling plant back to connection point and suitably capped.
- .5 Control Systems
  - .1 Existing control systems to be modified / adapted / stripped out accordingly to suit requirements of new air handling plant for future phase installation.

### **3.6 PHASE 5**

- .1 Ventilation
  - .1 New air handling plant FA-AHU-02, RC-AHU-04 and RC-AHU-05 shall be installed with all interconnecting ductwork and accessories ready for connection to the existing system.
  - .2 New humidifiers HUM-002 and HUM-003 shall be installed alongside the new air handling units as indicated on the proposed drawings.
- .2 Chilled water services
  - .1 Chilled water pipework shall be installed to serve the new air handling plant and be connected to the previously installed extended flow and return headers on the buffer vessel, and the existing flow and return connections made available by the strip out of the existing units within the previous phase of works.
  - .2 Commissioning activities shall take place for the newly installed equipment, ready for connection to the existing ventilation system.
- .3 Heating services
  - .1 Heating pipework shall be installed to serve the new air handling plant and be connected to the existing heating mains at high level within the mechanical room, as indicated on the drawings. The existing pipework connections made available by the strip-out of the existing air handling units in the previous phase shall also be utilised as indicated on the drawings.
  - .2 Commissioning activities shall take place for the newly installed equipment, ready for connection to the existing ventilation system.

- .4 Gas services
  - .1 No works required within this phase.
- .5 Control Systems
  - .1 Newly installed ventilation plant and all associated accessories shall be connected and commissioned ready for connection to the existing ventilation system in the next phase.

### 3.7 PHASE 6

- .1 Ventilation
  - .1 Newly installed and commissioned plant shall be connected to the ventilation system as indicated on the drawings.
  - .2 Commissioning activities shall take place to enable the new ventilation units to serve the facility independently within the next phases of the project.
  - .3 Shut down of existing facility required to enable connection of new ventilation equipment (to be limited to as short a time period as possible).
- .2 Chilled water services
  - .1 Commissioning activities required to validate air handling unit coil performance.
- .3 Heating services
  - .1 Commissioning activities required to validate air handling unit coil performance.
- .4 Gas services
  - .1 No works required within this phase.
- .5 Control Systems
  - .1 Commissioning activities required to set up air handling plant.

### 3.8 PHASE 7

- .1 Ventilation
  - .1 Blanking plates and shut off dampers installed in phase 3 shall be used to isolate the existing air handling plant ready for strip out. Air handling plant 103AH1, 103-AH1-ERV, 103-AH1-RF and its associated ductwork, accessories and ancillaries shall be stripped out as indicated on the drawings, ensuring the remaining ventilation plant remains operational throughout the demolition works.
  - .2 Concrete bases shall be modified to suit the installation of new plant to replace the stripped out plant.
  - .3 Louvre connections shall be blanked where left open to avoid any risk of snow ingress to the mechanical room.
- .2 Chilled water services
  - .1 Isolation and strip out of the existing chilled water coil and associated pipework serving the existing air handling plant back to existing isolation valves.
- .3 Heating services

- .1 Isolation and strip out of the existing heating coil and associated pipework serving the existing air handling plant back to existing isolation valves.
- .4 Gas services
  - .1 Isolation, purge and strip out of existing gas pipework serving the existing air handling plant back to connection point and suitably capped.
- .5 Control Systems
  - .1 Existing control systems to be modified / adapted / stripped out accordingly to suit requirements of new air handling plant for future phase installation.

### 3.9 PHASE 8 (FINAL)

- .1 Ventilation
  - .1 New air handling plant FA-AHU-01 and RC-AHU-03 shall be installed with all interconnecting ductwork and accessories.
  - .2 New air handling plant shall be connected to the existing system.
  - .3 Final commissioning shall take place.
  - .4 New humidifier HUM-001 shall be installed to serve the new air handling unit RC-AHU-03
- .2 Chilled water services
  - .1 Chilled water pipework shall be installed to serve the new air handling plant and be connected to the previously installed extended flow and return headers on the buffer vessel, and the existing flow and return connections made available by the strip out of the existing units within the previous phase of works.
  - .2 Commissioning activities shall take place for the newly installed equipment, connection to the existing ventilation system shall take place.
  - .3 Final commissioning shall take place.
- .3 Heating services
  - .1 Heating pipework shall be installed to serve the new air handling plant and be connected to the existing heating mains at high level within the mechanical room, as indicated on the drawings. The existing pipework connections made available by the strip-out of the existing air handling units in the previous phase shall also be utilised as indicated on the drawings.
  - .2 Commissioning activities shall take place for the newly installed equipment, connection to the existing ventilation system shall take place.
  - .3 Final commissioning shall take place.
- .4 Gas services
  - .1 No works required within this phase.
- .5 Control Systems
  - .1 Newly installed ventilation plant and all associated accessories shall be connected and commissioned.
  - .2 Final commissioning shall take place.



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Nitrate Film Preservation Facility  
HVAC Remediation  
Project Number: R.067978.001

Section 01 32 16.19  
CONSTRUCTION PROGRESS SCHEDULE - BAR  
(GANTT) CHART  
Page 9 of 9

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**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 Ontario, Canada.
- .3      Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4      Allow 10 days for Departmental Representative's review of each submission.
- .5      Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

- .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 Accompany submissions with transmittal letter, containing:
  - .1 Date.
  - .2 Project title and number.
  - .3 Contractor's name and address.
  - .4 Identification and quantity of each shop drawing, product data and sample.
  - .5 Other pertinent data.
- .8 Submissions include:
  - .1 Date and revision dates.
  - .2 Project title and number.
  - .3 Name and address of:
    - .1 Subcontractor.
    - .2 Supplier.
    - .3 Manufacturer.
  - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
  - .5 Details of appropriate portions of Work as applicable:
    - .1 Fabrication.
    - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
    - .3 Setting or erection details.
    - .4 Capacities.
    - .5 Performance characteristics.
    - .6 Standards.
    - .7 Operating weight.
    - .8 Wiring diagrams.
    - .9 Single line and schematic diagrams.
    - .10 Relationship to adjacent work.
- .9 After Departmental Representative's review, distribute copies.
- .10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.

- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
- .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
  - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of 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 Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general concept.
  - .1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
  - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

**1.3 PHOTOGRAPHIC DOCUMENTATION**

- .1 Submit electronic copy of colour digital photography in jpg format, standard resolution monthly with progress statement .
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Number of viewpoints: 4 locations.
  - .1 Viewpoints and their location as determined by Departmental Representative.
- .4 Frequency of photographic documentation: weekly .

**1.4 CERTIFICATES AND TRANSCRIPTS**

- .1 Immediately after award of Contract, submit Workers' Compensation Board 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            REFERENCE STANDARDS**

- .1    Province of Ontario
  - .1       Occupational Health and Safety Act and Regulations for Construction Projects, R.S.O. 1990, c.0.1, as amended and O. Reg. 213/91 as amended - current edition.
- .2    Comply with the Health and Safety requirements of CSA Z462 Workplace Electrical Safety
- .3    Comply with the Health and Safety requirements of CSA Z460 Control of Hazardous Energy

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Submit site-specific Health and Safety Plan: Within 10 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    Submit electronic copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative.
- .4    Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors to the Departmental Representative within 24 hrs and as soon as practicable.
- .5    Submit copies of any Notice required by legislation, or of any incident and accident reports to Departmental Representative and as soon as practicable.
- .6    Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 10 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 5 days after receipt of comments from Departmental Representative.
- .7    Submit two (2) complete Hazard Assessment Site-Specific Health and Safety plans (HASSSP's) in a three ring binder, in an indexed format. Maintain a copy on site. The other copy will be given to the Departmental Representative.
- .8    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.
- .9    Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.

- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.
- .11 The constructor shall advise the Departmental Representative of any accident, injury, near-mis incident, fire, explosion or chemical spill occurring at the work site and any visit to the site by a governmental enforcement official.
- .12 The constructor shall provide a written report within 24 hours of any accident, injury, near-miss incident, fire explosion or chemical spill.

### **1.3 FILING OF NOTICE**

- .1 File Notice of Project with Ontario authorities prior to beginning of Work.
- .2 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

### **1.4 SAFETY ASSESSMENT**

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

### **1.5 REGULATORY REQUIREMENTS**

- .1 Do Work in accordance with Section 01 00 10 - General Instructions.

### **1.6 PROJECT/SITE CONDITIONS**

- .1 Refer to DSR for any noted hazardous or contaminated materials or substances present at project site.
- .2 The contractor shall note the following materials whilst carrying out works on site that consideration and care is required when working with and around these substances:
  - .1 Nitrate film media.
  - .2 propylene glycol.
  - .3 Galvanised steel ductwork and heavy grade steel pipework.

### **1.7 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.

### **1.8 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 Contractor will be responsible and assume the role Constructor as described in the Ontario Occupational Health and Safety Act and Regulations for Construction Projects.

- .3 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
- .4 Ensure the site supervisor is an employee of the Constructor and that this person is present and available at all-times throughout the life of the project.

#### **1.9 UNFORSEEN HAZARDS**

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.
- .2 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise Safety Officer and follow procedures in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.

#### **1.10 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 site-related working experience specific to activities associated with mechanical systems and installation.
  - .2 Have working knowledge of occupational safety and health regulations.
  - .3 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.
  - .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

#### **1.11 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 having jurisdiction, and in consultation with Departmental Representative

#### **1.12 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.

#### **1.13 BLASTING**

- .1 Blasting or other use of explosives is not permitted.



**1.14            POWDER ACTUATED DEVICES**

- .1        Use powder actuated devices only after receipt of written permission from Departmental Representative.

**1.15            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.

**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 This Section references to laws, by laws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction, and other legally enforceable requirements applicable to Work and that are; or become, in force during performance of Work.

**1.2 RELATED REQUIREMENTS**

- .1 Section 22 05 05 - Selective Demolition for Plumbing
- .2 Section 23 05 05 - Selective Demolition for HVAC
- .3 Section 26 05 05 - Selective Demolition for Electrical

**1.3 REFERENCES TO REGULATORY REQUIREMENTS**

- .1 Perform Work in accordance with National Building Code of Canada (NBC) 2015, National Fire Code of Canada 2015, National Plumbing Code of Canada 2015, Ontario Electrical Safety Code 27<sup>th</sup> Edition including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Specific design and performance requirements listed in specifications or indicated on Drawings may exceed minimum requirements established by referenced Building Code; these requirements will govern over the minimum requirements listed in Building Code
  - .1 Meet or exceed requirements of:
    - .1 Contract documents.
    - .2 Specified standards, codes and referenced documents.

**1.4 BUILDING SMOKING ENVIRONMENT**

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

**1.5 QUALITY ASSURANCE**

- .1 Regulatory Requirements: Except as otherwise specified, Constructor shall apply for, obtain, and pay fees associated with, permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:
  - .1 Regulatory requirements and fees in force on date of Bid submission, and
  - .2 A change in regulatory requirements or fees scheduled to become effective after date of tender submission and of which public notice has been given before date of tender submission

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**2.2 PERMITS**

- .1 Building Permit:
  - .1 Departmental Representative has applied for a building permit. Contractor is responsible for paying for and obtaining the permit along with obtaining or coordinating other permits required for Work and its various parts.
  - .2 Contractor will require that specific Subcontractor's obtain and pay for permits required by authorities having jurisdiction, where their Work is affected by Work requiring permits.
  - .3 Contractor shall display building permit and other permits in a conspicuous location at Place of Work.
- .2 Occupancy Permits:
  - .1 Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by authority having jurisdiction.
  - .2 Departmental Representative will issue appropriate instructions to Contractor for correction to Work where Contract Document deficiencies are required to be corrected in order to obtain occupancy permits, including partial occupancy permits.
  - .3 Contractor shall correct deficiencies in accordance with Departmental Representative's instructions. Where deficiency is not corrected, Departmental Representative reserves the right to make correction and charge Contractor for costs incurred.
  - .4 Contractor shall turn occupancy permits over to Departmental Representative.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 INSPECTION**

- .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative will pay cost of examination and replacement.

**1.2 INDEPENDENT INSPECTION AGENCIES**

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Departmental Representative.
- .2 The contractor shall provide a commissioning schedule for the project within 15 days of contract award to the Departmental Representative. This schedule will then be kept up to date with progress on site and issued to the Departmental alongside the main programme of works.
- .3 The contractor shall liaise with the independent inspection agencies with regards to visiting site to undertake witnessing of systems and inspection of works completed, in line with their commissioning schedule.
- .4 The contractor shall allow for personnel to be available as required by the independent inspection agencies to ensure full witnessing is available at the time of visit to site.
- .5 Provide equipment required for executing inspection and testing by appointed agencies.
- .6 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .7 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

**1.3 ACCESS TO WORK**

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

#### **1.4 PROCEDURES**

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

#### **1.5 REJECTED WORK**

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

#### **1.6 REPORTS**

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

#### **1.7 MILL TESTS**

- .1 Submit mill test certificates as required of specification Sections.

#### **1.8 FACTORY TESTING**

- .1 The contractor shall include for full factory testing of the main items of plant, as described within Section 01 91 13.16 – Commissioning Plan.

#### **1.9 EQUIPMENT AND SYSTEMS**

- .1 Submit adjustment and balancing reports for mechanical, electrical systems.
- .2 Refer to Section 01 91 13.16 Commissioning Plan for definitive requirements.

### **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 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
  - .2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
- .3 CSA Group (CSA)
  - .1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CSA-0121-M1978 (R2003), Douglas Fir Plywood.
  - .3 CAN/CSA-Z321-96 (R2001), Signs and Symbols for the Occupational Environment.
- .4 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 INSTALLATION AND REMOVAL**

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

**1.4 HOISTING**

- .1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .2 Cranes to be operated by qualified operator.

**1.5 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.

**1.6 CONSTRUCTION PARKING**

- .1 Parking will be permitted on site adjacent the facility..
- .2 Parking for the Contractor and Departmental Representative shall be allowed for in accordance with Section 01 14 00 Work Restrictions.
- .3 Provide and maintain adequate access to project site.
- .4 Clean runways and taxi areas where used by Contractor's equipment.

**1.7 OFFICES**

- .1 Provide office heated to 22 degrees C, lighted 500 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices.
- .4 Provide temporary office for Departmental Representative.
- .5 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.
- .6 Maintain in clean condition.

**1.8 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.

**1.9 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.

**1.10 CONSTRUCTION SIGNAGE**

- .1 Signs and notices for safety and instruction in both official languages Graphic symbols to CAN/CSA-Z321.
- .2 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Departmental Representative.

**1.11 PROTECTION AND MAINTENANCE OF TRAFFIC**

- .1 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.
- .2 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of



equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

- .3 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .4 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.
- .5 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.
- .6 Dust control: adequate to ensure safe operation at all times.
- .7 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .8 Provide snow removal during period of Work to ensure the proposed works are able to continue as intended.

**1.12 CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

**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 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as Of: May 14, 2004.

**1.2 INSTALLATION AND REMOVAL**

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

**1.3 HOARDING**

- .1 Site Hoarding: Erect temporary chain-link or welded wire fabric fencing enclosures using the following:
  - .1 Height: minimum 2400mm.
  - .2 Galvanized or prefinished metal shapes and wire.
  - .3 45mm minimum dimension schedule 40 vertical and horizontal steel support framing. Support framing to complete perimeter of each fence panel with welded connections.
  - .4 Minimum 2.5mm base metal wire thickness.
  - .5 Woven wire fabric with maximum 65mm openings.
  - .6 Heavy duty post connectors between panels.
  - .7 Ballasted footing supports.

**1.4 GUARD RAILS AND BARRICADES**

- .1 Provide secure, rigid guard rails and barricades around excavations, and open edges of floors.
- .2 Provide as required by governing authorities.

**1.5 DUST TIGHT SCREENS**

- .1 Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public in line with the phasing of the project activities
- .2 Maintain and relocate protection until such work is complete.

**1.6 ACCESS TO SITE**

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

**1.7 FIRE ROUTES**

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

**1.8 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY**

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

**1.9 PROTECTION OF BUILDING FINISHES**

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

**1.10 OVERHEAD PROTECTION**

- .1 The contractor shall provide overhead protection where there is any risk of materials falling onto the public or workforce whilst entering or exiting any of the doors into the facility (includes fire escapes).

**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      Within text of each specifications section, reference may be made to reference standards.
- .2      Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .3      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.
- .4      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            AVAILABILITY**

- .1      Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2      In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

**1.4 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 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

**1.5 TRANSPORTATION**

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Departmental Representative will be paid for by Departmental Representative. Unload, handle and store such products.

**1.6 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.

**1.7 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.

#### **1.8 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.

#### **1.9 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.

**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 EXISTING SERVICES**

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.
- .2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

**1.2 LOCATION OF EQUIPMENT AND FIXTURES**

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Departmental Representative of impending installation and obtain approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

**1.3 SUBSURFACE CONDITIONS**

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

**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 07 84 00 – Firestopping.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit written request in advance of cutting or alteration which affects:
  - .1        Structural integrity of elements of project.
  - .2        Integrity of weather-exposed or moisture-resistant elements.
  - .3        Efficiency, maintenance, or safety of operational elements.
  - .4        Visual qualities of sight-exposed elements.
  - .5        Work of Departmental Representative or separate contractor.
- .3        Include in request:
  - .1        Identification of project.
  - .2        Location and description of affected Work.
  - .3        Statement on necessity for cutting or alteration.
  - .4        Description of proposed Work, and products to be used.
  - .5        Alternatives to cutting and patching.
  - .6        Effect on Work of Departmental Representative or separate contractor.
  - .7        Written permission of affected separate contractor.
  - .8        Date and time work will be executed.

**1.3            MATERIALS**

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

**1.4            PREPARATION**

- .1        Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2        After uncovering, inspect conditions affecting performance of Work.
- .3        Beginning of cutting or patching means acceptance of existing conditions.
- .4        Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5        Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

**1.5 EXECUTION**

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

**1.6 WASTE MANAGEMENT AND DISPOSAL**

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

**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.
- .2      Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .3      Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .4      Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5      Provide on-site skip containers for collection of waste materials and debris.
- .6      Provide and use marked separate bins for recycling. Refer to Section 01 74 19 - Waste Management and Disposal.
- .7      Dispose of waste materials and debris off site.
- .8      Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9      Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10     Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11     Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12     Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.
- .13     Ensure the loading bay is maintained clean and dust free at all times it is not being used by the Contractor for intermittent loading / unloading of goods for the project.

**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 Departmental Representative.
- .5      Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.

- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors.
- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.

**1.3 WASTE MANAGEMENT AND DISPOSAL**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

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Nitrate Film Preservation Facility  
HVAC Remediation  
Project Number: R.067978.001

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Section 01 74 00  
CLEANING  
Page 3 of 3

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 This Section includes requirements for management of construction waste and disposal, which forms the Contractor's commitment to reduce and divert waste materials from landfill and includes the following:
  - .1 Preparation of a Draft Construction Waste Management Plan that will be used to track the success of the Construction Waste Management against actual waste diversion from landfill.
  - .2 Preparation of a Construction Waste Management Plan that provides guidance on a logical progression of tasks and procedures to be followed in a pollution prevention program to reduce or eliminate the generation of waste, the loss of natural resources, and process emissions through source reduction, reuse, recycling, and reclamation.
  - .3 Preparation of monthly progress reports indicating cumulative totals representing progress towards achieving diversion and reduction goals of waste materials away from landfill and identifying any special programs, landfill options or alternatives to landfill used during construction.
  - .4 Preparation of a Construction Waste Management Report containing detailed information indicating total waste produced by the project, types of waste material and quantity of each material, and total waste diverted and diversion rates indicated as a percentage of the total waste produced.
- .2 Departmental Representative has established that this project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors be employed by the Contractor.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASTM International (ASTM)
  - .1 ASTM E1609 01, Standard Guide for Development and Implementation of a Pollution Prevention Program
- .3 Recycling Certification Institute (RCI):
  - .1 RCI Certification Construction and Demolition Materials Recycling

**1.3 DEFINITIONS**

- .1 Clean Waste: Untreated and unpainted; not contaminated with oils, solvents, sealants or similar materials.
- .2 Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction.

- .3 Hazardous: Exhibiting the characteristics of hazardous substances including properties such as ignitability, corrosiveness, toxicity or reactivity.
- .4 Non hazardous: Exhibiting none of the characteristics of hazardous substances, including properties such as ignitability, corrosiveness, toxicity, or reactivity.
- .5 Non toxic: Not poisonous to humans either immediately or after a long period of exposure.
- .6 Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- .7 Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- .8 Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form; recycling does not include burning, incinerating, or thermally destroying waste.
- .9 Return: To give back reusable items or unused products to vendors for credit.
- .10 Reuse: To reuse a construction waste material in some manner on the project site.
- .11 Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- .12 Sediment: Soil and other debris that has been eroded and transported by storm or well production run off water.
- .13 Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- .14 Toxic: Poisonous to humans either immediately or after a long period of exposure.
- .15 Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- .16 Volatile Organic Compounds (VOC's): Chemical compounds common in and emitted by many building products over time through outgassing:
  - .1 Solvents in paints and other coatings;
  - .2 Wood preservatives; strippers and household cleaners;
  - .3 Adhesives in particleboard, fiberboard, and some plywood; and foam insulation.
  - .4 When released, VOC's can contribute to the formation of smog and can cause respiratory tract problems, headaches, eye irritations, nausea, damage to the liver, kidneys, and central nervous system, and possibly cancer.
- .17 Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.
- .18 Construction Waste Management Plan: A project related plan for the collection, transportation, and disposal of the waste generated at the construction site; the purpose of the plan is to ultimately reduce the amount of material being landfilled.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate waste management requirements with all Divisions of the Work for the project and ensure that requirements of the Construction Waste Management Plan are followed.



- .2 Preconstruction Meeting: Arrange a pre-construction meeting in accordance with Section 01 31 19 Project Meetings before starting any Work of the Contract attended by the Departmental Representative, to discuss the Contractor's Construction Waste Management Plan and to develop mutual understanding of the requirements for a consistent policy towards waste reduction and recycling.

## **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide required information in accordance with Section 01 33 00 Submittal Procedures.
- .2 Action Submittals: Provide the following submittals before starting any work of this Section:
  - .1 Draft Construction Waste Management Plan (Draft CWM Plan): Submit to Departmental Representative a preliminary analysis of anticipated site generated waste by listing a minimum of five (5) construction or demolition waste streams that have potential to generate the most volume of material indicating methods that will be used to divert construction waste from landfill and source reduction strategies; Departmental Representative will provide commentary before development of Contractor's Construction Waste Management Plan.
  - .2 Construction Waste Management Plan (CWM Plan): Submit a CWM Plan for this project prior to any waste removal from site and that includes the following information:
    - .1 Material Streams: Analysis of the proposed jobsite waste being generated, including material types and quantities forming a part of identified material streams in the Draft CWM Plan; materials removed from site destined for alternative daily cover at landfill sites and land clearing debris cannot be considered as contributing to waste diversion and will be included as a component of the total waste generated for the site.
    - .2 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials, and incorporate into CWM Plan.
    - .3 Alternative Waste Disposal: Prepare a listing of each material proposed to be salvaged, reused, recycled or composted during the course of the project, and the proposed local market for each material.
    - .4 Landfill Materials: Identify materials that cannot be recycled, reused or composted and provide explanation or justification energy will be considered as a viable alternative diversion strategy for these materials where facilities exist.
    - .5 Landfill Options: The name of the landfill where trash will be disposed of; landfill materials will form a part of the total waste generated by the project.
    - .6 Materials Handling Procedures: A description of the means by which any recycled waste materials will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.
    - .7 Transportation: A description of the means of transportation of the recyclable materials, whether materials will be site separated and self hauled to designated centers, or whether mixed materials will be

collected by a waste hauler and removed from the site, and destination of materials.

## **1.6 PROJECT CLOSEOUT SUBMISSIONS**

- .1 Record Documentation: Submit as constructed information in accordance with Section 01 78 00- Closeout Submittals as follows:
  - .1 Construction Waste Management Report (CWM Report): Submit a CWM Report for this project in a format acceptable to submittal requirements and that includes the following information:
    - .1 Accounting: Submit information indicating total waste produced by the project.
    - .2 Composition: Submit information indicating types of waste material and quantity of each material.
    - .3 Diversion Rate: Submit information indicating total waste diverted from landfill as a percentage of the total waste produced by the project.
    - .4 Diversion Documentation: Submit copies of transportation documents or shipping manifests indicating weights of materials, and other evidence of disposal indicating final location of waste diverted from landfill and waste sent to landfill.
    - .5 Alternative Daily Cover (ADC): Submit quantities of material that were used as ADC at landfill sites, and that form a part of the total waste generated by the project.
    - .6 Multiple Waste Hauling: Compile all information into a single CWM Report where multiple waste hauling and diversion strategies were used for the project.
    - .7 Photographs: Submit photographs of waste diversion facilities documenting location and signage describing usage of waste separation containers.

## **1.7 QUALITY ASSURANCE**

- .1 Resources for Development of Construction Waste Management Report (CWM Report): The following sources may be useful in developing the Draft Construction Waste Management Plan:
  - .1 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials, and incorporate into CWM Plan.
  - .2 Waste-to-Energy Systems: Investigate local waste-to-energy incentives where systems for diverting materials from landfill for reuse or recycling are not available.
- .2 Certifications: Provide proof of the following during the course of the Work:
  - .1 Compliance Certification: Provide proof that recycling center is third party verified and is listed as a Certified Facility through the registration and certification requirements of the Recycling Certification Institute.

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

- .1 Storage Requirements: Implement a recycling/reuse program that includes separate collection of waste materials as appropriate to the project waste and the available recycling and reuse programs in the project area.
- .2 Handling Requirements: Clean materials that are contaminated before placing in collection containers and ensure that waste destined for landfill does not get mixed in with recycled materials:
  - .1 Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.
  - .2 Arrange for collection by or delivery to the appropriate recycling or reuse facility.
- .3 Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 (CWM PLAN) IMPLEMENTATION**

- .1 Manager: Contractor is responsible for designating an on site party or parties responsible for instructing workers and overseeing and documenting results of the CWM Plan for the project.
- .2 Distribution: Distribute copies of the CWM Plan to the job site foreman, each Subcontractor, the Departmental Representative and other site personnel as required to maintain CWM Plan.
- .3 Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, composting and return methods being used for the project to Subcontractor's at appropriate stages of the project.
- .4 Separation Facilities: Lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, composting and return:
  - .1 Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.
  - .2 Hazardous wastes shall be separated, stored, and disposed of in accordance with local regulations.
- .5 Progressive Documentation: Submit a monthly summary of waste generated by the project to ensure that waste diversion goals are on track with project requirements:
  - .1 Submission of waste summary can coincide with application for progress payment, or similar milestone event as agreed upon between the Contractor and Departmental Representative.

- .2 Monthly waste summary shall contain the following information:
- .1 The amount in tonnes or m<sup>3</sup> and location of material landfilled,
  - .2 The amount in tonnes or m<sup>3</sup> and location of materials diverted from landfill, and
  - .3 Indication of progress based on total waste generated by the project with materials diverted from landfill as a percentage.

### 3.2 SUBCONTRACTOR'S RESPONSIBILITY

- .1 Subcontractor's shall cooperate fully with the Contractor to implement the CWM Plan.
- .2 Failure to cooperate may result in the Departmental Representative not achieving their environmental goals, and may result in penalties being assessed by the Contractor to the responsible Subcontractor's.

### 3.3 SAMPLE CONSTRUCTION WASTE MANAGEMENT FORMS

- .1 Sample waste tracking form below can be used by the Contractor to establish their own forms for recording management of construction waste:

SAMPLE WASTE MANAGEMENT FORM						
Material Stream	Diverted Waste by Report Date	Total	Units			
Sept	Oct	Nov	Dec			
Material Streams Contributing to Credit	Plastic	1.25	2.5	10	5	18.75 m <sup>3</sup>
Carpet	2.5	2.5	2.5	0	7.5	m <sup>3</sup>
Paper/Cardboard	5	2.5	2.5	5	15	m <sup>3</sup>
Clean Wood	0	25	0	1.25	26.25	m <sup>3</sup>
Metal	1.25	2.5	5.5	7	16.25	m <sup>3</sup>
Gypsum Board	2.5	2.5	4	5	14	m <sup>3</sup>
Brick/Concrete	10.5	2.5	5.5	8.75	27.25	m <sup>3</sup>
Asphalt Shingles	10	0	0	0	10	m <sup>3</sup>
Total Diverted Waste	135	m <sup>3</sup>				
Material Streams not Contributing to Credit	Landfill	10.75	7.5	15	10	43.25 m <sup>3</sup>
Screen Fines (ADC)	5	1.25	0	2.5	8.75	m <sup>3</sup>
150 mm Minus (ADC)	1.25	1.25	5	5.5	13	m <sup>3</sup>

Total Landfill/ADC Waste	65			m <sup>3</sup>				
Total Waste	200	m <sup>3</sup>						
Percent Diverted	67.5	%						

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        Canadian Environmental Protection Act (CEPA)
  - .1        SOR/2008-197, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations.

**1.2            ADMINISTRATIVE REQUIREMENTS**

- .1        Acceptance of Work Procedures:
  - .1        Contractor's Inspection: Contractor: 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's 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 and French 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, balanced and fully operational.
    - .4        Certificates required by chiller manufacturer, air handling unit manufacturer: submitted.
    - .5        Operation of systems: demonstrated to Departmental Representative's personnel.
    - .6        Commissioning of mechanical systems: completed in accordance with Section 01 91 13 General Commissioning Requirements and Section 01 91 13.13 Commissioning Plan, copies of final Commissioning Report submitted to Departmental Representative.
    - .7        Work: complete and ready for final inspection.
- .4        Final Inspection:
  - .1        When completion tasks are done, request final inspection of Work by Departmental Representative, and Contractor.
  - .2        When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.

- .5 Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.
- .6 Commencement of Lien and Warranty Periods: date of Departmental Representative's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.
- .7 Final Payment:
  - .1 When Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.
  - .2 When work deemed incomplete by Departmental Representative, complete outstanding items and request re-inspection.
- .8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

**1.3 FINAL CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**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 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Canadian Environmental Protection Act (CEPA)
  - .1 SOR/2008-197, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-warranty Meeting:
  - .1 Convene meeting four weeks prior to contract completion with Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:
    - .1 Verify Project requirements.
    - .2 Review warranty requirements and manufacturer's installation instructions.
  - .2 Departmental Representative to establish communication procedures for:
    - .1 Notifying construction warranty defects.
    - .2 Determine priorities for type of defects.
    - .3 Determine reasonable response time.
  - .3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
  - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 FORMAT**

- .1 Organize data as instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 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.
- .9 Provide 1:1 scaled CAD files in dwg format on CD and memory stick.

## **1.5 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 Departmental Representative and Contractor with name of responsible parties.
  - .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
  - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data.
  - .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

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

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to Contract.
  - .5 Reviewed shop drawings, product data, and samples.
  - .6 Field test records.
  - .7 Inspection certificates.
  - .8 Manufacturer's certificates.

- .2 Store record documents and samples in field office apart from documents used for construction.
  - .1 Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
  - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition.
  - .1 Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.

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

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

#### **1.8 OPERATIONS AND MAINTENANCE (O&M) MANUAL**

- .1 For each item of equipment and each system include description of unit or system, and component parts.

- .1 Give function, normal operation characteristics and limiting conditions.
- .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
  - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
  - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and Section 01 91 13 – General Commissioning Requirements.
- .15 Additional requirements: as specified in individual specification sections.

## **1.9 MAINTENANCE MATERIALS**

- .1 Spare Parts:
  - .1 Provide spare parts, in quantities specified in individual specification sections.
  - .2 Provide items of same manufacture and quality as items in Work.
  - .3 Deliver to site; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.
  - .5 Obtain receipt for delivered products and submit prior to final payment.
- .2 Extra Stock Materials:

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.
- .4 Receive and catalogue items.
  - .1 Submit inventory listing to Departmental Representative.
  - .2 Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.
- .3 Special Tools:
  - .1 Provide special tools, in quantities specified in individual specification section.
  - .2 Provide items with tags identifying their associated function and equipment.
  - .3 Deliver to site ; place and store.
  - .4 Receive and catalogue items.
    - .1 Submit inventory listing to Departmental Representative.
    - .2 Include approved listings in Maintenance Manual.

#### **1.10 DELIVERY, STORAGE AND HANDLING**

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

#### **1.11 WARRANTIES AND BONDS**

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative for approval.
- .3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
  - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within [ten] days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 4-month and 9-month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .9 Include information contained in warranty management plan as follows:
  - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
  - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include air handling units, chillers, dry air cooler, pumps, motors, HVAC balancing, commissioned systems.
  - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
    - .1 Name of item.
    - .2 Model and serial numbers.
    - .3 Location where installed.
    - .4 Name and phone numbers of manufacturers or suppliers.
    - .5 Names, addresses and telephone numbers of sources of spare parts.
    - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
    - .7 Cross-reference to warranty certificates as applicable.
    - .8 Starting point and duration of warranty period.
    - .9 Summary of maintenance procedures required to continue warranty in force.
    - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
    - .11 Organization, names and phone numbers of persons to call for warranty service.
    - .12 Typical response time and repair time expected for various warranted equipment.
  - .4 Contractor's plans for attendance at 4 and 9-month post-construction warranty inspections.
  - .5 Procedure and status of tagging of equipment covered by extended warranties.

- .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification to follow oral instructions.
- .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

**1.12 WARRANTY TAGS**

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
  - .1 Type of product/material.
  - .2 Model number.
  - .3 Serial number.
  - .4 Contract number.
  - .5 Warranty period.
  - .6 Inspector's signature.
  - .7 Construction Contractor.

**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 REQUIREMENTS**

- .1    Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of final inspection.
- .2    Departmental Representative: provide list of personnel to receive instructions, and coordinate their attendance at agreed-upon times.
- .3    Preparation:
  - .1    Verify conditions for demonstration and instructions comply with requirements.
  - .2    Verify designated personnel are present.
  - .3    Ensure equipment has been inspected and put into operation in accordance with Section 01 91 13.13 Commissioning Plan.
  - .4    Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 – General Commissioning Requirements and equipment and systems are fully operational.
- .4    Demonstration and Instructions:
  - .1    Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location.
  - .2    Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
  - .3    Review contents of manual in detail to explain aspects of operation and maintenance.
  - .4    Prepare and insert additional data in operations and maintenance manuals when needed during instructions.
- .5    Time Allocated for Instructions: ensure amount of time required for instruction of each item of equipment or system as follows:
  - .1    Division 22 – Plumbing System: 1 hour of instruction.
  - .2    Division 23 – HVAC Systems: 16 hours of instruction.
  - .3    Division 25 – Control Systems: 8 hours of instruction.
  - .4    Division 26 – Electrical Systems: 2 hours of instruction.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative's approval.
- .3    Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4    Give time and date of each demonstration, with list of persons present.

- .5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.3 QUALITY ASSURANCE**

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

**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 For Cx responsibilities refer to Section 01 91 13.13 - Commissioning Plan.
- .2 Cx to be a line item of Contractor's cost breakdown.

- .3 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .4 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 facility is 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.
- .5 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 Facility user and O&M personnel 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.
  - .2 Intermediate commissioning shall be undertaken for each phase of works where new installations connect to the live systems serving the facility, in accordance with Section 01 91 13.13 Commissioning Plan.
- .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 - Submittal Procedures.
  - .1 Submit no later than 4 weeks after award of Contract:
    - .1 Name of Contractor's Cx agent.
    - .2 Draft Cx documentation.
    - .3 Preliminary Cx schedule.
  - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 6 weeks prior to start of the first Cx activities within the phased works.
  - .3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 8 weeks prior to start of Cx.
  - .4 Provide additional documentation relating to Cx process required by Departmental Representative.

#### **1.8 COMMISSIONING DOCUMENTATION**

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Departmental Representative.

#### **1.9 COMMISSIONING SCHEDULE**

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .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 16.19 - Construction Progress Schedule - Bar (GANTT) Chart 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 40% construction completion stage 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 Cx Agent, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 40% 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 21 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.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
  - .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
  - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
  - .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
    - .1 Rejected equipment to be remove from site and replace with new.

- .2 Subject new equipment/systems to specified start-up procedures.

#### **1.15 START-UP DOCUMENTATION**

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

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

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit 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 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

#### **1.19 INSTRUMENTS/EQUIPMENT**

- .1 Submit to Departmental Representative for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.

- .3 Equipment as required to complete work.

#### **1.20 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx:
  - .1 Under 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.

#### **1.21 WITNESSING COMMISSIONING**

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

#### **1.22 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.

#### **1.23 EXTRAPOLATION OF RESULTS**

- .1 Cx of the new systems cannot be conducted under near-rated or near-design conditions. The contractor shall extrapolate part-load results to design conditions when approved by Departmental Representative in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae. The contractor shall then perform seasonal commissioning for peak summer and peak winter design conditions.

#### **1.24 EXTENT OF VERIFICATION**

- .1 All areas:
  - .1 Provide manpower and instrumentation to verify up to 100% of reported results.
- .2 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .3 Review and repeat commissioning of systems if inconsistencies found in more than 10% of reported results.
- .4 Perform additional commissioning until results are acceptable to Departmental Representative.

**1.25 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.

**1.26 SUNDRY CHECKS AND ADJUSTMENTS**

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

**1.27 DEFICIENCIES, FAULTS, DEFECTS**

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

**1.28 COMPLETION OF COMMISSIONING**

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities 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.

**1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

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

**1.30 TRAINING**

- .1 In accordance with Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

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

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

**1.32 OCCUPANCY**

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



**1.33 INSTALLED INSTRUMENTATION**

- .1 Use instruments installed under Contract for TAB and PV if:
  - .1 Accuracy complies with these specifications.
  - .2 Calibration certificates have been deposited with Departmental Representative.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

**1.34 PERFORMANCE VERIFICATION TOLERANCES**

- .1 Application tolerances:
  - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.
- .2 Instrument accuracy tolerances:
  - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
  - .1 Unless otherwise specified actual values to be within +/- 2% of recorded values.

**1.35 DEPARTMENTAL REPRESENTATIVE'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            SUMMARY**

- .1    Section Includes:
  - .1    Description of overall structure of Plan and roles and responsibilities of commissioning team.

**1.2            REFERENCE STANDARDS**

- .1    Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2    American Water Works Association (AWWA)
- .3    Public Works and Government Services Canada (PWGSC)
  - .1    PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
- .4    Underwriters' Laboratories of Canada (ULC)
- .5    CSA Standards – CSA Z320-11.

**1.3            GENERAL**

- .1    Provide a fully functional facility:
  - .1    Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
  - .2    Facility user and O&M personnel have been fully trained in aspects of installed systems.
  - .3    Optimized life cycle costs.
  - .4    Complete documentation relating to installed equipment and systems.
  - .5    Commissioning activities shall be undertaken throughout the project as described within this section for the phasing of the project to ensure the facility remains operational at all times with minimal disruption to provide connections / modifications to the existing system.
- .2    Term "Cx" in this section means "Commissioning".
- .3    Use this Cx Plan as master planning document for Cx:
  - .1    Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
  - .2    Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
  - .3    Sets out deliverables relating to O&M, process and administration of Cx.
  - .4    Describes process of verification of how built works meet Departmental Representative's requirements.
  - .5    Produces a complete functional system prior to issuance of Certificate of Occupancy.

- .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
  - .1 Overview of Cx.
  - .2 General description of elements that make up Cx Plan.
  - .3 Process and methodology for successful Cx.
- .7 The contractor shall ensure the following aspects are accounted for when developing the Cx Plan:
  - .1 The design conditions within the vaults must be maintained throughout the commissioning stages of the project.
  - .2 Media must remain in place and cannot be removed during testing.
  - .3 Commissioning will not necessarily take place at the 'design' conditions at peak winter and summer months. Seasonal commissioning activities are required to ensure adequate operation of the systems after completion of the project.
  - .4 It is not possible to provide an artificial load to the vaults while the systems are being commissioned (heat and moisture) due to the increased risk to the media.
  - .5 Main items of plant are required to be factory tested to the design conditions prior to delivery to site.
- .4 Acronyms:
  - .1 Cx - Commissioning.
  - .2 BMM - Building Management Manual.
  - .3 EMCS - Energy Monitoring and Control Systems.
  - .4 WHMIS Safety Data Sheets (SDS).
  - .5 PI - Product Information.
  - .6 PV - Performance Verification.
  - .7 TAB - Testing, Adjusting and Balancing.
  - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
  - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
  - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

#### **1.4 DEVELOPMENT OF 100% CX PLAN**

- .1 Cx Plan to be 95% completed before added into Project Specifications.
- .2 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
  - .1 Approved shop drawings and product data.
  - .2 Approved changes to contract.
  - .3 Project phasing.
  - .4 Contractor's project schedule.
  - .5 Cx schedule.

- .6 Contractor's, sub-contractor's, suppliers' requirements.
- .7 Project construction team's and Cx team's requirements.
- .3 Submit completed Cx Plan to Departmental Representative and obtain written approval.

#### **1.5 REFINEMENT OF CX PLAN**

- .1 During construction phase, revise, refine and update Cx Plan to include:
  - .1 Changes resulting from Client program modifications.
  - .2 Approved design and construction changes.
  - .3 Phasing strategy changes proposed by the Contractor and accepted by the Departmental Representative.
- .2 Revise, refine and update every 2 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

#### **1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM**

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
  - .1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
  - .2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
    - .1 Review of Cx documentation from operational perspective.
    - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
    - .3 Protection of health, safety and comfort of occupants and O&M personnel.
    - .4 Monitoring of Cx activities, training, development of Cx documentation.
    - .5 Work closely with members of Cx Team.
  - .3 Departmental Representative is responsible for:
    - .1 Organizing Cx.
    - .2 Monitoring operations Cx activities.
    - .3 Witnessing, certifying accuracy of reported results.
    - .4 Witnessing and certifying TAB and other tests.
    - .5 Developing BMM.
    - .6 Ensuring implementation of final Cx Plan.
    - .7 Performing verification of performance of installed systems and equipment.

- .8 Implementation of Training Plan.
- .4 Construction Team: contractor, subcontractors, suppliers and support disciplines, is responsible for construction/installation in accordance with Contract Documents, including:
  - .1 Testing.
  - .2 TAB.
  - .3 Performance of Cx activities.
  - .4 Delivery of training and Cx documentation.
  - .5 Assigning one person as point of contact with Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
  - .1 Demonstrations.
  - .2 Training.
  - .3 Testing.
  - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
  - .1 Receiving facility.
  - .2 Day-To-Day operation and maintenance of facility.

## **1.7 CX PARTICIPANTS**

- .1 Employ the following Cx participants to verify performance of equipment and systems:
  - .1 Installation contractor/subcontractor:
    - .1 Equipment and systems except as noted.
  - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
    - .1 To include performance verification.
  - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
  - .4 Specialist Cx agency:
    - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
  - .5 Client: responsible for intrusion and access security systems.
  - .6 Ensure that Cx participant:
    - .1 Could complete work within scheduled time frame.
    - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
      - .1 Modify ventilation rates to meet changes in off-gassing.

- .2 Changes to heating or cooling loads beyond scope of EMCS.
- .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
- .4 Redistribution of electrical services.
- .5 Modifications of fire alarm systems.
- .6 Modifications to voice communications systems.
- .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

## **1.8 EXTENT OF CX**

- .1 Commissioning activities shall take place in accordance with phasing strategy described within Section 01 32 16.19 Construction Progress Schedule – Bar (GANTT) Chart. Commission mechanical systems and associated equipment in accordance with the following (list not exhaustive, provided to give starting point for Contractor / Cx specialist to develop):
  - .1 Plant items to be factory tested prior to delivery to site:
    - .1 Air handling units – Factory test to prove:
      - .1 Air leakage
      - .2 Fan capacity
      - .3 Performance of thermal wheel
      - .4 Heating and cooling coil performance
      - .5 Dehumidification performance.
    - .2 Chillers – factory test to prove:
      - .1 Peak output performance
      - .2 Co-efficient of performance
      - .3 Part load operation
    - .3 Controls – factory test to prove:
      - .1 Functional operation of panel
      - .2 Software operational
      - .3 Bench test
  - .2 On-site commissioning:
    - .1 Validation of vault air volumes at the end of each day when vaults are switched over to the proposed new ductwork main branches.
    - .2 Commissioning validation to prove existing air handling units can serve entire facility when one half of the existing plant is stripped out.
    - .3 Set-up and commission 2 No. new chillers and dry air cooler.
    - .4 Initial set-up and commissioning of new ventilation plant installed to temporarily serve the existing facility in its entirety whilst other half of existing plant is removed, and new plant installed (includes chilled water and LTHW heating commissioning).
    - .5 Set-up and commissioning of new ventilation plant serving the main storage vaults to final commissioning figures in line with design

- requirements (including all LTHW heating and CHW cooling commissioning).
- .6 Set-up and commissioning of humidifiers for all new zones.
- .7 Set-up and commissioning of all new controls for the new systems, including full point to point operation, fault, soak test, calibration etc.
- .8 Set-up of acclimatization vaults air handling unit to final design requirements.
- .9 Final commissioning of all new chilled water plant to serve all new equipment.
- .3 Seasonal commissioning:
  - .1 Winter and summer seasonal commissioning works based on performance of new systems installed.
- .2 Commission electrical systems and equipment:
  - .1 Low voltage below 750 V:
    - .1 Low voltage distribution systems.
  - .2 Lighting systems:
    - .1 Lighting equipment.
    - .2 Distribution systems.
    - .3 Emergency lighting systems, including battery packs.
    - .4 Fire exit emergency signage.

## **1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES**

- .1 General requirements:
  - .1 Compile English and French documentation.
  - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
  - .1 Warranties.
  - .2 Project record documentation.
  - .3 Inventory of spare parts, special tools and maintenance materials.
  - .4 Maintenance Management System (MMS) identification system used.
  - .5 WHMIS information.
  - .6 WHMIS Safety Data Sheets (SDS).
  - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

## **1.10 DELIVERABLES RELATING TO THE CX PROCESS**

- .1 General:
  - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:

- .1 Cx as used in this section includes:
  - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
  - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
  - .1 Cx Specifications.
  - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
  - .3 Completed installation checklists (ICL).
  - .4 Completed product information (PI) report forms.
  - .5 Completed performance verification (PV) report forms.
  - .6 Results of Performance Verification Tests and Inspections.
  - .7 Description of Cx activities and documentation.
  - .8 Description of Cx of integrated systems and documentation.
  - .9 Tests of following witnessed by PWGSC Design Quality Review Team:
    - .1 All proposed installations.
  - .10 Tests performed by User.
  - .11 Training Plans.
  - .12 Cx Reports.
  - .13 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.

#### **1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION**

- .1 Items listed in this Cx Plan include the following:
  - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
  - .2 Departmental Representative to use approved check lists.
  - .3 Departmental Representative will monitor some of these pre-start-up inspections.
  - .4 Include completed documentation with Cx report.
  - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
  - .6 Departmental Representative will monitor some of these inspections and tests.
  - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
  - .1 Plumbing systems:
    - .1 "Bump" each item of equipment in its "stand-alone" mode.
    - .2 Complete pre-start-up checks and complete relevant documentation.



- .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
  - .2 HVAC equipment and systems:
    - .1 Ensure the facility is maintained at design condition, or downtime is limited to a number of hours while commissioning takes place.
    - .2 "Bump" each item of equipment in its "stand-alone" mode.
    - .3 At this time, complete pre-start-up checks and complete relevant documentation.
    - .4 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
    - .5 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
  - .3 EMCS:
    - .1 EMCS trending to be available as supporting documentation for performance verification.
    - .2 Perform point-by-point testing in parallel with start-up.
    - .3 Carry out point-by-point verification.
    - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
    - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
    - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .3 Pre-Cx activities - ELECTRICAL:
  - .1 Low voltage distribution systems under 750 V:
    - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
  - .2 Lighting systems:
    - .1 Emergency lighting systems:  
Tests to include verification of lighting levels and coverage, initially  
By disrupting normal power.
  - .3 Low voltage systems: these include:
    - .1 Low voltage lighting control systems and data communications systems.

## **1.12 START-UP**

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
  - .1 Air handling units.
  - .2 Chillers.
  - .3 Dry air cooler.
  - .4 Dehumidification plant.

- .5 Humidifiers.
- .3 Departmental Representative to monitor some of these start-up activities.
  - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Performance Verification (PV):
  - .1 Approved Cx Agent to perform.
    - .1 Repeat when necessary until results are acceptable to Departmental Representative.
  - .2 Use procedures modified generic procedures to suit project requirements.
  - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.
  - .4 Departmental Representative to approve completed PV reports and provide to Departmental Representative.
  - .5 Departmental Representative reserves the right to verify up to 30 % of reported results at random.
  - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

#### **1.13 CX ACTIVITIES AND RELATED DOCUMENTATION**

- .1 Perform Cx by specified Cx agency using procedures developed by Departmental Representative and approved by Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Departmental Representative to witness, certify reported results of, Cx activities and forward to Departmental Representative.
- .5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

#### **1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION**

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative and approved by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Departmental Representative and submitted to Departmental Representative for review.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Identification:
  - .1 In later stages of Cx, before hand-over and acceptance Contractor, Departmental Representative, and Cx Manager to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

**1.15            INSTALLATION CHECK LISTS (ICL)**

- .1        Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

**1.16            PRODUCT INFORMATION (PI) REPORT FORMS**

- .1        Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

**1.17            PERFORMANCE VERIFICATION (PV) REPORT**

- .1        Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

**1.18            DELIVERABLES RELATING TO ADMINISTRATION OF CX**

- .1        General:
  - .1        Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

**1.19            CX SCHEDULES**

- .1        Prepare detailed Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
  - .1        Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
    - .1        Design criteria, design intents.
    - .2        Pre-TAB review: 28 days after contract award, and before construction starts.
    - .3        Cx agents' credentials: 2 months before start of any Cx works.
    - .4        Cx procedures: 3 months after award of contract.
    - .5        Cx Report format: 3 months after contract award.
    - .6        Discussion of heating/cooling/dehumidification loads for Cx: 3 months before start-up.
    - .7        Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
    - .8        Notification of intention to start TAB: 21 days before start of TAB.
    - .9        TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
    - .10      Notification of intention to start Cx: 14 days before start of Cx.
    - .11      Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
    - .12      Identification of deferred Cx.
    - .13      Implementation of training plans.
    - .14      Cx reports: immediately upon successful completion of Cx.

- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Departmental Representative.
- .3 12 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

#### **1.20 CX REPORTS**

- .1 Submit reports of tests, witnessed and certified by Departmental Representative to Departmental Representative who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.

#### **1.21 ACTIVITIES DURING WARRANTY PERIOD**

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
  - .1 Fine tuning of HVAC systems.

#### **1.22 TRAINING PLANS**

- .1 Refer to Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

#### **1.23 FINAL SETTINGS**

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

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

**1.2 INSTALLATION/START-UP CHECK LISTS**

- .1 Include the following data:
  - .1 Product manufacturer's installation instructions and recommended checks.
  - .2 Special procedures as specified in relevant technical sections.
  - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

**1.3 PRODUCT INFORMATION (PI) REPORT FORMS**

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

**1.4 PERFORMANCE VERIFICATION (PV) FORMS**

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

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

#### **1.5 SAMPLES OF COMMISSIONING FORMS**

Departmental Representative will develop and provide to Contractor required project-specific Commissioning forms in electronic format.

- .1 Revise items on Commissioning forms to suit project requirements.
- .2 Complete all forms missing information and provide all the required forms that are not attached but required for this project.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

#### **1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS**

- .1 When additional forms are required, but are not available from Departmental Representative develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
  - .1 Additional commissioning forms to be in same format as provided by Departmental Representative.

#### **1.7 COMMISSIONING FORMS**

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
  - .1 Departmental Representative provides Contractor project-specific Commissioning forms with Specification data included.
  - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
  - .3 Confirm operation as per design criteria and intent.
  - .4 Identify variances between design and operation and reasons for variances.
  - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
  - .6 Record analytical and substantiating data.
  - .7 Verify reported results.
  - .8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative.
  - .9 Submit immediately after tests are performed.
  - .10 Reported results in true measured SI unit values.
  - .11 Provide Departmental Representative with originals of completed forms.
  - .12 Maintain copy on site during start-up, testing and commissioning period.
  - .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual in accordance with Section 01 92 00 - Facility Operation.

**1.8 LANGUAGE**

- .1 To suit the language profile of the awarded 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 RELATED WORK**

- .1 Fire stopping and smoke seals within Mechanical assemblies (i.e. inside ducts, dampers) and Electrical assemblies (i.e. inside cable trays) are specified in Mechanical and Electrical portions of the Specifications respectively.

**1.2 REFERENCES**

- .1 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S115-05. Standard Method of Fire Tests of Firestop Systems.

**1.3 SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit duplicate 300 x 300 mm samples showing actual firestop material proposed for project.
- .3 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- .4 Submit manufacturer's product data sheets for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction / Demolition Waste Management.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Fire stopping and smoke seal systems: in accordance with ULC-S115.
  - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended and conforming to special requirements specified in 3.5.
  - .2 Firestop system rating: to match fire resistance rating of wall and floor assembly as indicated in the drawings.



- .2 Service penetration assemblies: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No.40 U19.
- .3 Service penetration firestop components: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No.40 U19.13 and ULC Guide No.40 U19.15 under the Label Service of ULC.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with National Building Code (NBC) 2015.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .10 Sealants for vertical joints: non-sagging.
- .11 Firestop sealants: non-sagging, primerless, single component, self-leveling silicone sealant.
- .12 Firestop insulation: pre-formed, semi-rigid, non-combustible mineral wool, precut into 1220 mm lengths to required depth and width.
- .13 Junction box/outlet sealing putty: intumescent putty, preformed in pads.

### **Part 3 Execution**

#### **3.1 PREPARATION**

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare all existing openings in walls of existing electrical and mechanical rooms to receive firestopping. For large openings and penetrations, install steel stud framing, batt insulation and 15.9 mm Type X GWB to both sides of walls, prior to firestopping remainder of opening.
- .3 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .4 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

### **3.2 INSTALLATION**

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
- .2 Install around pipe, ductwork, cables, and other objects penetrating fire separations to provide fire resistance not less than the fire resistance rating of surrounding floor, ceiling and wall assembly.
- .3 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .4 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .5 Tool or trowel exposed surfaces to a neat finish.
- .6 Remove excess compound promptly as work progresses and upon completion.
- .7 Install firestop insulation as required and where indicated to form complete firestop and smoke seal. Install as backup material where required to areas receiving firestop sealant.
- .8 Install firestop sealant to areas indicated, ensure full depth of joint filled with material, remove excess immediately.
- .9 Seal around electrical boxes and outlets with sealing putty in accordance with manufacturer's instructions.

### **3.3 INSPECTION**

- .1 Notify Departmental Representative when ready for inspection and prior to concealing or enclosing firestopping materials and service penetration assemblies.

### **3.4 SCHEDULE**

- .1 Firestop and smoke seal at:
  - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  - .2 Top of fire-resistance rated masonry and gypsum board partitions.
  - .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
  - .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  - .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  - .6 Openings and sleeves installed for future use through fire separations.
  - .7 Around mechanical and electrical assemblies penetrating fire separations.
  - .8 Rigid ducts: greater than 129 cm<sup>2</sup>: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

**3.5 CLEAN UP**

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.
- .2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

**END OF SECTION**

**Part 1 General**

**1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for all above ground drainage pipework and fittings 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 Ontario, 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.

**1.2 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

**1.3 MAINTENANCE MATERIAL SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

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

**Part 2            Products**

**2.1            NOT USED**

- .1       Not used.

**Part 3            Execution**

**3.1            SYSTEM CLEANING**

- .1       Clean and flush interior and clean exterior of all plumbing systems including traps and strainers.

**3.2            FIELD QUALITY CONTROL**

- .1       Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 -ACTION AND INFORMATIONAL SUBMITTALS.
  - .1       Pressure testing of all new drainage systems serving new plant..
- .2       Manufacturer's Field Services:
  - .1       Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2       Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

**3.3            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.

**3.4            CLEANING**

- .1       Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1       Leave Work area clean at end of each day.
- .2       Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**3.5 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 This Section includes requirements for selective demolition and removal of plumbing and related mechanical components and incidentals required to complete work described in this Section.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 CSA Group (CSA)
  - .1 CSA S350 M1980, Code of Practice for Safety in Demolition of Structures.

**1.3 DEFINITIONS**

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Remove and Salvage: Detach items from existing construction and deliver them to Departmental Representative ready for reuse.
- .4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Action Submittals: Provide the following in accordance with Section 01 33 00- Submittal Procedures before starting work of this Section.

**1.5 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for Departmental Representatives-'s continued occupancy requirements during selective demolition and schedule staged occupancy and worksite

activities as a defined Activity in Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.

## **1.6 QUALITY ASSURANCE**

- .1 Regulatory Requirements: Perform work of this Section in accordance with the following:
  - .1 Provincial/Territorial Workers' Compensation Boards/Commissions
  - .2 Provincial/Territorial Occupational Health and Safety Standards and Programs

## **1.7 SITE CONDITIONS**

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.
- .2 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform the following activities:
  - .1 Refer to Section 01 41 00- Regulatory Requirements for directives associated with specific material types.
  - .2 Hazardous substances will be as defined in the Hazardous Products Act.
  - .3 Stop work in the area of the suspected hazardous substances.
  - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
  - .5 Hazardous substances will be removed by Contractor under a separate contract or as a change to the Work.
  - .6 Proceed only after written instructions have been received from Departmental Representative.

## **1.8 SALVAGE AND DEBRIS MATERIALS**

**Part 2 Demolished items become Contractor's property and will be removed from Project site; Products**

## **2.1 MATERIALS**

- .1 Plumbing Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.
- .2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.



**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

**3.2 PREPARATION**

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
  - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
  - .3 Prevent debris from blocking drainage inlets.
  - .4 Protect mechanical systems that must remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:
  - .1 Prevent debris from endangering the safe access to and egress from occupied buildings.
  - .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

**3.3 EXECUTION**

- .1 Removal: Coordinate requirements of this Section as follows:
  - .1 Disconnect and cap mechanical services in accordance with requirements of local Authority Having Jurisdiction.
  - .2 Remove redundant mechanical services back to a suitable tee / connection to ensure dead legs are kept to a minimum.
  - .3 Do not disrupt active or energized utilities without approval of the Departmental Representative.
  - .4 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.
  - .5 Demolish parts of existing building to accommodate new construction and remedial work as indicated.
  - .6 At end of each day's work, leave worksite in safe condition.
  - .7 Perform demolition work in a neat and workmanlike manner:

- .1 Remove any tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
- .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

### **3.4 CLOSEOUT ACTIVITIES**

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre).

**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1      Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2      Section 23 05 23.01 - Valves – Bronze.
- .3      Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

**1.2            REFERENCE STANDARDS**

- .1      Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2      American Society of Mechanical Engineers International (ASME)
  - .1      ANSI/ASME B16.15-13, Cast Copper Alloy Threaded Fittings, Classes 125 and 250.
  - .2      ANSI/ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3      ANSI/ASME B16.22-13, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - .4      ANSI/ASME B16.24-11, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
  - .5      ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
  - .6      ASME B31.9-14, Building Services Piping.
- .3      ASTM International (ASTM)
  - .1      ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .2      ASTM A351/A351M-16, Castings, Austenitic, for Pressure Containing Parts.
  - .3      ASTM B32-08 (2014), Standard Specification for Solder Metal.
  - .4      ASTM B42-15a, Seamless Copper Tube, Standard Sizes.
  - .5      ASTM B88M-14, Standard Specification for Seamless Copper Water Tube (Metric).
- .4      CSA Group (CSA)
  - .1      CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5      Underwriters Laboratories of Canada (ULC)
  - .1      CAN/ULC S101-07, Fire Endurance Tests of Buildings Construction and Materials.
  - .2      CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.
  - .3      CAN/ULC S115-11, Standard Method of Fire Tests of Firestop.
- .6      Department of Justice Canada (Jus)
  - .1      Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

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

.1 Safety Data Sheets (SDS).

.8 National Research Council (NRC)

.1 National Plumbing Code of Canada (NPC) 2015.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Closeout Submittals:

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

### **1.4 DELIVERY, STORAGE AND HANDLING**

.1 Packaging Waste Management: remove for recycling of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Place materials defined as hazardous or toxic in designated containers.

## **Part 2 Products**

### **2.1 PIPING**

.1 Domestic hot, cold and recirculation systems, within building.

.1 Above ground:

.1 Copper tube, hard drawn, type L: to ASTM B88M.

### **2.2 FITTINGS**

.1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.5 NPS 2 and larger:

.1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.

.6 NPS 1 ½ and smaller:

.1 Wrought copper to ANSI/ASME B16.22; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.

## **2.3 JOINTS**

- .1 Rubber gaskets, 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5 tin copper alloy.
- .4 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

## **2.4 BALL VALVES**

- .1 NPS 2 and under, soldered:
  - .1 To ANSI/ASME B16.18, Class 150.
  - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves – Bronze.

## **Part 3 Execution**

### **3.1 APPLICATION**

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

### **3.2 INSTALLATION**

- .1 Install in accordance with local authority having jurisdiction.
- .2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .6 Valves
  - .1 Isolate equipment, fixtures and branches with ball valves.

### **3.3 PRESSURE TESTS**

- .1 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

### **3.4 FLUSHING AND CLEANING**

- .1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is

clean to Provincial potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

### **3.5 PRE-START-UP INSPECTIONS**

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

### **3.6 DISINFECTION**

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction and approval of Departmental Representative.
- .2 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

### **3.7 START-UP**

- .1 Timing: start up after:
  - .1 Pressure tests have been completed.
  - .2 Disinfection procedures have been completed.
  - .3 Certificate of static completion has been issued.
  - .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
  - .1 Establish circulation and ensure that air is eliminated.
  - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
  - .3 Bring HWS storage tank up to design temperature slowly.
  - .4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.
  - .5 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

### **3.8 PERFORMANCE VERIFICATION**

- .1 Scheduling:
  - .1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.
- .2 Procedures:
  - .1 Verify that flow rate and pressure meet Design Criteria.

- .2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
- .4 Sterilize HWS and HWC systems for Legionella control.
- .5 Verify performance of temperature controls.
- .6 Verify compliance with safety and health requirements.
- .7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
- .8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.
- .3 Reports:
  - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
  - .2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

### **3.9 OPERATION REQUIREMENTS**

- .1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2 Operational requirements include:
  - .1 Cleaning materials and schedules.
  - .2 Repair and maintenance materials and instructions.

### **3.10 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 15 - Common installation requirements for HVAC pipework

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASTM International (ASTM)
  - .1 ASTM B32-08, Standard Specification for Solder Metal.
  - .2 ASTM B306-02, Standard Specification for Copper Drainage Tube (DWV).
  - .3 ASTM C564-03a, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .3 CSA Group (CSA)
  - .1 CSA B67-1972 (R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
  - .2 CAN/CSA-B70-06, Cast Iron Soil Pipe, Fittings and Means of Joining.
  - .3 CAN/CSA-B125.3-05, Plumbing Fittings.
- .4 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-36-00, Commercial Adhesives.
- .5 National Research Council Canada (NRC)
  - .1 National Plumbing Code of Canada 2015 (NPC).
- .6 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 DELIVERY, STORAGE AND HANDLING**

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



- .3 Packaging Waste Management: remove for recycling packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 COPPER TUBE AND FITTINGS**

- .1 Above ground sanitary and vent Type DWV to: ASTM B306.
  - .1 Fittings.
    - .1 Cast brass: to CAN/CSA-B125.3.
    - .2 Wrought copper: to CAN/CSA-B125.3.

### **2.2 CAST IRON PIPING AND FITTINGS**

- .1 Above ground sanitary and vent: to CAN/CSA-B70.
  - .1 Joints:
    - .1 Hub and spigot:
      - .1 Caulking lead: to CSA B67.
    - .2 Mechanical joints:
      - .1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

## **Part 3 Execution**

### **3.1 APPLICATION**

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

### **3.2 INSTALLATION**

- .1 In accordance with Section 23 05 15 - Common installation requirements for HVAC pipework.
- .2 Install in accordance with National Plumbing Code

### **3.3 TESTING**

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.

### **3.4 PERFORMANCE VERIFICATION**

- .1 Cleanouts:
  - .1 Ensure accessible and that access doors are correctly located.
  - .2 Open, cover with linseed oil and re-seal.

- .3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- .4 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

### **3.5**

#### **CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 15 - Common installation requirements for HVAC pipework.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International (ASTM)
  - .1 ASTM D2235- 04, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
  - .2 ASTM D2564- 04e1, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 CSA Group (CSA)
  - .1 CAN/CSA-Series B1800- 06, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.
- .3 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-36- 00, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS).
- .5 National Research Council Canada (NRC)
  - .1 National Plumbing Code of Canada 2015 (NPC).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for recycling packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 PIPING AND FITTINGS**

- .1 For above ground DWV piping to:
  - .1 CAN/CSA B1800.

**2.2 JOINTS**

- .1 Solvent weld for PVC: to ASTM D2564.
- .2 Solvent weld for ABS: to ASTM D2235.

**Part 3 Execution**

**3.1 APPLICATION**

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

**3.2 INSTALLATION**

- .1 In accordance with Section 23 05 15 - Common installation requirements for HVAC pipework.
- .2 Install in accordance with National Plumbing Code.

**3.3 TESTING**

- .1 Hydraulically test to verify grades and freedom from obstructions.

**3.4 PERFORMANCE VERIFICATION**

- .1 Cleanouts:
  - .1 Ensure accessible and that access doors are correctly located.
  - .2 Open, cover with linseed oil and re-seal.
  - .3 Verify cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Storm water drainage:
  - .1 Verify domes are secure.
  - .2 Ensure weirs are correctly sized and installed correctly.
  - .3 Verify provisions for movement of roof system.
- .4 Ensure fixtures are properly anchored, connected to system and effectively vented.
- .5 Affix applicable label (storm, sanitary, vent, pump discharge) c/w directional arrows every floor or 4.5 m (whichever is less).

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Use of mechanical systems during construction.
- .2 Related Requirements
  - .1 Section 01 32 16.19 Construction Progress Schedule – Bar (GANTT) Chart.

**1.2 USE OF SYSTEMS**

- .1 Use of new / existing permanent ventilating / heating / cooling systems for supplying temporary ventilation / heat / cooling to the mechanical plant room is permitted only under following conditions:
  - .1 As required in accordance with phasing strategy, described within Section 01 32 16.19 Construction Progress Schedule – Bar (GANTT) Chart.
  - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
  - .3 Areas to be heated/ventilated/cooled are clean and will not thereafter be subjected to dust-producing processes.
  - .4 There is no possibility of damage.
  - .5 Supply ventilation systems are inspected daily, filters changed every 4 weeks or more frequently as required.
  - .6 Return systems have approved filters over openings, inlets, outlets.
  - .7 Systems will be:
    - .1 Operated as per manufacturer's recommendations and instructions.
    - .2 Operated by Contractor.
    - .3 Monitored continuously by Contractor.
  - .8 Warranties and guarantees are not relaxed.
  - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
  - .10 Clean entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                PROJECT PHASING**

- .1        The existing ventilation and cooling systems shall be removed as indicated on the tender drawings. Where existing equipment is to be retained to continue to serve the existing facility the contractor shall:
  - .1        Monitor each item of plant daily to ensure its operation has not been compromised by its change of use or any works being undertaken.
- .2        The contractor shall demonstrate at the end of each phase the works completed within the phase have been commissioned / balanced to written approval of Departmental Representative prior to moving on to the next phase. This demonstration works shall not hold up any enabling / initial works able to be completed in the next phase without demonstration.

**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1    Section 01 33 00 – Submittal Procedures.
- .2    Section 01 45 00 – Quality Control.
- .3    Section 01 61 00 – Common Product Requirements.
- .4    Section 01 74 00 – Cleaning.
- .5    Section 01 78 00 – Closeout Submittals.
- .6    Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
- .7    Section 25 – Appendix 1 Controls In/Out Table

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for all proposed new equipment including but not limited to air handling units, dehumidifiers, chillers, dry air cooler, pumps, valves etc. 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 Ontario, 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 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for all proposed new equipment for the project, including but not limited to air handling units, dehumidifiers, chillers, dry air cooler, pumps, valves etc. for incorporation into manual.



- .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
- .2 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .3 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
  - .1 Submit 2 hard copies and an electronic copy of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information bi-weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.

- .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
  - .1 One set of packing for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One glass for each gauge glass.
  - .4 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 manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect all new components from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

**1.6 REFERENCE TO CONTROLS**

- .1 The contractor shall read all HVAC drawings and specifications in conjunction with Section 25 – Appendix 1 Controls In/Out Table to ensure all required control points are included within the scheme.

**Part 2 Products**

**2.1 MATERIALS**

- .1 HVAC and R Equipment:
  - .1 Refrigerant:
    - .1 HFO based refrigerant.

**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 new equipment and services distribution installations in accordance with manufacturer's written instructions.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**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 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

**3.4 DEMONSTRATION**

- .1 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.
- .2 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .3 Instruction duration time requirements as specified in appropriate sections.
- .4 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 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**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 This Section includes requirements for selective demolition and removal of heating, ventilation and air conditioning systems, controls and automated automation components, and related mechanical components and incidentals required to complete work described in this Section ready for the installation of new replacement plant / systems..

**1.2 RELATED REQUIREMENTS**

- .1 Section 01 32 16.19 – Construction Progress Schedule - Bar (GANTT) Chart.
- .2 Section 01 33 00 – Submittal Procedures.
- .3 Section 22 05 05 – Selective Demolition for Plumbing
- .4 Section 26 05 05 – Selective Demolition for Electrical

**1.3 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 CSA Group (CSA)
  - .1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures.

**1.4 DEFINITIONS**

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Remove and Salvage: Detach items from existing construction and deliver them to Departmental Representative ready for reuse.
- .4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

**1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Action Submittals: Provide in accordance with Section 01 33 00 - Submittal Procedures before starting work of this Section.

**1.6 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for Departmental Representative's continued occupancy requirements during selective demolition and schedule staged worksite activities as a defined in Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.

**1.7 QUALITY ASSURANCE**

- .1 Regulatory Requirements: Perform work of this Section in accordance with the following
  - .1 Provincial/Territorial Workers' Compensation Boards/Commissions.
  - .2 Provincial/Territorial Occupational Health and Safety Standards and Programs.

**1.8 SITE CONDITIONS**

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.

**1.9 SALVAGE AND DEBRIS MATERIALS**

- .1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Departmental Representative's property.

**Part 2 Products**

**2.1 MATERIAL**

- .1 HVAC Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.
- .2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials

necessary for proper execution and completion of the contract that could have been determined by a site visit.

### **3.2 PREPARATION**

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
  - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
  - .3 Prevent debris from blocking drainage inlets.
  - .4 Protect mechanical systems that must remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:
  - .1 Prevent debris from endangering the safe access to and egress from occupied buildings.
  - .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

### **3.3 EXECUTION**

- .1 Removal: As follows:
  - .1 Disconnect and cap gas supply and electrical services in accordance with requirements of local Authority Having Jurisdiction.
  - .2 Do not disrupt active or energized utilities without approval of the Departmental Representative.
  - .3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.
  - .4 At end of each day's work, leave worksite in safe condition.
  - .5 Perform demolition work in a neat and workmanlike manner:
    - .1 Remove any tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
    - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

### **3.4 CLOSEOUT ACTIVITIES**

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re use in new systems..

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Electrical motors, drives and guards for mechanical equipment and systems.
  - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
  - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.
  - .4 Sustainable requirements for construction and verification.
- .2 Related Requirements
  - .1 Section 01 33 00 – Submittal Procedures.
  - .2 Section 01 35 29.06 – Health and Safety Requirements
  - .3 Section 01 45 00 – Quality Control.
  - .4 Section 01 61 00 – Common Product Requirements.
  - .5 Section 01 74 00 – Cleaning.
  - .6 Section 01 74 19 – Waste Management and Disposal.
  - .7 Section 01 78 00 – Closeout Submittals.
  - .8 Section 23 34 00 – HVAC Fans.

**1.2 REFERENCE STANDARDS**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-01, 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 Safety Data Sheets (SDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.

- .1 Departmental Representative will make available electronic copy of systems supplier's installation instructions.
  - .3 Closeout Submittals
    - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- 1.4 QUALITY ASSURANCE**
  - .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations and CEPA.
  - .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.5 DELIVERY, STORAGE, AND HANDLING**
  - .1 Packing, shipping, handling and unloading:
    - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
    - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .2 Waste Management and Disposal:
    - .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- Part 2 Products**
  - 2.1 GENERAL**
    - .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.
  - 2.2 MOTORS**
    - .1 Provide motors for mechanical equipment as specified.
    - .2 Motors under 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.

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**Part 3            Execution**

**3.1            MANUFACTURER'S INSTRUCTIONS**

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

**3.2            INSTALLATION**

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

**3.3            FIELD QUALITY CONTROL**

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

**3.4            CLEANING**

- .1        Proceed in accordance with Section 01 74 00 - Cleaning.
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1        Section 07 84 00 – Fire Stopping.
- .2        Section 07 92 00 – Joint Sealants.
- .3        Section 23 08 16 – Cleaning and Start-Up of HVAC Piping Systems.

**1.2            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .3        Green Seal Environmental Standards (GSES)
  - .1        Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4        National Research Council Canada (NRC)
  - .1        National Fire Code of Canada 2015 (NFC).

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4            QUALITY ASSURANCE**

**1.5            DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements:
  - .1        Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3        Packaging Waste Management: remove for reuse by manufacturer of pallets padding crates packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

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**Part 2            Products**

**2.1            MATERIAL**

- .1    Paint: zinc-rich to CAN/CGSB-1.181.
  - .1       Primers: Red oxide paint for steel pipework in accordance with manufacturer's recommendations for surface conditions.
- .2    Sealants: in accordance with Section 07 92 00 - Joint Sealants.
- .3    Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

**Part 3            Execution**

**3.1            APPLICATION**

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

**3.2            CONNECTIONS TO EQUIPMENT**

- .1    In accordance with manufacturer's instructions unless otherwise indicated.
- .2    Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3    Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

**3.3            CLEARANCES**

- .1    Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .2    Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

**3.4            DRAINS**

- .1    Install piping with grade in direction of flow except as indicated.
- .2    Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3    Pipe each drain valve discharge separately to above floor drain.
  - .1       Discharge to be visible.
- .4    Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

### **3.5 AIR VENTS**

- .1 Install manual air vents in piping systems at high points.
- .2 Install isolating valve at each automatic air valve (automatic air vents to only be considered for installation if there is no space / it is not practical to install a manual air vent. The Contractor shall agree with Departmental Representative locations of automatic air vents where necessary).
- .3 Install drain piping to approved location and terminate where discharge is visible.

### **3.6 DIELECTRIC COUPLINGS**

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

### **3.7 PIPEWORK INSTALLATION**

- .1 Install pipework to the National Plumbing Code of Canada 2015..
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
  - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.

- .3 Install with stems above horizontal position unless indicated.
- .4 Valves accessible for maintenance without removing adjacent piping.
- .5 Install globe valves in bypass around control valves.
- .6 Use ball valves at branch take-offs for isolating purposes except where specified.
- .7 Install ball valves for glycol service.
- .8 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2000mm above floor in Mechanical Rooms.
- .15 Check Valves:
  - .1 Install silent check valves as indicated.

### 3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere:
    - .1 Provide space for fire stopping.
    - .2 Maintain the fire-resistance rating integrity of the fire separation.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### 3.9 PREPARATION FOR FIRE STOPPING

- .1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
- .3 Insulated pipes: ensure integrity of insulation and vapour barriers.

### **3.10 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Flush system in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 – Cleaning.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### **3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

### **3.12 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by Departmental Representative and in accordance with phasing strategy, described in Section 01 32 16.19 – Construction Progress Schedule – Bar (GANTT) Chart.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

### **3.13 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1        ANSI/ASME B31.1-2007, Power Piping.
  - .2        ANSI/ASME B31.3-2006, Process Piping.
  - .3        ANSI/ASME Boiler and Pressure Vessel Code-2007 :
    - .1        BPVC 2007 Section I: Power Boilers.
    - .2        BPVC 2007 Section V: Nondestructive Examination.
    - .3        BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .3        American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1        ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .4        American Welding Society (AWS)
  - .1        AWS C1.1M/C1.1-2000 (R2006), Recommended Practices for Resistance Welding.
  - .2        AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
  - .3        AWS W1-2000, Welding Inspection Handbook..
- .5        CSA Group (CSA)
  - .1        CSA W47.2-M1987 (R2008), Certification of Companies for Fusion Welding of Aluminum.
  - .2        CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
  - .3        CSA B51-03 (R2007), Boiler, Pressure Vessel and Pressure Piping Code.
  - .4        CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
  - .5        CSA W178.1-2008, Certification of Welding Inspection Organizations.
  - .6        CSA W178.2-2008, Certification of Welding Inspectors.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3            QUALITY ASSURANCE**

- .1        Qualifications:
  - .1        Welders:
    - .1        Welding qualifications in accordance with CSA B51.
    - .2        Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

- .3 Submit welder's qualifications to Departmental Representative.
- .4 Each welder to possess identification symbol issued by authority having jurisdiction.
- .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
  - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
  - .1 Registration of welding procedures in accordance with CSA B51.
  - .2 Copy of welding procedures available for inspection.
  - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of padding, crates, packaging materials, pallets in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 Series.

### **Part 3 Execution**

#### **3.1 APPLICATION**

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

#### **3.2 QUALITY OF WORK**

- .1 Welding: in accordance with relevant standards using procedures conforming to applicable requirements of provincial authority having jurisdiction.

#### **3.3 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
  - .1 Where used, fit to minimize gaps between ring and pipe bore.

- .2 Do not install at orifice flanges.
- .3 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

### **3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

### **3.5 SPECIALIST EXAMINATIONS AND TESTS**

- .1 General:
  - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
  - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
  - .3 Inspect and test 10 % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination magnetic particle (hereinafter referred to as "particle") tests.
- .2 Hydrostatically test welds to ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
  - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative.
- .5 Magnetic particle tests for LTHW heating and CHW cooling piping systems.

### **3.6 DEFECTS CAUSING REJECTION**

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

### **3.7 REPAIR OF WELDS WHICH FAILED TESTS**

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

### **3.8 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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Nitrate Film Preservation Facility  
HVAC Remediation  
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Section 23 05 17  
PIPE WELDING  
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**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 53 - Identification For HVAC Piping and Equipment.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
  - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
  - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .4 Efficiency Valuation Organization (EVO)
  - .1 International Performance Measurement and Verification Protocol (IPMVP)
    - .1 IPMVP 2007 Version.
- .5 Green Seal Environmental Standards (GS)
  - .1 GS-11-11, Standard for Paints and Coatings.
  - .2 GS-36-11, Standard for Commercial Adhesives.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges 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 Ontario, Canada.
- .4 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test and Evaluation Reports:

- .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store thermometers and pressure gauges indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Design point to be at mid-point of scale or range.
- .2 Ranges:
  - .1 LTHW heating -5°C to 115°C.
  - .2 CHW cooling -15°C to 50°C.

#### **2.2 DIRECT READING THERMOMETERS**

- .1 Industrial, lead-free, liquid filled, 160 mm scale length: to ASME B40.200 and CAN/CGSB-14.4.
  - .1 Resistance to shock and vibration.

#### **2.3 THERMOMETER WELLS**

- .1 Steel pipe: brass.

#### **2.4 PRESSURE GAUGES**

- .1 100 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:

- .1 Snubber for pulsating operation.
- .2 Diaphragm assembly for corrosive service.
- .3 Gasketed pressure relief back with solid front.
- .4 Bronze stop cock.

### **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 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 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 Install thermometers and gauges so they can be easily read from floor or platform.
  - .1 If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

#### **3.3 THERMOMETERS**

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Heat exchangers.
  - .2 Water heating and cooling coils.
  - .3 Chillers.
- .3 Use extensions where thermometers are installed through insulation.

#### **3.4 PRESSURE GAUGES**

- .1 Install in locations as follows:
  - .1 Suction and discharge of pumps.
  - .2 Upstream and downstream of PRV's.
  - .3 Upstream and downstream of control valves.
  - .4 Inlet and outlet of coils.
  - .5 In other locations as indicated.
- .2 Use extensions where pressure gauges are installed through insulation.

**3.5 NAMEPLATES**

- .1 Install engraved lamicoid nameplates in accordance with Section 23 05 53 - Identification For HVAC Piping and Equipment, identifying medium.

**3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.7 PROTECTION**

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

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ASTM International (ASTM)
  - .1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  - .4 ASTM B505/B505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
  - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario of Canada.
  - .2 Submit data for valves specified in this Section.

**1.3 CLOSEOUT SUBMITTALS**

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

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
  - .1 Furnish following spare parts:
    - .1 Valve seats: one for every 6 valves each size, minimum 1.
    - .2 Discs: one for every 6 valves, each size. Minimum 1.
    - .3 Stem packing: one for every 6 valves, each size. Minimum 1.
    - .4 Valve handles: 2 of each size.
    - .5 Gaskets for flanges: one for every 6 flanged joints.
  - .2 Tools:
    - .1 Furnish special tools for maintenance of systems and equipment.
    - .2 Include following:
      - .1 Lubricant gun for expansion joints.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .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 ANSI/ASME B1.20.1.
- .3 Lockshield Keys:
  - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
  - .1 Requirements common to gate valves, unless specified otherwise:
    - .1 Standard specification: MSS SP-80.
    - .2 Bonnet: union with hexagonal shoulders.
    - .3 Connections: screwed with hexagonal shoulders.
    - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
    - .5 Packing: non-asbestos.

- .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: handwheel.
- .5 Check Valves:
  - .1 Requirements common to check valves, unless specified otherwise:
    - .1 Standard specification: MSS SP-80.
    - .2 Connections: screwed with hexagonal shoulders.
- .6 Silent Check Valves:
  - .1 NPS 2 and under:
    - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
    - .2 Pressure rating: Class 150.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
    - .4 Disc and seat: renewable rotating disc.
    - .5 Stainless steel spring, heavy duty.
    - .6 Seat: regrindable.
- .7 Ball Valves:
  - .1 NPS 2 and under:
    - .1 Body and cap: cast high tensile bronze to ASTM B62.
    - .2 Pressure rating: Class 150 4140-kPa CWP, 860 kPa steam.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
    - .4 Stem: tamperproof ball drive.
    - .5 Stem packing nut: external to body.
    - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
    - .7 Stem seal: TFE with external packing nut.
    - .8 Operator: removable lever handle.
- .8 Butterfly Valves:
  - .1 NPS 2 1/2 through NPS 6, 2068 kPa lugged..
    - .1 Body: cast bronze, fully lugged.
    - .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 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            Genera**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American Society of Mechanical Engineers (ASME)
  - .1            ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings.
- .3        ASTM International (ASTM).
  - .1            ASTM A49-01 (2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
  - .2            ASTM A126-04, Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
  - .3            ASTM A536-84 (2004)e1, Standard Specification for Ductile Iron Castings.
  - .4            ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .5            ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .6            ASTM B85/B85M-08, Standard Specification for Aluminum-Alloy Die Castings.
  - .7            ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4        Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1            MSS SP-61-03, Pressure Testing of Steel Valves.
  - .2            MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
  - .3            MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4            MSS SP-82-1992, Valve Pressure Testing Methods.
  - .5            MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1            Provide manufacturer's printed product literature, specifications and datasheets for valves 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 Ontario, Canada.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
  - .1 Valve seats: one for every 6 valves each size, minimum 1.
  - .2 Discs: one for every 6 valves, each size, minimum 1.
  - .3 Stem packing: one for every 6 valves, each size, minimum 1.
  - .4 Valve handles: 2 of each size.
  - .5 Gaskets for flanges: one for every 6 flanged joints.
- .3 Tools:
  - .1 Furnish special tools for maintenance of systems and equipment.
  - .2 Include following:
    - .1 Lubricant gun for expansion joints.

**Part 2 Products**

**2.1 MATERIAL**

- .1 Valves:
  - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
  - .1 Gate valves: MSS SP-70.
  - .2 Globe valves: MSS SP-85.
  - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
  - .1 Valves to be suitable for propylene glycol concentration of 50% within heating and chilled water systems.
  - .2 Body, bonnet: ductile iron to ASTM A536 Grade 65-45-12.

- .3 Connections: flanged ends plain face to ANSI B16.1.
- .4 Inspection and pressure testing: to MSS SP-82.
- .5 Bonnet gasket: non-asbestos.
- .6 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
- .7 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
- .8 Gland packing: non-asbestos.
- .9 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
- .10 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

## **2.2 GATE VALVES**

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 150.
  - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
  - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
  - .4 Stem: bronze to ASTM B62.
  - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
  - .6 Seat: integral with body.
  - .7 Stem: wrought steel.
  - .8 Operator: handwheel.

## **2.3 GLOBE VALVES**

- .1 NPS 2 1/2 - 10, OSY:
  - .1 Body: with multiple-bolted bonnet.
  - .2 WP: 860 kPa steam, 1.4 MPa CWP.
  - .3 Bonnet-yoke gasket: non-asbestos.
  - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
  - .5 Seat ring: renewable, regrindable, screwed into body.
  - .6 Stem: bronze to ASTM B62.
  - .7 Operator: handwheel.

## **2.4 VALVE OPERATORS**

- .1 Install valve operators as follows:
  - .1 Handwheel: on valves except as specified.

- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

## **2.5 CHECK VALVES**

## **2.6 SILENT CHECK VALVES**

- .1 Construction:
  - .1 Body: ductile iron with integral seat.
  - .2 Pressure rating: Class 150, WP = 860 kPa.
  - .3 Connections: grooved ends.
  - .4 Disc: bronze renewable rotating disc.
  - .5 Seat: renewable, EPDM.
  - .6 Stainless steel spring, heavy duty.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.

### **3.2 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1        ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch).
  - .2        ASME B16.1-05, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25,125 and 250.
  - .3        ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
  - .4        ANSI/ASME B16.11-05, Forged Fittings, Socket-Welding and Threaded.
  - .5        ANSI/ASME B16.25-07, Butt welding Ends.
  - .6        ANSI/ASME B16.34-04, Valves - Flanged, Threaded and Welding Ends.
- .3        American Petroleum Institute (API)
  - .1        API Std. 609-04, Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .4        ASTM International (ASTM).
  - .1        ASTM A126-04), Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
  - .2        ASTM A536-84 (2004)e1, Standard Specification for Ductile Iron Castings.
  - .3        ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .4        ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
- .5        Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1        MSS SP-67-02a, Butterfly Valves.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2        Submit data for valves specified in this section.
- .3        Shop Drawings:
  - .1        Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
  - .1 Valve seats: one for every 6 valves each size, minimum 1.
  - .2 Discs: one for every 6 valves, each size, minimum 1.
  - .3 Stem packing: one for every 6 valves, each size, minimum 1.
  - .4 Valve handles: 3 of each size.
  - .5 Gaskets for flanges: one for every 6 flanged joints.
- .3 Tools:
  - .1 Furnish special tools for maintenance of systems and equipment.
  - .2 Include following:
    - .1 Lubricant gun for expansion joints.

**Part 2 Products**

**2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSI<SUP>2</SUP>G**

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Sizes:
  - .1 Lug type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
  - .1 NPS 2 - 12: 200 psig.
- .6 Minimum seat temperature ratings to 121 degrees C.
- .7 Application: on-off operation.

- .8 Full lug body (threaded).
- .9 Operators:
  - .1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
  - .1 Body aluminum bronze.
  - .2 Disc: coated ductile iron.
  - .3 Seat: EPDM.
  - .4 Shaft: 316 stainless steel.
  - .5 Taper pin: 316 SS.
  - .6 Key: stainless steel.
  - .7 O-Ring: EPDM.
  - .8 Bushings: Teflon.

## **2.2 MOUNTING FLANGES**

- .1 Class 150 steel to B16.5 pipe flanges.

## **2.3 ELECTRIC ACTUATORS**

- .1 Operation: designed to provide precise quarter turn electric operation.
  - .1 Torque range: up to 1.130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.
  - .2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.
- .2 Construction:
  - .1 Castings: heavy duty industrial grade for rugged use.
  - .2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.
  - .3 Gears and pinions constructed from hardened steel.
  - .4 Gear train to be permanently lubricated.
  - .5 Mechanical brake to ensure that gear is locked in precise position.
- .3 Electrical:
  - .1 Standard voltage: 120 VAC. 60 Hz.
  - .2 Control options: 0-10 V DC.
  - .3 CSA approved.
  - .4 Electrical rating: NEMA IV.

**Part 3 Execution**

**3.1 PREPARATION**

- .1 Valve and mating flange preparation.
  - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
  - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
  - .3 Install butterfly valves with disc in almost closed position.
  - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

**3.2 INSTALLATION OF VALVES**

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

**3.3 ACTUATOR INSTALLATION**

- .1 Air hoses or electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

**3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American Society of Mechanical Engineers (ASME)
  - .1        ASME B31.1-07, Power Piping.
- .3        ASTM International (ASTM)
  - .1        ASTM A125-1996 (2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2        ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3        ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .4        Factory Mutual (FM)
- .5        Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1        MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2        MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3        MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6        National Research Council Canada (NRC)
  - .1        National Plumbing Code of Canada 2015 (NPC).
- .7        Underwriter's Laboratories of Canada (ULC)

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Provide manufacturer's printed product literature 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 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.

### **1.3 CLOSEOUT SUBMITTALS**

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

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions and 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Design Requirements:
  - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
  - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
  - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .2 Performance Requirements:
  - .1 Design supports, platforms, catwalks, hangers to withstand seismic events.

## **2.2 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58. ANSI B31.1 and
- .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: painted with zinc-rich paint or galvanized after manufacture.
  - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed or 13 mm FM approved.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed or FM approved.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed or FM approved.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed or FM approved.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed or FM approved to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 22 mm or 28 mm rod.
- .6 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel galvanized.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.

- .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP69 FM approved or UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

## **2.4 RISER CLAMPS**

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

## **2.5 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

## **2.6 CONSTANT SUPPORT SPRING HANGERS**

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



## **2.7 VARIABLE SUPPORT SPRING HANGERS**

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

## **2.8 EQUIPMENT SUPPORTS**

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

## **2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

## **2.10 HOUSE-KEEPING PADS**

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

## **2.11 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, chillers, dry air coolers, air handling units, 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 all applicable codes and authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 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.
- .5 Within 300 mm of each elbow.

Maximum Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .6 Pipework greater than NPS 12: to MSS SP69.

### **3.4 HANGER INSTALLATION**

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

### **3.5 HORIZONTAL MOVEMENT**

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

### **3.6 FINAL ADJUSTMENT**

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

### **3.7 FIELD QUALITY CONTROL**

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

**3.8 CLEANING**

- .1 Clean in accordance with Section 01 74 00 – Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Vibration isolation materials and components, seismic control measures and their installation.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS)
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
- .4 National Research Council Canada (NRC)
  - .1 National Building Code of Canada 2015 (NBC).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit electronic copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
  - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
  - .3 Provide detailed drawings of seismic control measures for equipment and piping.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
  - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

#### **1.4 QUALITY ASSURANCE**

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

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

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 GENERAL**

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

#### **2.2 SPRINGS**

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

#### **2.3 SPRING MOUNT**

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

## **2.4 HANGERS**

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

## **2.5 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES**

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

## **2.6 HORIZONTAL THRUST RESTRAINT**

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

## **2.7 STRUCTURAL BASES**

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.

## **2.8 INERTIA BASE**

- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.
- .3 Concrete: suitable for application / structural load bearing.

## **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 fire stopping. Coordinate with Section 07 84 00 - Fire Stopping.
- .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 305 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. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
  - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

**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 - Testing, Adjusting and Balancing for HVAC.

- .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.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

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

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Canadian Gas Association (CGA)
  - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .4 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
  - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 QUALITY ASSURANCE**

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

**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .2 Dispose of unused paint or coating material at official hazardous material collections site approved by Departmental Representative.
  - .3 Do not dispose of unused coating or 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, 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.

.5 Identification for PSPC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

## 2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from Departmental Representative.

## 2.4 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Departmental Representative.
  - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Treated water	Green	TREATED WATER
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Safety valve vent	Yellow	STEAM VENT
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER

## 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 French and English.
- .2 Use one nameplate and label for each language.

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**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        Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2        Provide ULC or CSA registration plates as required by respective agency.
- .3        Identify systems, equipment to conform to PWGSC PMSS.

**3.3            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.

**3.4            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.

### **3.5 VALVES, CONTROLLERS**

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

### **3.6 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 – Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1            General**

**1.1            SUMMARY**

- .1    TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .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 30 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        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
  - .2        Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .3        National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
  - .4        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 is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

### **1.7 START-UP**

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

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

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

### **1.9 START OF TAB**

- .1 Notify Departmental Representative 10 days prior to start of TAB.
- .2 Start TAB in line with phasing strategy of project, outlined within Section 01 32 16.19 – Construction Progress Schedule – Bar (GANTT) Chart.

#### **1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus or minus 10 %.
  - .2 Hydronic systems: plus or minus 10 %.

#### **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.
- .3 Programme of proposed TAB works to sit alongside overall programme, to suit phasing requirements for the project and ensure that the facility remains operational wherever possible.

#### **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 electronic copies of TAB Report to Departmental Representative for verification and approval, in both official languages 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 NEBB, AABC, SMACNA, ASHRAE.
- .2 Do TAB of all new proposed systems.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by NEBB or AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 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.
- .7 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.
- .2 Building pressure conditions:

- .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
- .3 Zone pressure differences:
  - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.
  - .2 TAB procedures:
    - .1 All vaults to be positively pressurized.
- .4 Smoke management systems:
  - .1 Test for proper operation of all smoke and fire dampers installed as component parts of air systems specified Division 23.
  - .2 Emergency evacuation: see post-occupancy TAB activities specified below.

**1.21 POST-OCCUPANCY TAB**

- .1 Measure %RH, air flow patterns, DBT, in following areas: All vaults.
- .2 Emergency evacuation: participate in full scale emergency evacuation exercises.
- .3 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

**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 29 - Hangers and Supports for HVAC Piping and Equipment.

**1.2            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1        ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3        ASTM International (ASTM)
  - .1        ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
  - .2        ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .3        ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4        ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5        ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
  - .6        ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .7        ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .8        ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .9        ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4        Canadian General Standards Board (CGSB)
  - .1        CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .5        Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .6        Underwriters Laboratories of Canada (ULC)
  - .1        CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2        CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

### **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 by professional engineer registered or licensed in Ontario, Canada.
- .4 Samples:
  - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
  - .2 Mount sample on 12 mm plywood board.
  - .3 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

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

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2            Products**

**2.1            FIRE AND SMOKE RATING**

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

**2.2            INSULATION**

- .1    Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2    Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3    TIAC Code C-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      ULC listed.

**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    Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .5    Contact adhesive: quick-setting
- .6    Canvas adhesive: washable.
- .7    Tie wire: 1.5 mm stainless steel.
- .8    Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .9    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 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

**3.4 DUCTWORK INSULATION SCHEDULE**

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

	TIAC Code	Vapour Retarder	Thickness (mm)
All supply and exhaust ductwork proposed within mechanical room	C-2	yes	50
All ductwork within vault corridors	N/A	N/A	N/A

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1       Thermal insulation for piping and piping accessories in commercial type applications.
- .2    Related Requirements
- .3    Section 01 35 29.06 - Health and Safety Requirements.

**1.2            REFERENCE STANDARDS**

- .1    Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2    American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1       ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .3    ASTM International (ASTM)
  - .1       ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
  - .2       ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3       ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4       ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5       ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
  - .6       ASTM C547-2003, Mineral Fiber Pipe Insulation.
  - .7       ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .8       ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4    Canadian General Standards Board (CGSB)
  - .1       CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2       CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .5    Department of Justice Canada (Jus)
  - .1       Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2       Canadian Environmental Protection Act (CEPA), 1999, c. 33.

- .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS).
- .7 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .8 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
  - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

### **1.3 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
  - .1 CRF: Code Rectangular Finish.
  - .2 CPF: Code Piping Finish.

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

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit electronic copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.

### **1.5 QUALITY ASSURANCE**

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.
- .3 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
  - .1 Protect from weather, construction traffic.
  - .2 Protect against damage.
  - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
  - .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
  - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
  - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

**Part 2            Products**

**2.1            FIRE AND SMOKE RATING**

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

**2.2            INSULATION**

- .1    Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2    Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3    TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1      Mineral fibre: to CAN/ULC-S702 or ASTM C547.
  - .2      Maximum "k" factor: to CAN/ULC-S702.
- .4    TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1      Mineral fibre: to CAN/ULC-S702 or ASTM C547.
  - .2      Jacket: to CGSB 51-GP-52Ma.
  - .3      Maximum "k" factor: to CAN/ULC-S702 or ASTM C547.

**2.3            INSULATION SECUREMENT**

- .1    Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2    Contact adhesive: quick setting.
- .3    Canvas adhesive: washable.
- .4    Tie wire: 1.5 mm diameter stainless steel.
- .5    Bands: stainless steel, 19 mm wide, 0.5 mm thick.

**2.4            CEMENT**

- .1    Thermal insulating and finishing cement:
  - .1      Air drying on mineral wool, to ASTM C449/C449M.

**2.5            VAPOUR RETARDER LAP ADHESIVE**

- .1    Water based, fire retardant type, compatible with insulation.

**2.6            INDOOR VAPOUR RETARDER FINISH**

- .1    Vinyl emulsion type acrylic, compatible with insulation.

**2.7            OUTDOOR VAPOUR RETARDER FINISH**

- .1    Vinyl emulsion type acrylic, compatible with insulation.
- .2    Reinforcing fabric: fibrous glass, untreated 305 g/m<sup>2</sup>.

## **2.8 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .2 Colours: white.
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 85 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: 0.5 mm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: 0.50 mm sheet.
  - .3 Finish: stucco embossed.
  - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
  - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

## **Part 3 Execution**

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

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

### **3.2 PRE-INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

### **3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### 3.4 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
  - .1 Securements: SS bands at 300 mm on centre.
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
  - .1 Securements: SS bands at 300 mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.
  - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
  - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			to 1	1 ¼ to 2	2 ½ to 4	5 to 6	8
Glycol Heating	60 - 94	A-1	25	38	38	38	38
Chilled Water or Glycol	below 4	A-3	25	25	38	38	38
Chilled Water Pump Casing		A-3	25	25	25	25	25

- .5 Finishes:
  - .1 Exposed indoors: PVC jacket.
  - .2 Exposed in mechanical rooms: PVC jacket.
  - .3 Concealed, indoors: PVC jacket.
  - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
  - .5 Outdoors: water-proof aluminum jacket.
  - .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

### 3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.

- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .2 Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASTM International (ASTM)
  - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

**1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

- .1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

**1.4 REQUIREMENTS FOR PLANT PERFORMANCE VERIFICATION (FACTORY TESTING)**

- .1 Performance verification in the form of factory testing of new mechanical plant shall be undertaken as described within Section 01 91 13.13 Commissioning Plan.

**1.5 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)**

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
  - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
  - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
    - .1 Pump operation.
    - .2 Boiler and/or chiller operation.
    - .3 Pressure bypass open/closed.
    - .4 Control pressure failure.
    - .5 Maximum heating demand.
    - .6 Maximum cooling demand.
    - .7 Boiler and/or chiller failure.
    - .8 Cooling tower (and/or industrial fluid cooler) fan failure.
    - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

## **1.6 HYDRONIC SYSTEM CAPACITY TEST**

- .1 Perform hydronic system capacity tests after:
  - .1 TAB has been completed
  - .2 Verification of operating, limit, safety controls.
  - .3 Verification of primary and secondary pump flow rates.
  - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
  - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
    - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
    - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
  - .2 Test procedures:
    - .1 Open fully heat exchanger, heating coil and radiation control valves.
    - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
    - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.
- .7 Chilled water system capacity test:
  - .1 Test procedures:
    - .1 Open fully cooling coil control valves.
    - .2 Set thermostats on associated AHU's for maximum cooling.
    - .3 Set AHU's for design maximum air flow rates.
    - .4 Set load or demand limiters on chillers to 100%.
    - .5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

## **1.7 CONDENSER WATER AND HUMIDIFICATION SYSTEMS**

- .1 In addition to procedures specified above, perform following:
  - .1 Add chemicals once per week as required.

- .2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.

**1.8 GLYCOL SYSTEMS**

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

**1.9 REPORTS**

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Reports, supplemented as specified herein.

**1.10 TRAINING**

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified herein.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1       Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2    Related Requirements
  - .1       Section 23 25 00 - HVAC Water Treatment.
  - .2       Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

**1.2            REFERENCE STANDARDS**

- .1    Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2    ASTM International (ASTM)
  - .1       ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .3    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1       Safety Data Sheets (SDS).

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Product Data:
  - .1       Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2    Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1       Instructions: submit manufacturer's installation instructions.

**1.4            QUALITY ASSURANCE**

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

**1.5            DELIVERY, STORAGE, AND HANDLING**

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

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

## **Part 2 Products**

### **2.1 CLEANING SOLUTIONS**

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

## **Part 3 Execution**

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

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

### **3.2 CLEANING HYDRONIC SYSTEMS**

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
  - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
  - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
    - .1 Cleaning procedures, flow rates, elapsed time.
    - .2 Chemicals and concentrations used.
    - .3 Inhibitors and concentrations.
    - .4 Specific requirements for completion of work.
    - .5 Special precautions for protecting piping system materials and components.
    - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
  - .1 Systems: free from construction debris, dirt and other foreign material.
  - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

- .3 Strainers: clean prior to initial fill.
- .4 Install temporary filters on pumps not equipped with permanent filters.
- .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
  - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
  - .1 Fill system with water, ensure air is vented from system.
  - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
  - .3 Use water metre to record volume of water in system to +/- 0.5%.
  - .4 Add chemicals under direct supervision of chemical treatment supplier.
  - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
  - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
  - .7 Add chemical solution to system.
  - .8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
  - .1 In addition to procedures specified above perform specified procedures.
  - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

### **3.3 START-UP OF HYDRONIC SYSTEMS**

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation and expansion tank level, set pressure controls.
  - .2 Ensure air is removed.
  - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment.

- .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- .8 Repeat with water at design temperature.
- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure slowly.
- .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .12 Adjust pipe supports, hangers, springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 If bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .16 Check operation of drain valves.
- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

#### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 – Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 00 - Common Work Results for HVAC.
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .3 Section 23 05 17 - Pipe Welding.
- .4 Section 23 05 23.01 - Valves - Bronze.
- .5 Section 23 05 23.02 - Valves – Cast Iron.
- .6 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .7 Section 23 08 13 - Performance Verification HVAC Systems.
- .8 Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C111/A21.11-06, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .3 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.1-10, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - .2 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - .3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
  - .4 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.
  - .5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
  - .6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .4 ASTM International (ASTM)
  - .1 ASTM A47/A47M-99 (2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .3 ASTM A536-84 (2009), Standard Specification for Ductile Iron Castings.
  - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.



- .6 ASTM E202-10, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .5 CSA Group (CSA)
  - .1 CSA B242-05 (R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .6 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
  - .1 MSS-SP-67-2002a, Butterfly Valves.
  - .2 MSS-SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS-SP-71-05, Grey Iron Swing Check Valves Flanged and Threaded Ends.
  - .4 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS-SP-85-02, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
  - .2 Indicate on drawings:
    - .1 Components and accessories.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
  - .1 Include special servicing requirements.

### **1.5 EXTRA STOCK MATERIALS**

- .1 Supply spare parts as follows:
  - .1 Valve seats: 1 minimum for every six valves, each size. Minimum one.
  - .2 Discs: 1 minimum for every six valves, each size. Minimum one.
  - .3 Stem packing: 1 minimum for every six valves, each size. Minimum one.
  - .4 Valve handles: 2 minimum of each size.
  - .5 Gaskets for flanges: 1 minimum for every six flanges.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hydronic systems from any damage.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 PIPE**

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - .1 To NPS 6: Schedule 40.

### **2.2 PIPE JOINTS**

- .1 NPS 2 and under: screwed fittings with PTFE tape.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: plain, weld neck to ANSI/AWWA C111/A21.11.
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.2 or ASME B18.2.1.

### **2.3 FITTINGS**

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
  - .1 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASME B16.3 or ASTM A47/A47M.

## 2.4 VALVES

- .1 Connections:
  - .1 NPS 2 and smaller: screwed ends.
  - .2 NPS 2-1/2 and larger: flanged ends.
- .2 Gate valves: application: isolating equipment, control valves, pipelines to MSS-SP-80 or to MSS-SP-70:
  - .1 NPS 2 and under:
    - .1 Mechanical Room: Class 150, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
  - .2 NPS 2-1/2 and over:
    - .1 Mechanical Rooms: non-rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
    - .1 Operators: manual.
- .3 Butterfly valves: application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers) to MSS-SP-67 :
  - .1 NPS 2-1/2 and over: lug type: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: application: throttling, flow control, emergency bypass MSS-SP-80 or MSS-SP-85:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
  - .2 NPS 2-1/2 and over:
    - .1 With bronze disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
    - .2 Operators: manual.
- .5 Balancing, for TAB:
  - .1 Sizes: calibrated balancing valves, as specified this section.
  - .2 NPS 2 and under:
    - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .6 Drain valves: Gate, Class 150, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .7 Silent check valves:
  - .1 NPS 2 and under:
    - .1 As specified Section 23 05 23.01 - Valves - Bronze.
  - .2 NPS 2-1/2 and over:
    - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .8 Ball valves:
  - .1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

**Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 PIPING INSTALLATION**

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

**3.3 CIRCUIT BALANCING VALVES**

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

**3.4 CLEANING, FLUSHING AND START-UP**

- .1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

**3.5 TESTING**

- .1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

**3.6 BALANCING**

- .1 Balance water systems to within plus or minus 10 % of design output.
- .2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

**3.7 GLYCOL CHARGING**

- .1 Include mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

**3.8 PERFORMANCE VERIFICATION**

- .1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

**3.9 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.10 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASME
  - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .3 ASTM International (ASTM)
  - .1 ASTM A47/A47M-99 (2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01 (2011), Standard Specification for Grey Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84 (2009), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .4 CSA Group (CSA)
  - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers 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 Ontario, Canada.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Galvanized steel vertical pressurized diaphragm type expansion tank.
- .2 Suitable for use in systems with 50% propylene glycol.
- .3 Capacity: As indicated on schedules drawing.
- .4 Size: as indicated.
- .5 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .6 Working pressure: 520 kPa.
- .7 Air precharged to 84 kPa (initial fill pressure of system).
- .8 Base mount for vertical installation.
- .9 Supports: provide supports with hold down bolts and installation templates.
- .10 Renewable diaphragm.

### **2.2 AUTOMATIC AIR VENT**

- .1 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .2 Float: solid material suitable for 115 degrees C working temperature.

### **2.3 PIPE LINE STRAINER**

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 to 12: cast iron body to ASTM A278/A278M, Class 30 flanged connections.
- .3 Blowdown connection: NPS 1.
- .4 Screen: stainless steel with 1.19 mm perforations.
- .5 Working pressure: 860 kPa.

**Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 APPLICATION**

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

**3.3 GENERAL**

- .1 Run drain lines and blow off connections to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tapings for ancillaries and for equipment operating weights.

**3.4 STRAINERS**

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve and as indicated.

**3.5 AIR VENTS**

- .1 Install at high points of systems.
- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.

**3.6 EXPANSION TANKS**

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

**3.7 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.



**3.8 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 CSA Group (CSA)
  - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.
- .4 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .5 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2011, Motors and Generators.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
  - .2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 IN-LINE CIRCULATORS**

- .1 Suitable for use with systems with 50% propylene glycol.
- .2 Volute: cast iron radially split, with flanged design suction and discharge connections.
- .3 Impeller: cast bronze, fully enclosed dynamically balanced.
- .4 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .5 Seal assembly: mechanical for service to 110 degrees C.
- .6 Connection type: Flange
- .7 Coupling: rigid self-aligning.
- .8 Motor: drip proof, with sleeve bearing, r/min and kW efficiency as indicated.
- .9 Capacity: as indicated.
- .10 Design pressure: 860 kPa.

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

### **3.2 APPLICATION**

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

### **3.3 INSTALLATION**

- .1 In line circulators: install as indicated by flow arrows.
  - .1 Support at inlet and outlet flanges or unions.
  - .2 Install with bearing lubrication points accessible.
- .2 Base mounted type: supply templates for anchor bolt placement.
  - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
  - .2 Align coupling in accordance with manufacturer's recommended tolerance.
  - .3 Check oil level and lubricate.
- .3 Ensure that pump body does not support piping or equipment.
  - .1 Provide stanchions or hangers for this purpose.
  - .2 Refer to manufacturer's installation instructions for details.
- .4 Pipe drain tapping to nearest floor drain.
- .5 Check rotation prior to start-up.
- .6 Install pressure gauge test cocks.

### **3.4 START-UP**

- .1 General:
  - .1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements; supplemented as specified herein.
  - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
  - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
  - .2 After starting pump, check for proper, safe operation.
  - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
  - .4 Check base for free-floating, no obstructions under base.
  - .5 Run-in pumps for 12 continuous hours minimum.
  - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
  - .7 Eliminate air from scroll casing.
  - .8 Adjust water flow rate through water-cooled bearings.
  - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
  - .10 Adjust alignment of piping and conduit to ensure true flexibility.
  - .11 Eliminate cavitation, flashing and air entrainment.
  - .12 Adjust pump shaft seals, stuffing boxes, glands.
  - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.

- .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
- .15 Verify lubricating oil levels.

### **3.5 PERFORMANCE VERIFICATION (PV)**

- .1 General:
  - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified herein.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure valves on pump suction and discharge provide tight shut-off.
- .4 Multiple Pump Installations - Series and Parallel:
  - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .5 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .6 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning Requirements reports supplemented as specified herein. Reports to include:
  - .1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
  - .2 Use Report Forms specified in Section 01 91 13 - General Commissioning Requirements: Report Forms and Schematics.
  - .3 Pump performance curves (family of curves).

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 07 84 00 - Fire Stopping.
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .3 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .3 ASTM International (ASTM)
  - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
  - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .4 Green Seal Environmental Standards (GS)
  - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .5 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
- .4 Test and Evaluation Reports:
  - .1 Certification of Ratings:
    - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.
- .6 Ductwork Cleanliness
  - .1 All proposed new ductwork shall be shipped to the construction site suitably sealed to ensure the ductwork remains clean.
  - .2 When delivered to site, ductwork shall be stored in a clean and tidy environment, shall remain in its original packaging and shall be bagged / ends sealed to avoid dust and dirt ingress to the ductwork.
  - .3 Proposed ductwork once installed shall be subject to testing and verification of its cleanliness, should the ductwork cleanliness not meet the Departmental Representatives requirements, the contractor shall arrange for specialist cleaning contractors to clean the ductwork in accordance with the below requirements for the existing ductwork.
  - .4 All existing ductwork shall be assessed for installation of access doors by the contractor for testing purposes. With approval of the Departmental Representative, access doors shall be cut into the ductwork for visual inspection and vacuum testing.
  - .5 Subject to the Departmental Representatives approval / review, cleaning of the existing ductwork shall be carried out by the contractor in the form of a negative pressure high-volume extraction, with an air lance to dislodge particles within the ductwork. Cleaning shall be undertaken by a specialist ductwork cleaning contractor.

**Part 2 Products**

**2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
0 to 500	A

- .2 Seal classification:

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

**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 fiberglass tape, 50 mm wide.

**2.4 DUCT LEAKAGE**

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

**2.5 FITTINGS**

- .1 Fabrication: to SMACNA.

- .2 Radiused elbows:

- .1 Rectangular: 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 45 degrees entry on branch.  
.2 Round main and branch: enter main duct at 45 degrees with conical connection.  
.3 Provide volume control damper in branch duct near connection to main duct.  
.4 Main duct branches: with splitter damper.

- .5 Transitions:

- .1 Diverging: 30 degrees maximum included angle.  
.2 Converging: 30 degrees maximum included angle.

- .6 Offsets:

- .1 as indicated or full radiused elbows.

- .7 Obstruction deflectors: maintain full cross-sectional area.



- .1 Maximum included angles: as for transitions.

## **2.6 FIRE STOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Coordinate with 07 84 00 - Fire Stopping to ensure fire stopping materials and installation does not distort duct.

## **2.7 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

## **2.8 HANGERS AND SUPPORTS**

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Hanger configuration: to SMACNA.
  - .2 Hangers: galvanized steel angle with galvanized steel rods to following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

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

### 3.2 GENERAL

- .1 Do work in accordance with SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

### 3.3 HANGERS

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

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

### 3.4 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
  - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
  - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
  - .1 Weld joints of bottom and side sheets.
  - .2 Seal other joints with duct sealer.

### 3.5 SEALING AND TAPING

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

### 3.6 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

- .7 Complete test before performance insulation or concealment Work.

**3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 GENERAL**

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

## **2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame 1.8 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 Doors over 1000 mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.

## **2.4 TURNING VANES**

- .1 Factory or shop fabricated, 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 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .2 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 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 610 x 610 mm for person size entry.
    - .2 460 x 460 mm for servicing entry.
    - .3 305 x 305 mm for viewing.
    - .4 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.

- .4 And as indicated.
- .2 For temperature readings:
  - .1 At outside air intakes.
  - .2 In mixed air applications in locations as approved by Departmental Representative.
  - .3 At inlet and outlet of coils.
  - .4 Downstream of junctions of two converging air streams of different temperatures.
  - .5 And as indicated.
- .4 Turning Vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 Sheet Metal and Air Conditioning National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 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: 27L/s at 1000 Pa for a 1000mm x 1000mm 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 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 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 multi-blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Departmental Representative.

#### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASTM International (ASTM)
  - .1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and Section 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 dampers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 MULTI-LEAF DAMPERS**

- .1 Opposed blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.
- .3 Pressure fit self-lubricated bronze bearings.

- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Performance:
  - .1 Leakage: in closed position less than 2% of rated air flow at 300 Pa differential across damper.
  - .2 Pressure drop: at full open position less than 10 Pa differential across damper at 4 m/s.
- .6 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

## **2.2 DISC TYPE DAMPERS**

- .1 NOT TO BE USED.

## **2.3 BACK DRAFT DAMPERS**

- .1 multi leaf, aluminum construction with nylon bearings, spring assisted.

# **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 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .2 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 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

## **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 07 84 00 – Fire Stopping.
- .2 Section 23 33 00 - Air Duct Accessories.

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.
  - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
  - .3 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate the following:
    - .1 Fire dampers.
    - .2 Fusible links.
    - .3 Design details of break-away joints.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.4 CLOSEOUT SUBMITTALS**

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

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide:
  - .1 6 fusible links of each type.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect fire and smoke dampers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 FIRE DAMPERS**

- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of provincial fire authority, Fire Commissioner of Canada (FCC). Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .1 Fire dampers: 1½ hour fire rated unless otherwise indicated.
  - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .4 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .5 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .6 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

- .7 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .8 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .9 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

### **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 fire and smoke 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 in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Coordinate installation of fire stopping with Section 07 84 00 - Fire Stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

#### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.



**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1      Section 23 05 13 - Common Motors Requirements for HVAC Equipment.
- .2      Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .3      Section 23 33 00 - Air Duct Accessories.

**1.2            REFERENCE STANDARDS**

- .1      Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2      American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1          ANSI/AMCA Standard 99-2010, Standards Handbook.
  - .2          ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3          ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
  - .4          ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .3      The Master Painters Institute (MPI)
  - .1          Architectural Painting Specification Manual - current edition.
    - .1              MPI #18, Primer, Zinc Rich, Organic.

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1          Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans 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 Ontario, Canada.
  - .2          Provide:
    - .1              Fan performance curves showing point of operation, kW and efficiency.
    - .2              Sound rating data at point of operation.
  - .3          Indicate:
    - .1              Motors, sheaves, bearings, shaft details.
    - .2              Minimum performance achievable with as appropriate, variable speed controllers.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
    - .1 Provide:
      - .1 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
        - .1 Bearings and seals.
        - .2 Addresses of suppliers.
        - .3 List of specialized tools necessary for adjusting, repairing or replacing.

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

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

### **Part 2 Products**

#### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
  - .2 Capacity: flow rate, external static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
  - .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
  - .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300.
  - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

#### **2.2 FANS GENERAL**

- .1 Motors:

- .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
- .2 For use with variable speed controllers.
- .3 Sizes as indicated.
- .4 Fully variable speed, inverter driven.
- .2 Accessories and hardware: as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

## **2.3 CENTRIFUGAL FANS**

- .1 Fan wheels:
  - .1 Welded aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 50 % of first critical speed.
  - .3 forward curved blades, as indicated.
- .2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 200,000 hours.
- .3 Housings:
  - .1 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
  - .2 Provide latched airtight access doors with handles.
- .4 Variable volume control devices:
  - .1 Mounted by fan manufacturer.

## **2.4 DIRECT DRIVE / PLUG FANS**

- .1 Shall be constructed in accordance with AMCA Standard 99-0401-86 'Spark A' requirements, fans to be constructed in aluminium.
- .2 Fan motor to be housed out of the air stream.
- .3 Shall be mounted on suitable anti-vibration mounts.
- .4 Shall be supplied with disconnect switch provided by the fan manufacturer.

## **2.5 UTILITY SETS**

- .1 Characteristics and construction: for centrifugal fans.

- .2 Preassemble single width centrifugal fan with removable protective hood with vents, and automatic spring loaded back draft dampers and 12 mm mesh birdscreens.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

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

#### **3.2 FAN INSTALLATION**

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

#### **3.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces.

#### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 25 05 60 EMCS: Field Installation

**1.2 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 International Organization of Standardization (ISO)
  - .1 ISO 3741-2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5 Underwriter's Laboratories (UL)
  - .1 UL 181-2005 (R2008), Factory-Made Air Ducts and Air Connectors.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air terminal units 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 Ontario, Canada.
  - .2 Indicate the following:
    - .1 Capacity.
    - .2 Pressure drop.
    - .3 Noise rating.
    - .4 Leakage.
- .4 Samples:
  - .1 Submit samples.
  - .2 Samples are required for following: VAV terminal units.

- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Test and Evaluation Reports:
  - .1 Test data: to ANSI/AMCA Standard 210.

#### **1.4 CLOSEOUT SUBMITTALS**

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

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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 air terminal units from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

#### **2.2 MANUFACTURED UNITS**

- .1 Terminal units of the same type to be product of one manufacturer.

#### **2.3 ELECTRONIC VARIABLE AIR VOLUME BOXES**

- .1 Pressure independent, reset to air flow between zero and maximum air volume.
- .2 At inlet velocity of 5 m/s, differential static pressure not to exceed 100 Pa.
- .3 Air velocity sensor flow grid as standard to manufacturer.

- .4 Signals between temperature sensing device, velocity controller, velocity sensor and damper actuator analogue as indicated. Shielded or twisted wire requirements is not acceptable.
- .5 Electronic control package provided by the EMCS contractor in accordance with Section 25 05 60 EMCS: Field Installation. Features to accommodate field calibration and readjustment of air volume settings to include:
  - .1 Metre taps for balancing with digital DC voltmeter.
  - .2 Adjustable flow settings at thermostat.
- .6 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.
- .7 Terminal unit to be CSA certified.
- .8 Casing: galvanized steel, internally lined with 25 mm. 0.7 kg density fibrous glass, to NFPA 90A or UL 181. Mount control components inside protective metal shroud.
- .9 Damper: steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .10 Sizes and capacity: as indicated.

### **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 terminal units installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers and access panels for easy access.

#### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.



- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2 ASTM International (ASTM)
  - .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 National Research Council Canada (NRC)
  - .1 National Building Code of Canada 2015 (NBC).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

**1.2 GENERAL**

- .1 Existing louvres are to be retained for re-use.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvres, intakes and vents 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 Seal with caulking to ensure weather tightness new ductwork connections.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  - .1            ANSI/ASHRAE 52.2-12, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).
- .3        Canadian General Standards Board (CGSB)
  - .1            CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .2            CAN/CGSB-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type.
  - .3            CAN/CGSB-115.12-M85, Filters, Air, Medium Efficiency, Disposable, Bag Type.
  - .4            CAN/CGSB-115.13-85, Filter Media, Automatic Roll.
  - .5            CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .6            CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
  - .7            CAN/CGSB-115.16-M82, Activated Carbon for Odor Removal from Ventilating Systems.
  - .8            CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
  - .9            CAN/CGSB-115.20-95, Polarized Media Air Filter.
- .4        International Organization of Standardization (ISO)
  - .1            ISO 14644-1-99 Clean Rooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness.
- .5        National Fire Protection Association (NFPA)
  - .1            NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6        Underwriters' Laboratories of Canada (ULC)
  - .1            ULC -S111-07, Standard Method of Fire Tests for Air Filter Units.
  - .2            ULC-S646-06, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.
- .7        US Department of Defense - Test Method Standard
  - .1            MIL-STG-282-95, Filter Units, Protective Clothing, Gas-Mask Components and Related Products; Performance Test Methods.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC filters 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 Ontario, Canada.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in 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.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC filters from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 GENERAL**

- .1 Media: suitable for air at 100% RH and air temperatures between -40 and 50 degrees C.

- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

## **2.2 ACCESSORIES**

- .1 Holding frames: permanent channel section construction of galvanized steel, 1.6 mm thick, except where specified.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: upstream face of filter bank via access door.

## **2.3 FIBROUS GLASS PANEL FILTERS**

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.
- .3 Performance: to ANSI/ASHRAE 52.2.
- .4 Fire rated: to ULC -S111.

## **2.4 RIGID, SUPPORTED BAG TYPE FILTERS, 30-35 % EFFICIENCY**

- .1 Media: disposable preformed fibrous glass, synthetic media cartridge.
- .2 Holding frame: galvanized steel with bracing.
- .3 Media support: welded wire grid.
- .4 Performance:
  - .1 Average atmospheric dust spot efficiency to ANSI/ASHRAE 52.2.
  - .2 Average synthetic dust weight arrestance to ANSI/ASHRAE 52.2.
- .5 Fire rated: to ULC -S111.

## **2.5 BAG TYPE FILTERS, 80-85% EFFICIENCY**

- .1 Disposable media bag type of self-inflating ultrafine glass:
  - .1 High efficiency to CAN/CGSB-115.11.
  - .2 Medium efficiency to CAN/CGSB-115.12.
- .2 Holding frame: galvanized steel.
- .3 Media support: welded galvanized steel.

## **2.6 ACTIVATED CARBON TYPE FILTERS**

- .1 Media:
  - .1 Regenerative activated carbon from coconut shell: to CAN/CGSB-115.16.
  - .2 50-55 minute absorption capacity in accordance with standard accelerated chloropicrin test.

- .3 Density: 550 kg/m<sup>3</sup>.
- .4 95 hardness in accordance with Ball abrasion test.
- .5 Particle size (Tyler mesh screen): 6.3 x 10 mm.
- .6 Quantity of media: 4.25 kg/100 L/s.
- .2 Holding frame: removable, non-disposable, corrosion resistant steel.
- .3 Filter housing: corrosion resistant steel.
- .4 Test element:
  - .1 Detachable, to indicate extent of saturation of actual installation.
  - .2 1 per bank.

## **2.7 FILTER GAUGES - DIAL TYPE**

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 2 times initial pressure.

## **2.8 FILTER GAUGES - MANOMETER TYPE**

- .1 Inclined acrylic tube.
- .2 Complete with levelling screws.
- .3 Range: 0 to 2 times initial pressure.

## **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 filter 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 GENERAL**

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

### **3.3 ACTIVATED CARBON TYPE FILTERS**

- .1 During testing, adjusting and balancing, install substitute media.
- .2 Install permanent media only after painting is completed.

**3.4 REPLACEMENT MEDIA**

- .1 Replace media with new upon acceptance.
- .2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

**3.5 FILTER GAUGES**

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

**3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI)
  - .1 AHRI-550/590-03, Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.
- .2 CSA Group (CSA)
  - .1 CSA B52-05 SMART, Mechanical Refrigeration Code.
- .3 Environment Canada, (EC)/Environmental Protection Services (EPS)
  - .1 EPS 1/RA/2-1996, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for chillers and dry air cooler 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 Ontario, Canada.
  - .2 Indicate:
    - .1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.
    - .2 Wiring as assembled and schematics.
    - .3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
    - .4 Type of refrigerant used.
- .4 Factory testing:
  - .1 Factory testing shall be undertaken as described within Section 01 91 13.13 Commissioning Plan.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for chillers and dry air cooler for incorporation into manual.
- .3 Data to include:

- .1 Description of equipment giving manufacturers name, model type and year, capacity and serial numbers.
- .2 Provide part load performance curves.
- .3 Details on operation, servicing and maintenance.
- .4 Recommended spare parts list.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect chillers and dry air cooler from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, padding, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Provide 2No. complete air cooled scroll type chiller packages including: compressor; evaporator; condenser, motor and motor starter; controls; control centre; piping; wiring; refrigeration and oil change; ready for connection to chilled water circuit, and electric power source, installed in welded steel frame with heavy gauge panels and access doors finished to manufacturers standard.
- .2 Provide 1No. dry air cooler package, including: Controls; control centre; piping; wiring to provide a complete system.

#### **2.2 CHILLER CAPACITY**

- .1 Certified ratings based on AHRI 550/590:
  - .1 Chillers to be rated at 61,000 W, when cooling 2.97 L/s of water from 0.5 degrees C to minus 5.5 degrees C with 50% propylene glycol.
  - .2 Air cooled condenser supplied with 35 degrees C entering air design ambient temperature and minimum ambient temperature of -25 degrees C entering air.
  - .3 Power input, including electrical components: 20 kW.
  - .4 Refrigerant: R404A – suitable for external ambient conditions of -40°C.

## **2.3 COMPRESSOR**

- .1 Two compressors per chiller, scroll design.
- .2 Compressor to include suction and discharge shut-off valves; oil sight glass; separate circuit crankcase heater; and cylinder unloading device.
- .3 Provide nameplate to show capacity at design temperature, type of refrigerant used and total weight in system.
- .4 Compressors shall run at 100% duty when in operation, overall turn down of the chillers shall therefore be limited to 50% of the output of the chiller (one compressor operating at 100% duty).

## **2.4 COMPRESSOR MOTOR**

- .1 Open type with overload protection.

## **2.5 EVAPORATOR**

- .1 Steel shell and seamless copper tube, gasketed heads, direct expansion: to CSA B52. Insulated to  $R=0.53 \text{ m}^2 \cdot \text{degrees C/W}$  minimum.

## **2.6 CONDENSER**

- .1 Air cooled:
  - .1 Aluminum fins mechanically bonded to copper tube, pressure tested to 3.1 MPa.
  - .2 Direct driven, steel or aluminum propeller type fan, statically and dynamically balanced. Motor with overload protection, permanently lubricated ball bearings.

## **2.7 DRY AIR COOLER**

- .1 To be rated at 61,000 W, when cooling 2.97 L/s of water from 0.5 degrees C to minus 5.5 degrees C with 50% propylene glycol.
- .2 Suitable for operation from minus 6.5 degrees Celsius to minus 30 degrees Celsius.
- .3 Selected to give free cooling of chilled water when external ambient temperature allows.
- .4 Each fan shall be fully variable speed, inverter driven to match the output setpoint required.

## **2.8 CONTROL CENTRE**

- .1 All controls to be visible on the BAS System and shall be wired by the controls specialist.
- .2 To EEMAC standard and include:
  - .1 Control circuit ON/OFF switch.
  - .2 Oil pressure safety switch.
  - .3 High and low pressure safety switch.
  - .4 Water temperature controller.
  - .5 Suction and discharge pressure gauges and shut-off valves.
  - .6 Chilled water flow switch.
  - .7 Compressor short cycling and restart delay timer.

- .8 Starting sequence switches.
- .9 Compressor and fan motor circuit breakers.
- .10 Reset low water temperature cut-out switch.
- .11 Motor contactors, control relays and indicator lights to include: "start-stop" switch; anti-recycle 30 minute (adjustable) time delay; low chilled water temperature cutout and automatic reset; excess purge signal light and reset switch; manual/automatic oil pump operating switch and signal light; oil heater signal light; manual reset power failure and signal light; chilled water flow interruption light, metre to indicate number of compressor starts and elapsed running time.
- .12 Field power and control circuit terminal blocks.
- .13 Alarm for refrigerant leakage.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

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

#### **3.2 APPLICATION**

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

#### **3.3 GENERAL**

- .1 Provide appropriate protection apparatus.
- .2 Install unit as indicated, to manufacturers recommendations, and in accordance with EPS 1/RA/2.
- .3 Ensure adequate clearances for servicing and maintenance.
- .4 Manufacturer to approve installation, to supervise startup and to instruct operators. Include 3 days per unit.

#### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 PROTECTION**

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

**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1        Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .2        Section 23 33 00 - Air Duct Accessories.
- .3        Section 23 34 00 - HVAC Fans.
- .4        Section 23 40 00 - HVAC Air Cleaning Devices.

**1.2            REFERENCE STANDARDS**

- .1        Where the below standards are not the last revision published, most up to date version shall be referenced / used by the contractor.
- .2        American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
  - .1            ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
  - .2            ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3        Green Seal (GS)
  - .1            GS-11-11, Standard for Paints and Coatings.
- .4        National Fire Protection Association (NFPA)
  - .1            NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5        Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

**1.3            DEFINITIONS**

- .1        Catalogued or published ratings: ratings obtained from tests carried out by manufacturer or manufacturer's designated independent testing agency which signify adherence to codes and standards in force.

**1.4            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1            Submit manufacturer's instructions, printed product literature and data sheets for insulation, filters, and paints 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 Ontario, Canada.
  - .2            Indicate on drawings:

- .3 Actual cooling and heating fluid entering and leaving conditions for stated air side requirements.
- .4 Factory testing:
  - .1 Factory testing shall be undertaken as described within Section 01 91 13.13 Commissioning Plan.

## **1.5 CLOSEOUT SUBMITTALS**

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

## **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish 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.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air handling equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of padding, pallets, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 5No. new air handling units shall be provided as indicated.
- .2 Field assembled components to form units supplying air at design conditions as indicated.

### **2.2 FANS**

- .1 In accordance with Section 23 34 00 - HVAC Fans.

## 2.3 CASING

- .1 General:
  - .1 Factory manufactured galvanized steel casing of 1.3 mm thick steel reinforced and braced for rigidity and flanged for bolted sub- assemblies, to withstand a pressure differential as indicated.
  - .2 Provide inspection doors to allow access to internal parts and component removal.
    - .1 Inspection doors: insulated factory manufactured complete with latches, two handles and neoprene gaskets. Hinge doors to open against air pressure complete with hold open devices.
  - .3 Paint over steel, where steel is not galvanized, or where galvanized steel sheet is cut, with corrosion resistant paint to MPI #18.
    - .1 Finish inside and out, over prime coat, with enamel paint.
  - .4 Internally insulate casing with 25 mm thick, 72 kg/m<sup>3</sup> density, neoprene coated rigid acoustic duct liner with metal nosings at edges, pinned and cement in place.
    - .1 Ensure expanded polystyrene and polyurethane insulation materials are not produced using ozone depleting substances.
  - .5 Openings and bolted sections gasketed.
  - .6 Provide duplex receptacle and vapour tight marine lights complete with gaskets and cast aluminum guards in each section in accordance with Division 26.
- .2 Acoustic panels:
  - .1 Factory manufactured with Sound Transmission Coefficients and Acoustical Absorption Coefficients as indicated.
  - .2 All openings / holes cut for pipework services to be made by the manufacturer prior to delivery to site.

## 2.4 COILS

- .1 General:
  - .1 Cleanable tube type: copper tubes and headers, silver brazed.
  - .2 Plate fin type: tubes mechanically bonded to fins.
  - .3 Spiral wound fin type: mechanically bonded to tubes.
  - .4 Non-ferrous tubes and headers: brazed assembly.
  - .5 Maximum tube length: 3.6 m unless specified otherwise.
  - .6 Factory tested with air under water.
- .2 Capacities: as indicated on equipment schedule.
- .3 Ratings: Certified by manufacturer. Submit with shop drawings actual cooling and heating fluid entering and leaving conditions for stated air side requirements.
- .4 Do not use removable headers at working gauge pressures above 0.7 MPa.
  - .1 Unless indicated, dehumidifying coils rated for 2.5 m/s face velocity.
  - .2 Unless indicated, preheat coils rated for 2.5 m/s.
  - .3 Pressure drop through heating coils: 30 kPa maximum.



- .4 Pressure drop through cooling coils: 50 kPa maximum.
- .5 Water velocity: 1.2 m/s maximum. Under 0.6 m/s, turbulators may be used if manufacturer's standard practice.
- .5 Coil casings:
  - .1 Mounting: designed for bolting to other sections.
  - .2 Steel: die formed 1.6 mm thick galvanized steel sheet.
  - .3 Tube supports: allow for expansion and contraction.
  - .4 Supports: steel channel or double angle frames or other approved support. Provide brass supports for copper coils.
  - .5 Blank-off plates: of similar material as casing to prevent air bypass. Seal openings where pipes pass through casing using methods recommended by SMACNA.
- .6 Heating and Chilled water coils: cleanable fins.
  - .1 Tubes: copper.
  - .2 Fins: plastic coated aluminum.
  - .3 Headers: Copper.
  - .4 Pressure tests: 1.7 MPa.

## **2.5 MOISTURE ELIMINATORS**

- .1 Removable factory manufactured eliminators of 0.6 mm thick plastic to NFPA 90A, and UL/ULC requirements.

## **2.6 DRAIN PANS**

- .1 Construction: stainless steel. Rounded corners.
- .2 Insulation: external foam type, minimum 13 mm thick.
- .3 Drain connection: in bottom at low point.
- .4 Installation: slope without sag minimum 1% to ensure no standing water.
- .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

## **2.7 FILTER BOX**

- .1 Material to match casing complete with bag / panel type filter arrangement as indicated using disposable type filters. Provide access to filter through hinged door.
- .2 Filters: in accordance with Section 23 40 00 - HVAC Air Cleaning Devices.
  - .1 Minimum Efficiency Reporting Value (MERV) value 8 filtration media to ANSI/ASHRAE 52.2, to be used on return air section of 'fresh air' air handling units.
  - .2 Immediately prior to occupancy, replace filtration media with new filtration media with Minimum Efficiency Reporting Value (MERV) of 13 in accordance with ANSI/ASHRAE 52.2.
- .3 Provide spring loaded filter boxes around filters.

## **2.8 CARBON FILTERS**

- .1 Frame material to match air handling unit casing. Provide access to filter through hinged door.
- .2 Shall be provided within each recirculation air handling unit, suitable for the removal of fumes associated with Nitrate media.

## **2.9 DEHUMIDIFIER**

- .1 Each dehumidifier shall be housed within the fresh air, air handling units, rotor type with regeneration air heater (electric) and fan made as part of the air handling unit make up.
- .2 The dehumidifier shall be electrically powered and thyristor controlled.
- .3 The dehumidifier shall have energy recovery, where the regeneration air passes over the rotary heat wheel twice to reach the moisture setpoint required whilst reducing the temperature of the heat wheel for adsorption within the process air stream.
- .4 The rotary wheel shall be of the desiccant type, suitably sized for the application stated within the schedules drawing.
- .5 The dehumidifier shall be pre-wired with safety thermostats for the heater compartment and regeneration discharge air temperature. The unit shall be controlled via a controls thermostat located within the heater compartment.
- .6 The dehumidifier shall come with a rotation guard, to signal if the rotation of the desiccant wheel has stopped due to failure of component (motor, belt etc.).

## **2.10 THERMAL WHEEL HEAT RECOVERY DEVICES**

- .1 Each heat exchanger shall comply with the following:
  - .1 The AHU manufacturer shall liaise with the Controls Specialist to ensure total compatibility between the heat recovery and control system.
  - .2 The heat recovery section shall have a stainless steel drain pan complete drain connection as described previously for all drains.
  - .3 The thermal wheel shall have a minimum heat recovery efficiency of the applicable standard, or 80% (most onerous requirement).
  - .4 The thermal wheel shall be of the hygroscopic type, to enable moisture transfer as well as heat recovery. The latent heat transfer efficiency shall be a minimum of 50%
- .2 Larger heat recovery components shall be provided in manageable components in terms of weight and size. For example - thermal wheels shall be provided in quadrants.

## **2.11 VIBRATION ISOLATION**

- .1 Flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Vibration isolators on each fan section in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

**Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 INSTALLATION**

- .1 Provide appropriate protection apparatus.
- .2 Fabricate to provide smooth air flow through components.
  - .1 Limit air leakage to 1 % of rated air flow at 2.5 kPa pressure.

**3.3 FANS**

- .1 Suspension for hung units: install four part hanger type, ceiling flange, top hanger, bottom hanger and vibration isolator with takeup for levelling.
- .2 Install flexible connections at fan inlets and outlets as indicated.
  - .1 Ensure metal bands of connectors are parallel and not touching.
  - .2 Ensure that fan outlet and duct are aligned when fan is running.

**3.4 DRIP PAN**

- .1 Install deep deal P trap and trap seal primer on drain lines.
  - .1 Depth of water seal to be 1.5 minimum times static pressure at this point.

**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for humidifiers 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 Ontario, Canada.
  - .2 Submit shop drawings to indicate project layout, dimensions and extent of humidification system.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Manufacturer's Field Reports:
  - .1 Submit manufacturer's field reports specified.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.
  - .3 Provide following: one complete set of renewable evaporator media.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect humidifiers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE**

- .1 CSA certified and ULC listed.
- .2 Components housed in factory fabricated cabinet with factory enameled finish and electrically interlocked door.
- .3 Factory sealed disposable steam cylinder complete with factory installed electrodes to suit water condition.
- .4 Controls:
  - .1 Solid state panel.
  - .2 Solenoid valve on water and drain lines.
  - .3 Duct humidistat.
  - .4 Airflow proving switch.
  - .5 Adjustable flush cycle timer.
  - .6 Amp meter.
  - .7 Cylinder replacement indicator light.
- .5 Duct distribution header complete with condensate drain and supply hose.

**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 humidifiers installation in accordance with manufacturer's written instructions.

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

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturers instructions.
- .2 Humidifier and evaporator media to be new and clean when project is accepted.
- .3 Water service overflow drain: to manufacturers' recommendation.
- .4 Install access doors or panels in adjacent ducting.
- .5 When installing in ducting, provide waterproof duct up and downstream in accordance with Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.
- .6 Install capped drain connection at low point in duct.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
  - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, at stages listed:
    - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of the Work, after cleaning is carried out.
  - .4 Obtain reports, within 3 days of review, and submit immediately to Departmental Representative.
- .2 Performance Verification (PV):
  - .1 General: in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.
  - .2 Timing:
    - .1 After TAB of ducted air systems.
    - .2 At same time as PV of related air handling units.
- .3 Start-up:

- .1 General: in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.
- .2 Verify:
  - .1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.
  - .2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.
  - .3 Visually check distribution manifold to ensure:
    - .1 Even distribution of vapour.
    - .2 Freedom from water deposits.
- .4 Commissioning Reports:
  - .1 General: in accordance with Section 01 91 13 - General Commissioning Requirements: reports, supplemented as specified. Include:
    - .1 PV results on approved PV Report Forms.
    - .2 Product Information Report Forms.

### **3.4 DEMONSTRATION**

- .1 Training: in accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel.

### **3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
    - .1 Start-up testing and verification of systems.
    - .2 Check out demonstration or proper operation of components.
    - .3 On-site operational tests.
  - .2 Related Requirements
    - .1 Section 25 05 01 - EMCS: General Requirements.

**1.2 DEFINITIONS**

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  - .1 Outage of main power supply in excess of back-up power sources, provided that:
    - .1 Automatic initiation of back-up was accomplished.
    - .2 Automatic shut-down and re-start of components was as specified.
  - .2 Failure of communications link, provided that:
    - .1 Controller automatically and correctly operated in stand-alone mode.
    - .2 Failure was not due to failure of any specified EMCS equipment.
  - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
    - .1 System recorded said fault.
    - .2 Equipment defaulted to fail-safe mode.
    - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

**1.3 DESIGN REQUIREMENTS**

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



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

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

#### **1.5 CLOSEOUT SUBMITTALS**

- .1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

#### **1.6 COMMISSIONING**

- .1 Do commissioning in accordance with Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.
- .2 Note commissioning will need to be completed in several stages as each phase of the ductwork / plant modification takes place, refer to phasing drawings, the operation and correct conditioning of the media cells is to be maintained throughout the works (apart from short pre-planned and agreed shut downs).
- .3 Carry out commissioning under direction of Departmental Representative and in presence of PWGSC Commissioning Manager
- .4 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
  - .1 Location and part of system to be tested or commissioned.
  - .2 Testing/commissioning procedures, anticipated results.
  - .3 Names of testing/commissioning personnel.
- .5 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .6 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .7 Load system with project software.
- .8 Perform tests as required.

## **1.7 COMPLETION OF COMMISSIONING**

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and PWGSC Commissioning Manager

## **1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

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

## **Part 2 Products**

### **2.1 EQUIPMENT**

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

## **Part 3 Execution**

### **3.1 PROCEDURES**

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

### **3.2 FIELD QUALITY CONTROL**

- .1 Pre-Installation Testing.
  - .1 General: consists of field tests of equipment just prior to installation.

- .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
  - .1 DP transmitters.
  - .2 VAV supply duct SP transmitters.
  - .3 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp metre at source.
- .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
- .8 Departmental Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".
- .9 Transmitters above 0.5 % error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test operating software.
    - .8 Test application software and provide samples of logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug software.
    - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
    - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and

Departmental Representative or Commissioning Manager. This document will be used in final startup testing.

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

.5 Commissioning Manager to verify reported results.

**3.3 ADJUSTING**

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

**3.4 DEMONSTRATION**

- .1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section [01 79 00 - Demonstration and Training].

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.
- .2 Related Requirements
  - .1 Section 25 05 01 - EMCS: General Requirements.
  - .2

**1.2 DEFINITIONS**

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

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 QUALITY ASSURANCE**

- .1 Provide bilingual, competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

**1.5 INSTRUCTIONS**

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

**1.6 TIME FOR TRAINING**

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

## **1.7 TRAINING MATERIALS**

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

## **1.8 TRAINING PROGRAM**

- .1 To be in 2 phases over 6 month period.
- .2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor and Departmental Representative.
  - .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
  - .2 Supplement with on-the-job training during 30 day test period.
  - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: 2 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.
  - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
    - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
    - .2 Equipment maintenance training: provide personnel with 1/2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
    - .3 Programmers: provide personnel with 1 1/2] days training within 5 day period in following subjects in approximate percentages of total course shown:

Software and architecture: 10 %
Application programs: 15 %
Controller programming: 50 %
Trouble shooting and debugging: 10 %
Colour graphic generation: 15 %

## **1.9 ADDITIONAL TRAINING**

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

## **1.10 MONITORING OF TRAINING**

- .1 Departmental Representative to monitor training program and may modify schedule and content.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.
- .2 Related Requirements
  - .1 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process
  - .2 Section 25 05 54 - EMCS: Identification.

**1.2 REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5-[1985], Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1-[1993], American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135-[R2001], BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 CSA Group (CSA).
  - .1 CAN/CSA-Z234.1-[89 (R1995)], Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-[B-2002], Control Network Protocol Specification.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Safety Data Sheets (SDS).
- .7 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

**1.3 ABBREVIATIONS AND ACRONYMS**

- .1 Acronyms used in EMCS:
  - .1 AEL - Average Effectiveness Level
  - .2 AI - Analog Input
  - .3 AIT - Agreement on International Trade
  - .4 AO - Analog Output

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

#### 1.4

#### DEFINITIONS

- .1 Point: may be logical or physical.

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

## **1.5 SYSTEM DESCRIPTION**

- .1 Refer to control schematics for system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point summary tables.
  - .3 OWS(s).

- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements of system.
  - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
  - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
  - .4 Provide utility power to EMCS and emergency power to EMCS.
  - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .4 Language Operating Requirements:
  - .1 Provide English operator selectable access codes.
  - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
  - .3 Operating system executive: provide primary hardware-to-software interface [specified as part of hardware purchase] with associated documentation to be in English.
  - .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
  - .5 Include, in English:
    - .1 field related changes alarms Input and output commands and messages from operator-initiated functions] as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
    - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
    - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

**1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process and 01 33 00 - Submittal Procedures.
- .2 Submit for review:
  - .1 Equipment list systems manufacturers within 10 days after award of contract.
  - .2 List existing field control devices to be re-used included in tender, along with unit price.
- .3 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
  - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - .6 Permits and fees: in accordance with general conditions of contract.
  - .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
  - .8 Existing devices intended for re-use: submit test report.

**1.7 QUALITY ASSURANCE**

- .1 Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .5 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse or recycling
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper plastic corrugated cardboard polystyrene packaging material for recycling in accordance with Waste Management Plan.
  - .4 Separate for recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
  - .5 Place materials defined as hazardous or toxic in designated containers.
  - .6 Label location of salvaged material's storage areas and provide barriers and security devices.
  - .7 Ensure emptied containers are sealed and stored safely.
  - .8 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

## **1.9 EXISTING- CONTROL COMPONENTS**

- .1 Utilize existing control wiring as indicated.
- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.
  - .1 Do not modify original design of existing devices without written permission from Departmental Representative.
  - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
  - .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
  - .2 Failure to produce test report will constitute acceptance of existing devices by contractor.
- .4 Non-functioning items:
  - .1 Provide with report specification sheets or written functional requirements to support findings.
  - .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.
- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.

- .1 Be responsible for items repaired or replaced by Departmental Representative.
- .2 Be responsible for repair costs due to negligence or abuse of equipment.
- .3 Responsibility for existing devices terminates and applicable portions of EMCS as approved by Departmental Representative upon final acceptance of EMCS.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

## **Part 2 Products**

### **2.1 EQUIPMENT**

- .1 Control Network Protocol : to ASHRAE STD 135
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

### **2.2 ADAPTORS**

- .1 Provide adaptors between metric and imperial components.

## **Part 3 Execution**

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

- .1 Installation: to manufacturer's recommendations.

### **3.2 PAINTING**

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

### **3.3 FIELD QUALITY CONTROL**

- .1 Verification requirements include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.

- .7 Certified Wood.
- .8 Low-emitting materials.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).
- .2 Related Requirements:
  - .1 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
  - .2 Section 25 05 01 – EMCS: General Requirements.

**1.2 DEFINITIONS**

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

**1.3 DESIGN REQUIREMENTS**

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

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 5 working days after contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

## **1.5 PRELIMINARY SHOP DRAWING REVIEW**

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

## **1.6 DETAILED SHOP DRAWING REVIEW**

- .1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
  - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
  - .2 Wiring diagrams.
  - .3 Piping diagrams and hook-ups.
  - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

- .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Associated field wiring schematics, schedules and terminations.
  - .4 Complete Point Name Lists.
  - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
  - .6 Software and programming details associated with each point.
  - .7 Manufacturer's recommended installation instructions and procedures.
  - .8 Input and output signal levels or pressures where new system ties into existing control equipment.
- .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- .7 Graphic system schematic displays of water and air systems with point identifiers and textual description of system, and typical floor plans as specified.
- .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
- .9 Listing and example of specified reports.
- .10 Listing of time of day schedules.
- .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- .12 Type and size of memory with statement of spare memory capacity.
- .13 Full description of software programs provided.
- .14 Sample of "Operating Instructions Manual" to be used for training purposes.
- .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

## **1.7 QUALITY ASSURANCE**

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

- .4 Factory testing:
  - .1 Factory testing shall be undertaken for the proposed new BMS equipment as described within Section 01 91 13.13 Commissioning Plan.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.
- .2 Related Requirements
  - .1 Section 25 05 01 – EMCCS: General Requirements.
  - .2 Section 25 05 02 - EMCS: Submittals and Review Process.
  - .3 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
  - .4

**1.2 DEFINITIONS**

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

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 AS-BUILTS**

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1 Changes to Contract Documents as well as addenda and contract extras.
  - .2 Changes to interface wiring.
  - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.

- .4 Locations of obscure devices to be indicated on drawings.
- .5 Listing of alarm messages.
- .6 Panel/circuit breaker number for sources of normal/emergency power.
- .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance electronic copy incorporating changes made during final review.

## **1.5 O&M MANUALS**

- .1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4 Functional description to include:
  - .1 Functional description of theory of operation.
  - .2 Design philosophy.
  - .3 Specific functions of design philosophy and system.
  - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
  - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
  - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented [or planned] for implementation in automatic mode.
- .5 System operation to include:
  - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
  - .2 Operation of computer peripherals, input and output formats.
  - .3 Emergency, alarm and failure recovery.
  - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command

so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

- .6 Software to include:
  - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - .2 Detailed descriptions of program requirements and capabilities.
  - .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
  - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
  - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
  - .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
  - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
  - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes.
  - .1       Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.
- .2    Related Requirements
  - .1       Section 25 05 01 - EMCS: General Requirements..

**1.2            REFERENCE STANDARDS**

- .1    CSA Group (CSA).
  - .1       CSA C22.1-[02], The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

**1.3            DEFINITIONS**

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

**1.4            SYSTEM DESCRIPTION**

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

**1.5            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2    Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

**Part 2            Products**

**2.1            NAMEPLATES FOR PANELS**

- .1    Identify by 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
- .2    Sizes: 25 x 67 mm minimum.
- .3    Lettering: minimum 7 mm high, black.
- .4    Inscriptions: machine engraved to identify function.

**2.2            NAMEPLATES FOR FIELD DEVICES**

- .1    Identify by plastic encased cards attached by plastic tie.
- .2    Sizes: 50 x 100 mm minimum.



- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

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

- .1 Identify by labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

### **2.4 WARNING SIGNS**

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

### **2.5 WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

### **2.6 CONDUIT**

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

## **Part 3 Execution**

### **3.1 NAMEPLATES AND LABELS**

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

### **3.2 EXISTING PANELS**

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

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 36 00 – Air Terminal Units.
- .2 Section 25 05 20 – EMCS: Warranty and Maintenance.
- .3 Section 25 05 54 - EMCS: Identification.

**1.2 REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ASME B16.22-Latest, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  - .2 ANSI C2-Latest, National Electrical Safety Code.
  - .3 ANSI/NFP1A 70-Latest, National Electrical Code.
- .2 CSA Group (CSA)
  - .1 CSA C22.1-12,
  - .2 CAN/CSA C22.2 No. 45.1-07 R2012, Electrical Rigid Metal Conduit.
  - .3 CAN/CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CAN/CSA C22.2 No. 83-M1985 R2013, Electrical Metallic Tubing.

**1.3 SYSTEM DESCRIPTION**

- .1 Electrical:
  - .1 Provide power wiring from existing power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
  - .2 Hard wiring between field control devices and EMCS field panels.
  - .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
  - .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .2 Mechanical:
  - .1 Pipe Taps Required For EMCS equipment will be supplied and installed by Division 23.
  - .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.
  - .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.
- .3 VAV Terminal Units.

- .1 Air flow probe for VAV boxes to be supplied and installed under Section 23 36 00 – Air Terminal Units. Air flow DP sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.
- .4 Structural:
  - .1 Special steelwork as required for installation of work shall be provided by EMCS contractor.

#### **1.4 PERSONNEL QUALIFICATIONS**

- .1 Qualified supervisory personnel to:
  - .1 Continuously direct and monitor all work.
  - .2 Attend site meetings.

#### **1.5 EXISTING CONDITIONS**

- .1 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

### **Part 2 Products**

#### **2.1 WIRING**

- .1 As per requirements of Division 26.
- .2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4 Sizes:
  - .1 120V Power supply: to match or exceed breaker, size #12 minimum.
  - .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
  - .3 Field wiring to digital device: 20 AWG stranded twisted pair
  - .4 Analog input and output: shielded #20 minimum stranded twisted pair Wiring must be continuous without joints.
  - .5 More than 4 conductors: #22 minimum solid copper.
- .5 Terminations:
  - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

## **2.2 CONDUIT**

- .1 As per requirements of Division 26.
- .2 Electrical metallic tubing to CAN/CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CAN/CSA C22.2 No. 56. Rigid steel threaded conduit to CAN/CSA C22.2 No. 45.1.
- .3 Junction and pull boxes: welded steel.
  - .1 Surface mounting cast FS: screw-on flat covers.
  - .2 Flush mounting: covers with 25 mm minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 100 mm minimum, square.
- .6 Conduit boxes, fittings:
  - .1 Bushings and connectors: with nylon insulated throats.
  - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
  - .1 Couplings and fittings: threaded type steel.
  - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
  - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for thin wall conduit:
  - .1 Connectors and couplings: steel, set screw type.

## **2.3 WIRING DEVICES, COVER PLATES**

- .1 Conform to CSA.
- .2 Receptacles:
  - .1 Duplex: CSA type 5-15R.
  - .2 Single: CSA type 5-15R.
  - .3 Cover plates and blank plates: finish to match other plates in area.

## **2.4 STARTERS, CONTROL DEVICES**

- .1 Across-the-line magnetic starters:
  - .1 Enclosures: CSA Type 1, except where otherwise specified.
  - .2 Size, type and rating: to suit motors.
- .2 Starter diagrams:
  - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .3 Auxiliary Control Devices:

- .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
- .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
- .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
- .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.
- .4 Finish for starters:
  - .1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .2 Interior: white.

## **2.5 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT**

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
  - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
  - .1 50 mm diameter and smaller: one-hole steel straps.
  - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
  - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

### **3.2 PIPING**

- .1 Hot water heating, chilled water: refer to Division 23.
- .2 Insulation: refer to Division 23.

### **3.3 ELECTRICAL GENERAL**

- .1 Do complete installation in accordance with requirements of:
  - .1 Division 26, this specification.
  - .2 CSA 22.1 Canadian Electrical Code.
  - .3 ANSI/NFPA 70.
  - .4 ANSI C2.

- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

### 3.4 CONDUIT SYSTEM

- .1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
- .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
- .4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
- .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .7 Limit conduit length between pull boxes to less than 30 m.
- .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
- .9 Fastenings and supports for conduits, cables, and equipment:
  - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

- .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
- .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
- .10 Install polypropylene fish cord in empty conduits for future use.
- .11 Where conduits become blocked, remove and replace blocked sections.
- .12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.
- .13 Conduits may be run in flanged portion of structural steel.
- .14 Group conduits wherever possible on suspended or surface channels.
- .15 Pull boxes:
  - .1 Install in inconspicuous but accessible locations.
  - .2 Support boxes independently of connecting conduits.
  - .3 Fill boxes with paper or foam to prevent entry of construction material.
  - .4 Provide correct size of openings. Reducing washers not permitted.
  - .5 Mark location of pull boxes on record drawings.
  - .6 Identify AC power junction boxes, by panel and circuit breaker.
- .16 Install bonding conductor for 120 volt and above in conduit.

### **3.5 WIRING**

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
  - .1 Circuits are continuous, free from shorts, unspecified grounds.
  - .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Departmental Representative with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

### **3.6 WIRING DEVICES, COVER PLATES**

- .1 Receptacles:
  - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Cover plates:
  - .1 Install suitable common cover plate where wiring devices are grouped.
  - .2 Use flush type cover plates only on flush type outlet boxes.

### **3.7 STARTERS, CONTROL DEVICES**

- .1 Install and make power and control connections as indicated.
- .2 Install correct over-current devices.
- .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
- .4 Performance Verification:
  - .1 Operate switches and controls to verify functioning.
  - .2 Perform start and stop sequences of contactors and relays.
  - .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

### **3.8 GROUNDING**

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.
- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

### **3.9 TESTS**

- .1 General:
  - .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
  - .2 Give 14 days written notice of intention to test.
  - .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
  - .4 Conceal work only after tests satisfactorily completed.
  - .5 Report results of tests to Departmental Representative in writing.
  - .6 Preliminary tests:
    - .1 Conduct as directed to verify compliance with specified requirements.
    - .2 Make needed changes, adjustments, replacements.
    - .3 Insulation resistance tests:



- .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
- .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

### **3.10 IDENTIFICATION**

- .1 Refer to Section 25 05 54 - EMCS: Identification.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).
- .2 Related Requirements
  - .1 Section 25 05 01 - EMCS: General Requirements.
- .3 References.
  - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
  - .2 CSA Group (CSA).
    - .1 CSA Z204-[94 (R1999)], Guidelines for Managing Indoor Air Quality in Office Buildings.

**1.2 DEFINITIONS**

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
  - .1 Point name and location.
  - .2 Device type and range.
  - .3 Measured value.
  - .4 System displayed value.
  - .5 Calibration detail
  - .6 Indication if adjustment required,
  - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

- .1 Maintain records and logs of each maintenance task on site.
- .2 Organize cumulative records for each major component and for entire EMCS chronologically.
- .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

#### **1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD**

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Detailed preventative maintenance schedule shall be co-ordinated to match existing service contract inspections (see 3.1).
- .3 Emergency Service Calls:
  - .1 Initiate service calls when EMCS is not functioning correctly.
  - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
  - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
  - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
  - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .4 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .5 Work requests: record each service call request, when received separately on approved form and include:
  - .1 Serial number identifying component involved.
  - .2 Location, date and time call received.
  - .3 Nature of trouble.
  - .4 Names of personnel assigned.
  - .5 Instructions of work to be done.
  - .6 Amount and nature of materials used.
  - .7 Time and date work started.
  - .8 Time and date of completion.
- .6 Provide system modifications in writing.
  - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 FIELD QUALITY CONTROL**

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
  - .2 Calibrate each field input/output device in accordance with CSA Z204.
  - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
  - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
  - .2 Check equipment cooling fans as required.
  - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
  - .4 Review system performance with Departmental Representative to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
  - .1 Minor inspection.
  - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
  - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
  - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
  - .5 Provide mechanical adjustments, and necessary maintenance on printers.
  - .6 Run system software diagnostics as required.
  - .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
    - .1 Perform network analysis and provide report as described in Submittal article.

- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
  - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).
- .2 Related Requirements
  - .1 Section 25 05 01 - EMCS - General Requirements.

**1.2 REFERENCE STANDARDS**

- .1 CSA Group (CSA).
  - .1 CSA T529-[95 (R2000)], Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
  - .2 CSA T530-[99 (R2004)], Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
  - .1 IEEE Std 802.3TM-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
  - .1 TIA/EIA-568-[March 2004], Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
  - .2 TIA/EIA-569-A-[December 2001], Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
  - .1 TBITS 6.9-[2000], Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

**1.3 DEFINITIONS**

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

**1.4 SYSTEM DESCRIPTION**

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with [TIA/EIA-568] [CSA T529] [CSA T530] [TIA/EIA-569-A] [TBITS 6.9].
  - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to include, but not limited to:
  - .1 EMCS-LAN.
  - .2 Modems.
  - .3 Network interface cards.
  - .4 Network management hardware and software.
  - .5 Network components necessary for complete network.

## **1.5 DESIGN REQUIREMENTS**

- .1 EMCS Local Area Network (EMCS-LAN).
  - .1 The existing Operator workstation and LAN shall be extended and modified to accommodate the new EMS components and controllers etc.
  - .2 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with [IEEE 802.3/Ethernet Standard].
  - .3 EMCS-LAN to: [Proprietary Protocol] [BACnet,].
  - .4 Each EMCS-LAN to be capable of supporting at least 50 devices.
  - .5 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
  - .6 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be [10] Megabits per second minimum.
  - .7 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
  - .8 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
  - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
  - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
  - .1 Network medium: shielded twisted cable, compatible with network protocol to be used within buildings.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Hardware and software requirements for modifications to the existing operator station as required for compatibility with new systems installed.
- .2 Related Requirements
  - .1 Section 25 05 01 - EMCS: General Requirements.
  - .2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .3 Section 25 05 03 - EMCS: Project Record Documents.

**1.2 DEFINITIONS**

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

**1.3 OWS SYSTEM DESCRIPTION**

- .1 The existing computer located within the ventilation plantroom shall be reused. The graphics shall be updated to incorporate changes to the existing EMCS and incorporate all new elements of the system.
- .2 The computer shall be checked and verified as suitable for the proposed modifications and any deficiencies / recommendations provided to the Department Representative.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

**1.5 MAINTENANCE**

- .1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

**Part 2 Products**

**2.1 Not used**

**Part 3 Execution**

**3.1 Not used**

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for building automation controllers including:
    - .1 Master Control Unit (MCU).
    - .2 Local Control Unit (LCU).
    - .3 Equipment Control Unit (ECU).
    - .4 Terminal Control Unit (TCU).
  - .2 Related Requirements
    - .1 Section 25 05 01 - EMCS: General Requirements.
    - .2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
    - .3 Section 25 05 03 - EMCS: Project Record Documents.

**1.2 REFERENCE STANDARDS**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE [2003], Applications Handbook, SI Edition.
- .2 CSA Group (CSA).
  - .1 C22.2 No.205-[M1983 (R1999)], Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
  - .1 IEEE C37.90.1-[02], Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
  - .1 MD13800-[September 2000], Energy Management and Control Systems (EMCS) Design Manual. English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

**1.3 DEFINITIONS**

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

**1.4 DESCRIPTION**

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
  - .1 Provide sufficient controllers to meet intents and requirements of this section.
  - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

- .2      Controllers: stand-alone intelligent Control Units.
  - .1      Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
  - .2      Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
  - .3      Capable of interfacing with operator interface device.
  - .4      Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
    - .1      Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

## 1.5      **DESIGN REQUIREMENTS**

- .1      To include:
  - .1      Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
  - .2      Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
  - .3      Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4      Control of systems as described in sequence of operations.
  - .5      Execution of optimization routines as listed in this section.
- .2      Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.
- .3      Field Termination and Interface Devices:
  - .1      To: CSA C22.2 No.205.
  - .2      Electronically interface sensors and control devices to processor unit.
  - .3      Include, but not be limited to, following:
    - .1      Programmed firmware or logic circuits to meet functional and technical requirements.
    - .2      Power supplies for operation of logics devices and associated field equipment.
    - .3      Lockable wall cabinet.
    - .4      Required communications equipment and wiring (if remote units).
    - .5      Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
    - .6      Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
    - .7      Wiring terminations: use conveniently located screw type or spade lug terminals.
  - .4      AI interface equipment to:

- .1 Convert analog signals to digital format with [16] bit analog-to-digital resolution.
- .2 Provide for following input signal types and ranges:
  - .1 [4 - 20] mA;
  - .2 [0 - 10] V DC;
  - .3 100/1000 ohm RTD input;
- .3 Meet IEEE C37.90.1 surge withstand capability.
- .4 Have common mode signal rejection greater than [60] dB to [60] Hz.
- .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using [8] bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 [4 - 20] mA.
    - .2 [0 - 10] V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to [2] kHz.
- .7 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to [0.5] amps at [24] V AC.
  - .2 Switch up to [5] amps at [220] V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
  - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
  - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

## **1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

- .1 Submit product data sheets for each product item proposed for this project.

## **1.7 MAINTENANCE**

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

## **Part 2 Products**

### **2.1 MASTER CONTROL UNIT (MCU)**

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
  - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
  - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
  - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
  - .1 Processor to consist of minimum [16] bit microprocessor capable of supporting software to meet specified requirements.
  - .2 CPU idle time to be more than [30] % when system configured to maximum input and output with worst case program use.
  - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
    - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
  - .4 Include uninterruptible clock accurate to plus or minus [5] secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum [72] hour operation in event of power failure.

### **2.2 LOCAL CONTROL UNIT (LCU)**

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
  - .1 Include minimum [2] interface ports for connection of local computer terminal.
  - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
  - .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
  - .4 Include power supplies for operation of LCU and associated field equipment.
  - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
  - .6 Provide conveniently located screw type or spade lug terminals for field wiring.

## **2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)**

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
  - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller.
  - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
  - .2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.
  - .3 Controller to operate independent of network in case of communication failure.
  - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

## **2.4 SOFTWARE**

- .1 General.
  - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
  - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
  - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.

- .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
- .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
  - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
  - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Pseudo or calculated points.
  - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
  - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .5 Control Description Logic (CDL):
  - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Departmental Representative must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
  - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
  - .3 Perform changes to CDL on-line.
  - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
  - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
  - .6 MCU to be able to perform following pre-tested control algorithms:
    - .1 Two position control.
    - .2 Proportional Integral and Derivative (PID) control.
  - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
  - .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
  - .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and

- analyse controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyse status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .6 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will ensure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
- .7 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
- .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
- .1 Time of day scheduling.
  - .2 Calendar based scheduling.
  - .3 Temporary schedule overrides.
  - .4 Night setback control.
  - .5 Enthalpy (economizer) switchover.
  - .6 Absolute moisture level control
  - .7 Peak demand limiting.
  - .8 Temperature compensated load rolling.
  - .9 Fan speed/flow rate control.
  - .10 Hot water reset.
  - .11 Chilled water reset.
  - .12 Chiller sequencing.
- .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
- .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .8 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
- .1 MCUs to accumulate and store automatically run-time for binary input and output points.
  - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.



- .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
- .4 Totalization routine to have sampling resolution of [1] min or less for analog inputs.
- .5 Totalization to provide calculations and storage of accumulations up to [99,999.9] units (eg. kWh, litres, tonnes, etc.).
- .6 Store event totalization records with minimum of [9,999,999] events before reset.
- .7 User to be able to define warning limit and generate user-specified messages when limit reached.

## **2.5 LEVELS OF ADDRESS**

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
  - .1 Display analog values digitally to [1] place of decimals with negative sign as required.
  - .2 Update displayed analog values and status when new values received.
  - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
  - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

## **2.6 POINT NAME SUPPORT**

- .1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

## **Part 3 Execution**

### **3.1 LOCATION**

- .1 Location of Controllers to be approved by Departmental Representative.

### **3.2 INSTALLATION**

- .1 Install Controllers in secure locking enclosures as directed by Departmental Representative.
- .2 Provide necessary power from local [120] V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1    Control devices integral to the Building Energy Monitoring and Control System (EMCS): controls, valves, low voltage current transformers valve actuators, dampers, sensors, transmitters, switches, meters, transducers, damper operators,...
- .2    Related Sections:
  - .1    Section 01 73 00 - Execution.
  - .2    Section 07 84 00 - Fire stopping.
  - .3    Section 23 33 15 - Dampers - Operating.
  - .4    Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
  - .5    Section 25 05 01 - EMCS: General Requirements.
  - .6    Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .7    Section 25 05 54 - EMCS: Identification
  - .8    Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
  - .9    Section 26 05 00 - Common Work Results for Electrical.
  - .10   Section 26 27 10 - Modular Wiring System.
  - .11   Section 26 27 26 - Wiring Devices.

**1.2            REFERENCE STANDARDS**

- .1    American National Standards Institute (ANSI).
  - .1    ANSI C12.7-1993 R1999, Requirements for Watthour Meter Sockets.
  - .2    ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .2    ASTM International (ASTM)
  - .1    ASTM B148-97 03, Standard Specification for Aluminum-Bronze Sand Castings.
- .3    National Electrical Manufacturer's Association (NEMA).
  - .1    NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4    Air Movement and Control Association, Inc. (AMCA).
  - .1    AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
- .5    CSA Group CSA Group
  - .1    CSA-C22.1-[02], Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

**1.3            DEFINITIONS**

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

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

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Pre-Installation Tests.
  - .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .3 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions for specified equipment and devices.

#### **1.5 EXISTING CONDITIONS**

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, low temperature, assembly.
- .3 Operating conditions: -10 to 32 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA [4] enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, pressure, as indicated in I/O summary

#### **2.2 TEMPERATURE SENSORS**

- .1 General: except for vault sensors, to be resistance or thermocouple type to following requirements:

- .1 Thermocouples: limit to temperature range of -50 to 50 degrees C.
- .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
- .3 High accuracy +/-0.25 degrees C -20 to +20 degrees C
- .4 Sensing element: hermetically sealed.
- .5 Stem and tip construction: copper or type 304 stainless steel.
- .6 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
- .7 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length as required.
- .2 Cell temperature sensors and display wall modules.
  - .1 Duct temperature sensors:
  - .2 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length as required.
- .3 Outdoor air temperature sensors:
  - .1 Outside air type: non-corroding shield to minimize solar and wind effects, threaded fitting for mating to conduit, weatherproof construction in NEMA 4 enclosure.

## **2.3 TEMPERATURE TRANSMITTERS**

- .1 Requirements:
  - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
  - .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
  - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .4 Input and output short circuit and open circuit protection.
  - .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
  - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
  - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
  - .8 Integral zero and span adjustments.
  - .9 Temperature effects: not to exceed plus or minus [1.0] % of full scale/20 degrees C.
  - .10 Long term output drift: not to exceed 0.25 % of full scale/6 months.
  - .11 Transmitter ranges: select narrowest range to suit application from following:
    - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus [0.1] degrees C.

## **2.4 DUCT MOUNTED DEWPOINT SENSORS / HUMIDITY SENSORS**

- .1 High Accuracy Duct Sensor Requirements:

- .1 Range: 5- 90 % RH minimum.
- .2 Operating temperature range: -5 to +30 degrees C.
- .3 Absolute accuracy:
  - .1 Dewpoint plus or minus 0.25 Degrees C, Typical operating condition:
    - .1 duct temperature -5 to +5 degrees C
    - .2 duct dewpoint -15 degrees C
  - .2 Relative Humidity Reading: plus or minus 1 %.
- .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
- .5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
- .6 Duct mounted sensors: locate so that sensing element is in air flow in duct.
- .7 DEWPOINT / HUMIDITY TRANSMITTERS
- .2 Requirements:
  - .1 Input signal: from Dewpoint / RH sensor.
  - .2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
  - .3 Input and output short circuit and open circuit protection.
  - .4 Output variations: not to exceed 0.1 % of full scale output for supply voltage variations of plus or minus 5 %.
  - .5 Output linearity error: plus or minus 1.0% maximum of full scale output.
  - .6 Integral zero and span adjustment.
  - .7 Temperature effect: plus or minus 1.0 % full scale/6 months.
  - .8 Long term output drift: not to exceed 0.25 % of full scale output/[6] months.

## **2.5 PRESSURE TRANSDUCERS**

- .1 Requirements:
  - .1 Combined sensor and transmitter measuring pressure.
    - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
  - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
  - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
  - .5 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C.
  - .6 Over-pressure input protection to at least twice rated input pressure.
  - .7 Output short circuit and open circuit protection.
  - .8 Accuracy: plus or minus 1% of Full Scale.

## **2.6 DIFFERENTIAL PRESSURE TRANSMITTERS**

- .1 Requirements:

- .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
- .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
- .5 Integral zero and span adjustment.
- .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C.
- .7 Over-pressure input protection to at least twice rated input pressure.
- .8 Output short circuit and open circuit protection.
- .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

## **2.7 STATIC PRESSURE SENSORS**

- .1 Requirements:
  - .1 Multipoint element with self-averaging manifold.
    - .1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
  - .2 Accuracy: plus or minus 1 % of actual duct static pressure.

## **2.8 STATIC PRESSURE TRANSMITTERS**

- .1 Requirements:
  - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
  - .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
  - .3 Accuracy: 0.4 % of span.
  - .4 Repeatability: within 0.5 % of output.
  - .5 Linearity: within 1.5 % of span.
  - .6 Deadband or hysteresis: 0.1 % of span.
  - .7 External exposed zero and span adjustment.
  - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

## **2.9 VELOCITY PRESSURE SENSORS**

- .1 Requirements:
  - .1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
  - .2 Maximum pressure loss: 37 Pa at 1000 m/s.
  - .3 Accuracy: plus or minus 1 % of actual duct velocity.

## **2.10 VELOCITY PRESSURE TRANSMITTERS**

- .1 Requirements:

- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .2 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.
- .3 Accuracy: 0.4 % of span.
- .4 Repeatability: within 0.1 % of output.
- .5 Linearity: within 0.5 % of span.
- .6 Deadband or hysteresis: 0.1 % of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

## **2.11 LIQUID AND STEAM FLOW METERS**

- .1 Requirements:
  - .1 Pressure rating: as specified in I/O summaries.
  - .2 Temperature rating: as specified in I/O summaries.
  - .3 Repeatability: plus or minus 0.2 %.
  - .4 Accuracy and linearity: plus or minus 1.0 %.
  - .5 Flow rangability: at least 10:1.
  - .6 Ends:
    - .1 NPS 2 and under: screwed.
    - .2 NPS 2.1/2 and over: flanged.

## **2.12 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES**

- .1 Requirements:
  - .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
  - .2 Adjustable setpoint and differential.
  - .3 Switch: snap action type, rated at 24 V DC, 15 amps .
  - .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
  - .5 Accuracy: within 2 % repetitive switching.
  - .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
  - .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

## **2.13 ELECTROMECHANICAL RELAYS**

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

- .4 Relay to have visual status indication

## **2.14 SOLID STATE RELAYS**

- .1 General:
  - .1 Relays to be socket or rail mounted.
  - .2 Relays to have LED Indicator
  - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
  - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
  - .5 Relays to be CSA Certified.
  - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
  - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
  - .1 Control voltage, 3 to 32 VDC.
  - .2 Drop out voltage, 1.2 VDC.
  - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output.
  - .1 AC or DC Output Model to suit application.

## **2.15 CURRENT TRANSDUCERS**

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

## **2.16 CURRENT SENSING RELAYS**

- .1 Requirements:
  - .1 Suitable to detect belt loss or motor failure.
  - .2 Trip point adjustment, output status LED.
  - .3 Split core for easy mounting.
  - .4 Induced sensor power.



- .5 Relay contacts: capable of handling 0.5amps at 30 VAC/DC. Output to be NO solid state.
- .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
- .7 Adjustable latch level.

## **2.17 CONTROL DAMPERS**

- .1 AHU complete with dampers, provide actuators

## **2.18 ELECTRONIC CONTROL DAMPER ACTUATORS**

- .1 Requirements:
  - .1 Direct mount proportional type as indicated.
  - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
  - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
  - .4 Power requirements: 5 VA maximum at 24 V AC.
  - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
  - .6 For VAV box applications floating control type actuators may be used.
  - .7 Damper actuator to drive damper from full open to full closed in less than [120] seconds.

## **2.19 CONTROL VALVES**

- .1 Body: globe style or characterized ball.
  - .1 Flow characteristic as indicated on control valve schedule: equal percentage.
  - .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
  - .3 Normally open , as indicated.
  - .4 Three / Two port, as indicated.
  - .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
  - .6 Packing easily replaceable.
  - .7 Stem, stainless steel.
  - .8 Plug and seat, stainless steel.
  - .9 Disc, replaceable, material to suit application.
- .10 NPS 2 and under:
  - .1 Screwed National Pipe Thread (NPT) tapered female connections.
  - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  - .3 Rangeability 50:1 minimum.
- .11 NPS 2½ and larger:
  - .1 Flanged connections.
  - .2 Valves to ANSI Class or 250, valves to bear ANSI mark.
  - .3 Rangeability 100:1 minimum.

## **2.20 ELECTRONIC/ELECTRIC VALVE ACTUATORS**

- .1 Requirements:
  - .1 Construction: steel, cast iron, aluminum.
  - .2 Control signal: 0-10V DC.
  - .3 Positioning time: to suit application. 90 sec maximum.
  - .4 Fail to normal position as indicated.
  - .5 Scale or dial indication of actual control valve position.
  - .6 Size actuator to meet requirements and performance of control valve specifications.
  - .7 Minimum shut-off pressure: refer to control valve schedule.

## **2.21 WATTHOUR METERS AND CURRENT TRANSFORMERS**

- .1 Requirements:
  - .1 Include three phases, test and terminal blocks for watthour metre connections and connections for monitoring of current. [Provide two transformers for 600 V 3 wire systems for watthour metre use]. Accuracy: plus or minus 0.25 % of full scale. For chiller applications: to have instantaneous indicator with analog or digital display.
  - .2 Watthour metre sockets: to ANSI C12.7.
  - .3 Potential and current transformers: to ANSI/IEEE C57.13.
  - .4 Potential transformers: provide two primary fuses.
  - .5 Demand meters: configure to measure demand at 15 minute intervals.

## **2.22 PANELS**

- .1 Free-standing enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

## **2.23 WIRING**

- .1 In accordance with Section 26 27 10 - Modular Wiring System and 26 27 26 - Wiring Devices.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
  - .1 Field wiring to digital device: 20AWG stranded twisted pair.
  - .2 Analog input and output: shielded 20 minimum stranded twisted pair

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Fire stopping. Maintain the fire-resistance rating integrity of the fire separation.
- .6 Electrical:
  - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
  - .3 Refer to electrical control schematics included as part of control design schematics on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.
  - .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - .5 Install communication wiring in conduit.
    - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
    - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
    - .3 Maximum conduit fill not to exceed 40%.
    - .4 Design drawings do not show conduit layout.
  - .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.
- .7 VAV Terminal Units: supply, install and adjust as required.
  - .1 Air probe, actuator and associated vav controls.
  - .2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.
  - .3 Co-ordinate air flow adjustments with balancing trade.

### **3.2 TEMPERATURE AND HUMIDITY SENSORS**

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by non-corroding shields.
  - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
  - .1 Do not mount in dead air space.
  - .2 Locate within sensor vibration and velocity limits.
  - .3 Securely mount extended surface sensor used to sense average temperature.
  - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
  - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
  - .1 Install averaging element horizontally across the ductwork starting 305 mm from top of ductwork. Each additional horizontal run to be no more than 305 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
  - .2 Wire multiple sensors in series for low temperature protection applications.
  - .3 Wire multiple sensors separately for temperature measurement.
  - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
  - .1 Locate well in elbow where pipe diameter is less than well insertion length.
  - .2 Thermowell to restrict flow by less than 30%.
  - .3 Use thermal conducting paste inside wells.

### **3.3 PANELS**

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

### **3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS**

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
  - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

**3.5 IDENTIFICATION**

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

**3.6 AIR FLOW MEASURING STATIONS**

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

**3.7 TESTING AND COMMISSIONING**

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**END OF SECTION**

## **Part 1 General**

### **1.1 SUMMARY**

- .1 Section Includes:
  - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
    - .1 Control Description Logic (CDL) for each system.
    - .2 Input/Output Point Summary Tables for each system.
    - .3 System Diagrams consisting of the following; Control Design Schematic for each system (as viewed on OWS); simplified humidity control logic schematic.

### **1.2 REFERENCE STANDARDS**

- .1 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
  - .1 MD250005-2009, Energy Monitoring and Control Systems (EMCS) Design Guidelines. English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

### **1.3 SEQUENCING**

- .1
- .2 Sequencing of operations for systems as follows:
  - .1 Refer to sequencing drawings and schematics.
  - .2 Control objective is to achieve the following conditions within the cells:
    - .1 Main Cells =  $2^{\circ}\pm 2^{\circ}\text{C}$ , 25%RH $\pm$ 5%RH, -14.7°C dewpoint
    - .2 Acclimatisation Cells =  $10^{\circ}\pm 2^{\circ}\text{C}$ , 25%RH $\pm$ 5%RH, -8.5°C dewpoint
    - .3 Corridor / Lobby – no direct control
  - .3 Main control principle is to operate the fresh air AHU's and the humidifiers to achieve a constant dewpoint within the cells, this is achieved by averaging the cell dewpoints and then using this to reset the set point for the discharge dewpoint from the AHU's / humidifier. For stability of the stored media a stable humidity level with minimal fluctuation is the primary requirement without any cycling of the condition over the day. The temperature may fluctuate within the above limits to keep the humidity constant, however this should also be non cyclic and a very slow rate of change. Cell temperature will be controlled based on the cell humidity, increasing temperature reduces humidity in the cell.
  - .4 All systems and controls shall be provided with control routines such that conditioning of the cells is not interrupted during a normal plant failure, with the either the standby unit being enabled or the operating unit ramping up to meet demand.
  - .5 The dry air cooler acts as the first stage of cooling when the ambient temperature is sufficiently low and reduces cycling of chillers at low ambient temperatures.

- .6 The chillers shall be sequenced to achieve the required flow temperature and charge level within the buffer vessel, the sequencing shall be rotated on each start such that the starts per day of each compressor is minimised as far as possible.
- .7 The existing control system serving plant not directly replaced in this contract (i.e. boilers and ancillary systems) shall be integrated into the new control system and all documentation updated to ensure it encompasses the entire system (new and existing).
- .8 All existing control components and software shall be reviewed prior to commencing any works and a report produced identifying condition and suitability for re-use in the new control system.

#### **1.4 POINT SCHEDULES**

- .1 Refer to appended points schedule following this section for detailed breakdown of controls points required for all systems.

#### **Part 2 Products**

##### **2.1 NOT USED**

- .1 Not Used.

#### **Part 3 Execution**

##### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

# LIBRARY AND ARCHIVES CANADA

## Controls In / Out Table including programming notes

Date:	22/06/2020
Revision:	R0
Produced By Date:	P Broadbent 23/06/2020
Reviewed By Date:	O Cook
Approved By Date:	

Comments
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Input Output Summary Table

Project Number		R.067978.001				Departmental Representative			CPW LLP		M&E System Reference			Cells		
Area Identifier		TBC				MCU NUMBER			TBC		EMCS System Identifier					
Area Expansion		Nitrate Archive				LOCATION OF MCU			Plant Room		EMCS System Expansion					
1	2	3			4	5	6		7	8	9		10	11	12	13
POINT IDENTIFICATION					AUXILIARY DEVICES					ALARMS		DI/DO	DI	DO	13	
P O I N T #	POINT IDENTIFIER	POINT EXPANSION	T Y P E	ENG U N I T S	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	S U P P L I E D	I N S T A L L E D	W I R E D	C R C A M A	A L I A M I T O T S		C O N T A C T	A C T I O N	H V Y M O T O R	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE	
										L1	H1					NO NC
1	CELL01_TMP	Existing temperature sensor in Cell01	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
2	CELL01_HUM	Existing humidity sensor in Cell01	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
3	CELL01_DEWPOINT	Calculated dewpoint in Cell01	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
4	CELL02_TMP	Existing temperature sensor in Cell02	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
5	CELL02_HUM	Existing humidity sensor in Cell02	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
6	CELL02_DEWPOINT	Calculated dewpoint in Cell02	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
7	CELL03_TMP	Existing temperature sensor in Cell03	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
8	CELL03_HUM	Existing humidity sensor in Cell03	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
9	CELL03_DEWPOINT	Calculated dewpoint in Cell03	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
10	CELL04_TMP	Existing temperature sensor in Cell04	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
11	CELL04_HUM	Existing humidity sensor in Cell04	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
12	CELL04_DEWPOINT	Calculated dewpoint in Cell04	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
13	CELL05_TMP	Existing temperature sensor in Cell05	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
14	CELL05_HUM	Existing humidity sensor in Cell05	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
15	CELL05_DEWPOINT	Calculated dewpoint in Cell05	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
16	CELL06_TMP	Existing temperature sensor in Cell06	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
17	CELL06_HUM	Existing humidity sensor in Cell06	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
18	CELL06_DEWPOINT	Calculated dewpoint in Cell06	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
19	CELL07_TMP	Existing temperature sensor in Cell07	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
20	CELL07_HUM	Existing humidity sensor in Cell07	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
21	CELL07_DEWPOINT	Calculated dewpoint in Cell07	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
22	CELL08_TMP	Existing temperature sensor in Cell08	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
23	CELL08_HUM	Existing humidity sensor in Cell08	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
24	CELL08_DEWPOINT	Calculated dewpoint in Cell08	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
25	CELL09_TMP	Existing temperature sensor in Cell09	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
26	CELL09_HUM	Existing humidity sensor in Cell09	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
27	CELL09_DEWPOINT	Calculated dewpoint in Cell09	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
28	CELL10_TMP	Existing temperature sensor in Cell10	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
29	CELL10_HUM	Existing humidity sensor in Cell10	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
30	CELL10_DEWPOINT	Calculated dewpoint in Cell10	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
31	CELL11_TMP	Existing temperature sensor in Cell11	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
32	CELL11_HUM	Existing humidity sensor in Cell11	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
33	CELL11_DEWPOINT	Calculated dewpoint in Cell11	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
34	CELL12_TMP	Existing temperature sensor in Cell12	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
35	CELL12_HUM	Existing humidity sensor in Cell12	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
36	CELL12_DEWPOINT	Calculated dewpoint in Cell12	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
37	CELL13_TMP	Existing temperature sensor in Cell13	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
38	CELL13_HUM	Existing humidity sensor in Cell13	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
39	CELL13_DEWPOINT	Calculated dewpoint in Cell13	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
40	CELL14_TMP	Existing temperature sensor in Cell14	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
41	CELL14_HUM	Existing humidity sensor in Cell14	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
42	CELL14_DEWPOINT	Calculated dewpoint in Cell14	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
43	CELL15_TMP	Existing temperature sensor in Cell15	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
44	CELL15_HUM	Existing humidity sensor in Cell15	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
45	CELL15_DEWPOINT	Calculated dewpoint in Cell15	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
46	CELL16_TMP	Existing temperature sensor in Cell16	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
47	CELL16_HUM	Existing humidity sensor in Cell16	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
48	CELL16_DEWPOINT	Calculated dewpoint in Cell16	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
49	CELL17_TMP	Existing temperature sensor in Cell17	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
50	CELL17_HUM	Existing humidity sensor in Cell17	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
51	CELL17_DEWPOINT	Calculated dewpoint in Cell17	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
52	CELL18_TMP	Existing temperature sensor in Cell18	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
53	CELL18_HUM	Existing humidity sensor in Cell18	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
54	CELL18_DEWPOINT	Calculated dewpoint in Cell18	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
55	CELL19_TMP	Existing temperature sensor in Cell19	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
56	CELL19_HUM	Existing humidity sensor in Cell19	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
57	CELL19_DEWPOINT	Calculated dewpoint in Cell19	AI	°C	calculated dewpoint	x	x	x		-17	-13				P1	
58	CELL20_TMP	Existing temperature sensor in Cell20	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
59	CELL20_HUM	Existing humidity sensor in Cell20	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
60	CELL20_DEWPOINT	Calculated dewpoint in Cell20	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
61	CELL21_TMP	Existing temperature sensor in Cell21	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
62	CELL21_HUM	Existing humidity sensor in Cell21	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
63	CELL21_DEWPOINT	Calculated dewpoint in Cell21	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
64	CELL22_TMP	Existing temperature sensor in Cell22	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
65	CELL22_HUM	Existing humidity sensor in Cell22	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
66	CELL22_DEWPOINT	Calculated dewpoint in Cell22	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
67	CELL23_TMP	Existing temperature sensor in Cell23	AI	°C	Existing temperature sensor	x	x	x		-2	6				N1	
68	CELL23_HUM	Existing humidity sensor in Cell23	NA	%RH	Existing humidity sensor	x	x	x		15%	35%				N1	
69	CELL23_DEWPOINT	Calculated dewpoint in Cell23	AI	°C	calculated dewpoint	25	x	x		-17	-13				P1	
70	AV_NORTH_TMP	Calculated average temperature - North Cells	NA	°C	Existing temperature sensor	25	25	x		-2	6				P2	
71	AV_NORTH_HUM	Calculated average humidity - North Cells	NA	%RH	Existing humidity sensor	25	25	x		15%	35%				P2	
72	AV_NORTH_DEWPOINT	Calculated average dewpoint - North Cells	NA	°C	calculated dewpoint	25	25	x		-17	-13				P3	
73	AV_SOUTH_TMP	Calculated average temperature - South Cells	NA	°C	Existing temperature sensor	25	25	x		-2	6				P2	
74	AV_SOUTH_HUM	Calculated average humidity - South Cells	NA	%RH	Existing humidity sensor	25	25	x		15%	35%				P2	
75	AV_SOUTH_DEWPOINT	Calculated average dewpoint - South Cells	NA	°C	calculated dewpoint	25	25	x		-17	-13				P3	
76	AV_ACCL_TMP	Calculated average temperature - Acclimatisation Cells	NA	°C	Existing temperature sensor	25	25	x		6	14				P2	
77	AV_ACCL_HUM	Calculated average humidity- Acclimatisation Cells	NA	%RH	Existing humidity sensor	25	25	x		15%	35%				P2	
78	AV_ACCL_DEWPOINT	Calculated average dewpoint- Acclimatisation Cells	NA	°C	calculated dewpoint	25	25	x		-10.5	-6.5				P3	

Input Output Summary Table

Project Number			R.067978.001			Departmental Representative		CPW LLP		M&E System Reference			RC_AHU03					
Area Identifier			TBC			MCU NUMBER		TBC		EMCS System Identifier								
Area Expansion			Nitrate Archive			LOCATION OF MCU		Plant Room		EMCS System Expansion								
1	2		3	4	5	6	7	8	9	10	11	12	13					
POINT IDENTIFICATION																		
POINT IDENTIFIER	POINT EXPANSION	TYP E	ENG UNITS	AUXILIARY DEVICES														
				CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE														
				DIVISION			L1			H1			NO NC			C/R O/R DELAY		
				S	U	I	C	R	A	L	O	C	A	D	O	R		
				P	P	L	I	E	D	E	M	A	G	S	T	O		
1 S_FAN_START	Enable signal to supply fan	DO	ON/OFF	Relay Contact	25	25	25							P14				
2 S_FAN_SPEED	Signal to modulate supply fan speed	AO	%	VSD Input	25	25	25		30%	100%				P14				
3 S_FAN_FAULT	Fault signal from supply fan / inverter	DI	NM/AL	VSD Contact	25	25	25							P14				
4 S_FAN_DPS	Differential Pressure Switch over supply fan	DI	NM/AL	Relay Contact	25	25	25							P14				
5 HCV	Heating Coil Valve	AO	%	2 port control valve modulating	25	22	25		0%	100%				P17				
6 CCV	CHW control valve	AO	%	2 port control valve modulating	25	22	25		0%	100%				P17				
7 FILTER_DPS	Differential Pressure Sensor over filter	AI	Pa	DP Sensor	25	25	25	50	200					N3				
8 VAV_POSITION	VAV box position signal	AO	%	% input to VAV	25	23	25							P10				
9 VAV_AIRFLOW	VAV box airflow signal	AI	L/s	L/s airflow from VAV	25	23	25	52	81									
10 E_FAN_START	Enable signal to extract fan	DO	ON/OFF	Relay Contact	25	25	25					Y		P14				
11 E_FAN_SPEED	Signal to modulate extract fan speed	AO	%	VSD Input	25	25	25		30%	100%				P15				
12 E_FAN_FAULT	Fault signal from extract fan / inverter	DI	NM/AL	VSD Contact	25	25	25							P15				
13 E_FAN_DPS	Differential Pressure Switch over extract Fan	DI	NM/AL	Relay Contact	25	25	25							P15				
14 SA_DEWPOINT	Supply air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8					P20				
15 SA_HUMIDITY	Calculated supply air humidity	NA	%RH	calculated	25	25	x											
16 SA_TMP	Supply air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	9					P18				
17 SA_PRESS	Supply air static pressure sensor	AI	Pa	Pressure Sensor	25	23	25	100	400					P14				
18 EXHAUSTAIR_DEWPOINT	Exhaust air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8									
19 EXHAUSTAIR_HUMIDITY	Calculated Exhaust air humidity	NA	%RH	calculated	25	25	x											
20 EXHAUSTAIR_TMP	Exhaust air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	10									
21 EXHAUSTAIR_PRESS	Exhaust air static pressure sensor	AI	Pa	Pressure Sensor	25	23	25	100	400					P15				
22 CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	25	22	25							P14				
23 CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	25	22	25							P16				
24 EXHAUSTAIR_GAS	Nitrogen Dioxide Sensor PPM in exhaust air	AI	ON/OFF	Offgassing sensor	25	22	25							N7				
25 HUMIDIFIER_START	Enable signal to humidifier	DO	ON/OFF	Relay Contact	25	22	25							P19				
26 HUMIDIFIER_OUTPUT	Signal to modulate humidifier output	AO	%	% input to humidifier	25	23	25							P19				
27 HUMIDIFIER_FAULT	Fault signal from humidifier	DI	NM/AL	Relay Contact	25	22	25											

Input Output Summary Table

Project Number			R.067978.001			Departmental Representative		CPW LLP		M&E System Reference			RC_AHU04						
Area Identifier			TBC			MCU NUMBER		TBC		EMCS System Identifier									
Area Expansion			Nitrate Archive			LOCATION OF MCU		Plant Room		EMCS System Expansion									
1	2		3	4	5	6	7	8	9	10	11	12	13						
POINT IDENTIFICATION																			
POINT IDENTIFIER		POINT EXPANSION		TYP E		ENG UNITS		CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE						APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE					
1 S_FAN_START		Enable signal to supply fan		DO		ON/OFF		Relay Contact		25 25 25				P14					
2 S_FAN_SPEED		Signal to modulate supply fan speed		AO		%		VSD Input		25 25 25		30%		100%		P14			
3 S_FAN_FAULT		Fault signal from supply fan / inverter		DI		NM/AL		VSD Contact		25 25 25				NO		P14			
4 S_FAN_DPS		Differential Pressure Switch over supply fan		DI		NM/AL		Relay Contact		25 25 25				NO		P14			
5 HCV		Heating Coil Valve		AO		%		2 port control valve modulating		25 22 25		0%		100%		P17			
6 CCV		CHW control valve		AO		%		2 port control valve modulating		25 22 25		0%		100%		P17			
7 FILTER_DPS		Differential Pressure Sensor over filter		AI		Pa		DP Sensor		25 25 25		50		200		N3			
8 VAV_POSITION		VAV box position signal		AO		%		% input to VAV		25 23 25						P10			
9 VAV_AIRFLOW		VAV box airflow signal		AI		L/s		L/s airflow from VAV		25 23 25		260		460					
10 E_FAN_START		Enable signal to extract fan		DO		ON/OFF		Relay Contact		25 25 25				NO		Y		P14	
11 E_FAN_SPEED		Signal to modulate extract fan speed		AO		%		VSD Input		25 25 25		30%		100%				P15	
12 E_FAN_FAULT		Fault signal from extract fan / inverter		DI		NM/AL		VSD Contact		25 25 25				NO				P15	
13 E_FAN_DPS		Differential Pressure Switch over extract Fan		DI		NM/AL		Relay Contact		25 25 25				NO				P15	
14 SA_DEWPOINT		Supply air dewpoint sensor		AI		°C		High accuracy sensor		25 23 25		-20		-8				P20	
15 SA_HUMIDITY		Calculated supply air humidity		NA		%RH		calculated		25 25 x									
16 SA_TMP		Supply air temperature sensor		AI		°C		High accuracy sensor		25 23 25		-5		9				P18	
17 SA_PRESS		Supply air static pressure sensor		AI		Pa		Pressure Sensor		25 23 25		100		400				P14	
18 EXHAUSTAIR_DEWPOINT		Exhaust air dewpoint sensor		AI		°C		High accuracy sensor		25 23 25		-20		-8					
19 EXHAUSTAIR_HUMIDITY		Calculated Exhaust air humidity		NA		%RH		calculated		25 25 x									
20 EXHAUSTAIR_TMP		Exhaust air temperature sensor		AI		°C		High accuracy sensor		25 23 25		-5		10					
21 EXHAUSTAIR_PRESS		Exhaust air static pressure sensor		AI		Pa		Pressure Sensor		25 23 25		100		400				P15	
22 CHW_PUMP_FAULT		Fault signal from CHW_PUMP		DI		NM/AL		Relay Contact		25 22 25				NO				P14	
23 CHW_PUMP_START		Enable signal to CHW_PUMP		DO		ON/OFF		Relay Contact		25 22 25				NO				P16	
24 EXHAUSTAIR_GAS		Nitrogen Dioxide Sensor PPM in exhaust air		AI		PPM		Offgassing sensor		25 22 25				NO				N7	
25 HUMIDIFIER_START		Enable signal to humidifier		DO		ON/OFF		Relay Contact		25 22 25				NO				P19	
26 HUMIDIFIER_OUTPUT		Signal to modulate humidifier output		AO		%		% input to humidifier		25 23 25								P19	
27 HUMIDIFIER_FAULT		Fault signal from humidifier		DI		NM/AL		Relay Contact		25 22 25				NO					

Input Output Summary Table

Project Number			R.067978.001			Departmental Representative			CPW LLP		M&E System Reference			RC_AHU05																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Area Identifier			TBC			MCU NUMBER			TBC		EMCS System Identifier																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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Input Output Summary Table

Project Number		R.067978.001			Departmental Representative		CPW LLP		M&E System Reference		FA_AHU01	
Area Identifier		TBC			MCU NUMBER		TBC		EMCS System Identifier			
Area Expansion		Nitrate Archive			LOCATION OF MCU		Plant Room		EMCS System Expansion			
1	2	3	4	5	6	7	8	9	10	11	12	13
POINT IDENTIFICATION												
POINT IDENTIFIER	POINT EXPANSION	TYP E	ENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	S U P P L I E D	I N S T A L L E D	C R A M L I O T C S M A	A L N I A M L I O T G S	C O N T I A C T	H I	NO NC	C/R O/R DELAY
1	5_FAN_START	Enable signal to supply fan	DO	ON/OFF	Relay Contact	25	25	25				P4
2	5_FAN_SPEED	Signal to modulate supply fan speed	AO	%	VSD Input	25	25	25	30%	100%		P5
3	5_FAN_FAULT	Fault signal from supply fan / inverter	DI	NM/AL	VSD Contact	25	25	25				P4
4	5_FAN_DPS	Differential Pressure Switch over supply fan	DI	NM/AL	Relay Contact	25	25	25				P4
5	5A_FLOW	Supply air flow sensor	AI	L/s	Flow sensor	25	23	25	344	1001		P6
6	CCV	CHW control valve	AO	%	2 port control valve modulating	25	22	25	0%	100%		P7
7	DEHUM_FAULT	Fault signal from dehumidifier	DI	NM/AL	VSD Contact	25	23	25				P4
8	DEHUM_OUTPUT	Signal to modulate dehumidifier output	AO	%	Hum Input	25	23	25	10%	100%		P8
9	DEHUM_START	Enable signal to dehumidifier	DO	ON/OFF	Relay Contact	25	23	25				P8
10	HCV	Heating Coil Valve	AO	%	2 port control valve modulating	25	22	25	0%	100%		P7
11	THWHEEL_FAULT	Fault signal from thermal wheel	DI	NM/AL	Wheel Contact	25	23	25				P4
12	THWHEEL_SPEED	Signal to modulate thermal wheel speed	AO	%	Wheel input	25	23	25	0%	100%		P11
13	THWHEEL_START	Enable signal to thermal wheel	DO	ON/OFF	Relay Contact	25	23	25				P11
14	THWHEEL_Enthalpy	Enthalpy of air off thermal wheel	AI	kJ	Sensor	25	23	25	-5	10		P11
15	FILTER_DPS	Differential Pressure Sensor over filter	AI	Pa	DP Sensor	25	25	25	50	200		
16	EA_DAMP	Exhaust air damper	AO	%	Damper actuator	25	25	25	0%	100%		P3
17	EA_DAMP_ES	Exhaust air damper end switch	DI	NM/AL	End switch	25	25	25				P3
18	FA_DAMP	Fresh air damper	AO	%	Damper actuator	25	25	25	0%	100%		P3
19	FA_DAMP_ES	Fresh air damper end switch	DI	NM/AL	End switch	25	25	25				P3
20	FA_DEWPOINT	Fresh air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-25	21		
21	FA_Enthalpy	Calculated fresh air enthalpy	AI	kJ	calculated	25	25	x	-10	70		P11
22	FA_HUMIDITY	Calculated Fresh air humidity	NA	%RH	calculated	25	25	x	0	100		
23	FA_TMP	Fresh air temperature sensor	AI	PPM	High accuracy sensor	25	23	25	30			
24	EXHAUSTAIR_DEWPOINT	Exhaust air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8		
25	EXHAUSTAIR_HUMIDITY	Calculated Exhaust air humidity	NA	%RH	calculated	25	25	x	10	50		
26	EXHAUSTAIR_TMP	Exhaust air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	10		
27	EXHAUSTAIR_Enthalpy	Calculated exhaust air enthalpy	AI	kJ	calculated	25	23	25	-5	10		P11
28	DEHUMAIR_DEWPOINT	Off dehumidification AHU air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8		P8, P12
29	DEHUMAIR_HUMIDITY	Calculated Off dehumidification AHU humidity	NA	%RH	calculated	25	25	x	5	50		
30	DEHUMAIR_TMP	Off dehumidification AHU air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	10		P7
31	DEHUMAIR_PRESS	Off dehumidification AHU air pressure sensor	AI	Pa	static duct pressure	25	23	25	100	400		
32	CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	25	22	25				
33	CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	25	22	25				P3

Input Output Summary Table

Project Number Area Identifier			R.067978.001 TBC			Departmental Representative MCU NUMBER		CPW LLP TBC		M&E System Reference EMCS System Identifier		FA_AHU02	
Area Expansion			Nitrate Archive			LOCATION OF MCU		Plant Room		EMCS System Expansion			
1	2	POINT IDENTIFICATION											
POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	AUXILIARY DEVICES								
					DIVISION	ALARMS		D/DO		C/R		DELAY	
						L1	H1	NO	NC	O/R			
1	S_FAN_START	Enable signal to supply fan	DO	ON/OFF	Relay Contact	25	25	25					P4
2	S_FAN_SPEED	Signal to modulate supply fan speed	AO	%	VSD Input	25	25	25	30%	100%			P5
3	S_FAN_FAULT	Fault signal from supply fan / inverter	DI	NM/AL	VSD Contact	25	25	25		NO			P4
4	S_FAN_DPS	Differential Pressure Switch over supply fan	DI	NM/AL	Relay Contact	25	25	25		NO			P4
5	SA_FLOW	Supply air flow sensor	AI	L/s	Flow sensor	25	23	25	344	1001			P6
6	CCV	CHW control valve	AO	%	2 port control valve modulating	25	22	25	0%	100%			P7
7	DEHUM_FAULT	Fault signal from dehumidifier	DI	NM/AL	VSD Contact	25	23	25		NO			P4
8	DEHUM_OUTPUT	Signal to modulate dehumidifier output	AO	%	Hum Input	25	23	25	10%	100%			P8
9	DEHUM_START	Enable signal to dehumidifier	DO	ON/OFF	Relay Contact	25	23	25		NO			P8
10	HCV	Heating Coil Valve	AO	%	2 port control valve modulating	25	22	25	0%	100%			P7
11	THWHEEL_FAULT	Fault signal from thermal wheel	DI	NM/AL	Wheel Contact	25	23	25		NO			P4
12	THWHEEL_SPEED	Signal to modulate thermal wheel speed	AO	%	Wheel input	25	23	25	0%	100%			P7
13	THWHEEL_START	Enable signal to thermal wheel	DO	ON/OFF	Relay Contact	25	23	25		NO			P11
14	THWHEEL_Enthalpy	Enthalpy of air off thermal wheel	AI	kJ	Sensor	25	23	25	-5	10			P11
15	FILTER_DPS	Differential Pressure Sensor over filter	AI	Pa	DP Sensor	25	25	25	50	200			
16	EA_DAMP	Exhaust air damper	AO	%	Damper actuator	25	25	25	0%	100%			P3
17	EA_DAMP_ES	Exhaust air damper end switch	DI	NM/AL	End switch	25	25	25		NO			P3
18	FA_DAMP	Fresh air damper	AO	%	Damper actuator	25	25	25	0%	100%			P3
19	FA_DAMP_ES	Fresh air damper end switch	DI	NM/AL	End switch	25	25	25		NO			P3
20	FA_DEWPOINT	Fresh air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-25	21			
21	FA_Enthalpy	Calculated fresh air enthalpy	AI	kJ	calculated	25	25	x	-10	70			P11
22	FA_HUMIDITY	Calculated Fresh air humidity	NA	%RH	calculated	25	25	x	0	100			
23	FA_TMP	Fresh air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-30	30			
24	EXHAUSTAIR_DEWPOINT	Exhaust air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8			
25	EXHAUSTAIR_HUMIDITY	Calculated Exhaust air humidity	NA	%RH	calculated	25	25	x	10	50			
26	EXHAUSTAIR_TMP	Exhaust air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	10			
27	EXHAUSTAIR_Enthalpy	Calculated exhaust air enthalpy	AI	kJ	calculated	25	23	25	-5	10			P11
28	DEHUMAIR_DEWPOINT	Off dehumidification AHU air dewpoint sensor	AI	°C	High accuracy sensor	25	23	25	-20	-8			P8, P12
29	DEHUMAIR_HUMIDITY	Calculated Off dehumidification AHU humidity	NA	%RH	calculated	25	25	x	5	50			
30	DEHUMAIR_TMP	Off dehumidification AHU air temperature sensor	AI	°C	High accuracy sensor	25	23	25	-5	10			P7
31	DEHUMAIR_PRESS	Off dehumidification AHU air pressure sensor	AI	Pa	static duct pressure	25	23	25	100	400			
32	CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	25	22	25		NO			
33	CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	25	22	25		NO			P3

Input Output Summary Table

Project Number			R.067978.001			Departmental Representative		CPW LLP		BE System Reference			CH01													
Area Identifier			TBC			MCU NUMBER		TBC		ICS System Identifier																
Area Expansion			Nitrate Archive			LOCATION OF MCU		Plant Room		CS System Expansion																
1	2		3	4	5	6	7	8	9	10	11	12	13													
POINT IDENTIFICATION													ALARMS	DI/DO	DI	DO	13									
POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	AUXILIARY DEVICES								C/R	NO	NC	O/R	DELAY	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE								
					SUPLIED		INSTALLED		CRCA		MOT								C	O	N	T	I	O	N	R
					P		P		L		I															
					L		I		E		D															
1	CHILLER_FAULT	Fault signal from CHILLER	DO	ON/OFF	Relay Contact	22	25	22																		
2	CHILLER_SP	Set point for CHILLER control	AO	°C	Chiller Input flow temperature	22	25	22	-5	5								P21								
3	CHILLER_START	Enable signal to CHILLER	DI	NM/AL	Relay Contact	22	25	22									Y	P21								
4	CHILLER_WARNING	warning / maintenance signal from CHILLER	DI	NM/AL	Relay Contact	22	25	22																		
5	CHW_DPRESS	Chilled water flow differential pressure sensor	AI	kPa	Differential pressure sensor	22	22	22	20	40								N4								
6	CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22										N4								
7	CHW_PUMP_SP	Set point for CHW_PUMP control	AO	%	Pump speed	22	25	22	-5	5																
8	CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	22	25	22										N4								
9	CHW_PUMP_WARNING	warning / maintenance signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22										N4								
10	CHW_FLOW	Chilled water flow temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5								P21								
11	CHW_RET	Chilled water return temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5																
12	CCV	CHW control valve	AO	%	2 port control valve on/off	22	25	22										N4, P22								



Input Output Summary Table

Project Number		R.067978.001		Departmental Representative		CPW LLP		BE System Reference		CH02	
Area Identifier		TBC		MCU NUMBER		TBC		ICS System Identifier			
Area Expansion		Nitrate Archive		LOCATION OF MCU		Plant Room		CS System Expansion			
1	2	3	4	5	6	7	8	9	10	11	12
POINT IDENTIFICATION					AUXILIARY DEVICES		ALARMS		DI/DO		13
POINT IDENTIFIER	POINT EXPANSION	TYPENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	DIVISION	S U P P L I E D	I N S T A L L E D	C R C A M L I A O T G S M A	A L A C O N T I A C T	H V Y M O T O R	APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE	13
1	CHILLER_FAULT	Fault signal from CHILLER	DO	ON/OFF	Relay Contact	22	25	22			
2	CHILLER_SP	Set point for CHILLER control	AO	°C	Chiller Input flow temperature	22	25	22	-5	5	P21
3	CHILLER_START	Enable signal to CHILLER	DI	NM/AL	Relay Contact	22	25	22			P21
4	CHILLER_WARNING	warning / maintenance signal from CHILLER	DI	NM/AL	Relay Contact	22	25	22			
5	CHW_DPRESS	Chilled water flow differential pressure sensor	AI	kPa	Differential pressure sensor	22	22	22	20	40	N4
6	CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22			N4
7	CHW_PUMP_SP	Set point for CHW_PUMP control	AO	%	Pump speed	22	25	22	-5	5	
8	CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	22	25	22			N4
9	CHW_PUMP_WARNING	warning / maintenance signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22			N4
10	CHW_FLOW	Chilled water flow temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5	P21
11	CHW_RET	Chilled water return temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5	
12	CCV	CHW control valve	AO	%	2 port control valve on/off	22	25	22			N4, P22



Input Output Summary Table

Project Number				R.067978.001				Departmental Representative		CPW LLP		E System Reference				DAC01				
Area Identifier				TBC				MCU NUMBER		TBC		ICS System Identifier								
Area Expansion				Nitrate Archive				LOCATION OF MCU		Plant Room		CS System Expansion								
1	2	3	4	5	6	7	8	9	10	11	12	13								
POINT IDENTIFICATION													ALARMS		DI/DO		DI		DO	
POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	DIVISION								C/R		O/R		APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE			
					SUPT				INSTR				CALS		CONC			C/R		
					PLANT				WATER				ALARM		NO			O/R		
					ELECT				MOTOR				GAS		T			O		
					DETECT				MOTOR				MOTOR		T			R		
1	DAC_FAULT	Fault signal from DAC	DO	ON/OFF	Relay Contact	22	25	22												
2	DAC_SP	Set point for DAC control	AO	°C	Chiller Input flow temperature	22	25	22	-5	5						P21				
3	DAC_START	Enable signal to DAC	DI	NM/AL	Relay Contact	22	25	22							Y	P21				
4	DAC_WARNING	warning / maintenance signal from DAC	DI	NM/AL	Relay Contact	22	25	22												
5	CHW_PUMP_FAULT	Fault signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22								N4				
6	CHW_PUMP_SP	Set point for CHW_PUMP control	AO	%	Pump speed	22	25	22	-5	5										
7	CHW_PUMP_START	Enable signal to CHW_PUMP	DO	ON/OFF	Relay Contact	22	25	22								N4				
8	CHW_PUMP_WARNING	warning / maintenance signal from CHW_PUMP	DI	NM/AL	Relay Contact	22	25	22								N4				
9	CHW_FLOW	Chilled water flow temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5						P21				
10	CHW_RET	Chilled water return temperature	AI	°C	pipe mounted insertion sensor	22	22	22	-5	5										
11	CCV	CHW control valve	AO	%	2 port control valve on/off	22	25	22								N4, P22				

Input Output Summary Table

Project Number				R.067978.001				Departmental Representative				CPW LLP				E System Reference				CHW			
Area Identifier				TBC				MCU NUMBER				TBC				ICS System Identifier							
Area Expansion				Nitrate Archive				LOCATION OF MCU				Plant Room				CS System Expansion							
1	2	3	4	5	6	7	8	9	10	11	12	13											
POINT IDENTIFICATION													ALARMS										
POINT IDENTIFIER	POINT EXPANSION	TYPE	ENG UNITS	CONTROL OR AUXILIARY SENSING DEVICE, TYPE OF SENSOR OR OUTPUT DEVICE	AUXILIARY DEVICES																		
					S U P P L I E R D				I N S T A L L E D														
					C R A M C L I A O G M A				C O N T I A C T														
					DIVISION				L1 H1 NO NC O/R DELAY														
					22 25 22				22 25 22														
1	PRESS_UNIT_START	Enable signal to PRESS_UNIT	DO	ON/OFF	Relay Contact	22	25	22															
2	PRESS_UNIT_FAULT	Fault signal from PRESS_UNIT	DI	°C	Relay Contact	22	25	22	-5	5													
3	CHW_FLOW	Chilled water flow temperature	AI	°C	pipe mounted insertion sensor	22	25	22	-5	5													
4	CHW_RET	Chilled water return temperature	AI	°C	pipe mounted insertion sensor	22	25	22	-5	5													
5	BUFFER_TOP	Buffer Vessel top connection temperature sensor	AI	°C	pipe mounted insertion sensor	22	25	22	-5	5		N5											
6	BUFFER_HIGH	Buffer Vessel high level temperature sensor	AI	°C	vessel mounted insertion sensor	22	25	22	-5	5		N5											
7	BUFFER_MID	Buffer Vessel middle level temperature sensor	AI	°C	vessel mounted insertion sensor	22	25	22	-5	5		N5											
8	BUFFER_LOW	Buffer Vessel low level temperature sensor	AI	°C	vessel mounted insertion sensor	22	25	22	-5	5		N5											
9	BUFFER_BOTTOM	Buffer Vessel bottom connection temperature sensor	AI	°C	pipe mounted insertion sensor	22	25	22	-5	5		N5											
10	BUFFER_CHARGE	Buffer vessel percentage charged	NA	%	Calculated percentage charge	22	25	x				N5											
11	METER_WATER	Water Meter	NA	litres	litres of water consumed	22	25	22				N6											

APPLICABLE PROGRAMS AND/OR NOTES REFER TO PST LEGEND PAGE

Programs	Description
P1	Temperature and humidity readings to be used to calculate the dewpoint within the cell, dewpoint becomes one of the primary control parameters for the main plant.
P2	Poll all sensors and disregard any out of range or fault values, average remaining value for the relevant zone (North, South, Acclimatisation)
P3	Average Temperature and humidity readings for the zone to be used to calculate the average dewpoint within the zone.
P4	Fan interlocked with respective damper(s), dehumidifier and thermal wheels, fan disable if humidifier fault present or dampers are not proven open.
P5	Under normal operation both of the fans in the two FA AHU's run at the same speed to maintain a constant flow and pressure to the VAV box's. Upon failure of one fan the remainder ramps up to maintain pressure and flow to the VAV box's
P6	Provide upper and lower limits for fan speed adjustment to give resilience should pressure sensor fail. Sets limits that P5 can modulate the fan speed within.
P7	PID control to maintain set temperature DEHUMAIR_TMP, set at 2°C.
P8	PID loop to control AHU supply dewpoint
P9	
P10	Open to pre-set condition in normal operation, close when supply fan is not operational.
P11	Thermal wheel is enabled when enthalpy of exhaust air deviates from the fresh air by more than 2kJ. Once operational the wheel speed shall modulate to achieve a discharge enthalpy of 4 kJ off the thermal wheel
P12	Set point adjusted on 'very slow' PID loop based on measured average dewpoint in zone served (north / south/Accl)
P13	Starts when there is a demand >5% from the cooling coil served, stops when demand falls to 0%
P14	Fan interlocked with respective damper(s), exhaust fan and CHW pump. Once operational RA_AHU01 & RA_AHU02 run at same speed to achieve SA_Press, on failure of one AHU then running AHU speed modulated to achieve SA_Press.
P15	Fan interlocked with respective damper(s) and supply fan. Once operational RA_AHU01 & RA_AHU02 run at same speed to achieve EXHAUSTAIR_Press, on failure of one AHU then running AHU speed modulated to achieve EXHAUSTAIR_Press.
P16	Pump enabled when cooling demand >5%, pump switched off when demand drops to 0%, minimum off period = 15mins
P17	Control valve modulates to achieve required SA_TEMP off AHU
P18	Supply air temperature set point reset based on proportional control (very slow) from average cell humidity, set to achieve 25%RH. Subject to minimum cell temperature of 0°C and maximum 4°C.
P19	Modulates to achieve the required SA_DEWPOINT
P20	Set point adjusted on 'very slow' PID loop based on measured average dewpoint in zone served (north / south/Accl), plus 0.5°C to give offset from FA dehumidifiers.
P21	Chilled water set point adjusted based on demand from cooling coils, flow temperature should be just sufficient to allow cooling to be achieved with the worst case CCV at 95% open. Unit (s) staged on / off based on demand from buffer vessel, increase by one stage when buffer vessel drops to 20%, decrease by one stage when buffer vessel is 80% charged or more. introduce delay of 30 minutes before the next stage can start. On initial start of the array decrease the delay to 5 minutes between stages for the first hour.
P22	Open / closed valve to isolate chiller when there is no requirement for it to run.
P23	Fan interlocked with respective damper(s), exhaust fan and CHW pump. AHU speed modulated to achieve SA_Press.
P24	Supply air temperature set point reset based on proportional control (very slow) from average cell humidity, set to achieve 25%RH. Subject to minimum cell temperature of 8°C and maximum 12°C.

Area  
System or Group  
Point

System or Group Reference	Description
RC_AHU03	Recirculating AHU serving Acclimatisation storage cells
RC_AHU04	Recirculating AHU serving North storage cells
RC_AHU05	Recirculating AHU serving South storage cells
FA_AHU01	Fresh air heat recovery and dehumidifier AHU
FA_AHU02	Fresh air heat recovery and dehumidifier AHU
Cells	Nitrate media storage Cell
DAC01	Dry Air Cooler
CH01	Water chiller
CH02	Water Chiller
CHW	Chilled water system
LTHW	Low Temperature Hot Water System
General	Sundry Items

POINT IDENTIFIER	POINT EXPANSION
AV_ACCL_DEWPOINT	Calculated average dewpoint- Acclimatisation Cells
AV_ACCL_HUM	Calculated average humidity- Acclimatisation Cells
AV_ACCL_TMP	Calculated average temperature - Acclimatisation Cells
AV_NORTH_DEWPOINT	Calculated average dewpoint - North Cells
AV_NORTH_HUM	Calculated average humidity - North Cells
AV_NORTH_TMP	Calculated average temperature - North Cells
AV_SOUTH_DEWPOINT	Calculated average dewpoint - South Cells
AV_SOUTH_HUM	Calculated average humidity - South Cells
AV_SOUTH_TMP	Calculated average temperature - South Cells
BUFFER_AV	Calculated buffer average temperature
BUFFER_BOTTOM	Buffer Vessel bottom connection temperature sensor
BUFFER_HIGH	Buffer Vessel high level temperature sensor
BUFFER_LOW	Buffer Vessel low level temperature sensor
BUFFER_MID	Buffer Vessel middle level temperature sensor
BUFFER_TOP	Buffer Vessel top connection temperature sensor
BUFFER_CHARGE	Buffer vessel percentage charged
CCV	CHW control valve
CELL01_DEWPOINT	Calculated dewpoint in Cell01
CELL01_HUM	Existing humidity sensor in Cell01
CELL01_TMP	Existing temperature sensor in Cell01
CELL02_DEWPOINT	Calculated dewpoint in Cell02
CELL02_HUM	Existing humidity sensor in Cell02
CELL02_TMP	Existing temperature sensor in Cell02
CELL03_DEWPOINT	Calculated dewpoint in Cell03
CELL03_HUM	Existing humidity sensor in Cell03
CELL03_TMP	Existing temperature sensor in Cell03
CELL04_DEWPOINT	Calculated dewpoint in Cell04
CELL04_HUM	Existing humidity sensor in Cell04
CELL04_TMP	Existing temperature sensor in Cell04
CELL05_DEWPOINT	Calculated dewpoint in Cell05
CELL05_HUM	Existing humidity sensor in Cell05
CELL05_TMP	Existing temperature sensor in Cell05
CELL06_DEWPOINT	Calculated dewpoint in Cell06
CELL06_HUM	Existing humidity sensor in Cell06
CELL06_TMP	Existing temperature sensor in Cell06
CELL07_DEWPOINT	Calculated dewpoint in Cell07
CELL07_HUM	Existing humidity sensor in Cell07
CELL07_TMP	Existing temperature sensor in Cell07
CELL08_DEWPOINT	Calculated dewpoint in Cell08
CELL08_HUM	Existing humidity sensor in Cell08
CELL08_TMP	Existing temperature sensor in Cell08
CELL09_DEWPOINT	Calculated dewpoint in Cell09
CELL09_HUM	Existing humidity sensor in Cell09
CELL09_TMP	Existing temperature sensor in Cell09
CELL10_DEWPOINT	Calculated dewpoint in Cell10
CELL10_HUM	Existing humidity sensor in Cell10
CELL10_TMP	Existing temperature sensor in Cell10
CELL11_DEWPOINT	Calculated dewpoint in Cell11
CELL11_HUM	Existing humidity sensor in Cell11
CELL11_TMP	Existing temperature sensor in Cell11
CELL12_DEWPOINT	Calculated dewpoint in Cell12
CELL12_HUM	Existing humidity sensor in Cell12
CELL12_TMP	Existing temperature sensor in Cell12
CELL13_DEWPOINT	Calculated dewpoint in Cell13
CELL13_HUM	Existing humidity sensor in Cell13
CELL13_TMP	Existing temperature sensor in Cell13
CELL14_DEWPOINT	Calculated dewpoint in Cell14
CELL14_HUM	Existing humidity sensor in Cell14
CELL14_TMP	Existing temperature sensor in Cell14
CELL15_DEWPOINT	Calculated dewpoint in Cell15
CELL15_HUM	Existing humidity sensor in Cell15
CELL15_TMP	Existing temperature sensor in Cell15
CELL16_DEWPOINT	Calculated dewpoint in Cell16
CELL16_HUM	Existing humidity sensor in Cell16
CELL16_TMP	Existing temperature sensor in Cell16
CELL17_DEWPOINT	Calculated dewpoint in Cell17
CELL17_HUM	Existing humidity sensor in Cell17
CELL17_TMP	Existing temperature sensor in Cell17
CELL18_DEWPOINT	Calculated dewpoint in Cell18
CELL18_HUM	Existing humidity sensor in Cell18
CELL18_TMP	Existing temperature sensor in Cell18
CELL19_DEWPOINT	Calculated dewpoint in Cell19
CELL19_HUM	Existing humidity sensor in Cell19
CELL19_TMP	Existing temperature sensor in Cell19
CELL20_DEWPOINT	Calculated dewpoint in Cell20
CELL20_HUM	Existing humidity sensor in Cell20
CELL20_TMP	Existing temperature sensor in Cell20
CELL21_DEWPOINT	Calculated dewpoint in Cell21
CELL21_HUM	Existing humidity sensor in Cell21
CELL21_TMP	Existing temperature sensor in Cell21
CELL22_DEWPOINT	Calculated dewpoint in Cell22
CELL22_HUM	Existing humidity sensor in Cell22
CELL22_TMP	Existing temperature sensor in Cell22
CELL23_DEWPOINT	Calculated dewpoint in Cell23
CELL23_HUM	Existing humidity sensor in Cell23
CELL23_TMP	Existing temperature sensor in Cell23
CHILLER_FAULT	Fault signal from CHILLER
CHILLER_SP	Set point for CHILLER control
CHILLER_START	Enable signal to CHILLER
CHILLER_WARNING	warning / maintenance signal from CHILLER
CHW_DPRESS	Chilled water flow differential pressure sensor
CHW_FLOW	Chilled water flow temperature
CHW_PUMP_FAULT	Fault signal from CHW_PUMP
CHW_PUMP_SP	Set point for CHW_PUMP control
CHW_PUMP_START	Enable signal to CHW_PUMP
CHW_PUMP_WARNING	warning / maintenance signal from CHW_PUMP
CHW_RET	Chilled water return temperature
DAC_FAULT	Fault signal from DAC
DAC_SP	Set point for DAC control
DAC_START	Enable signal to DAC
DAC_WARNING	warning / maintenance signal from DAC
DEHUM_FAULT	Fault signal from dehumidifier
DEHUM_OUTPUT	Signal to modulate dehumidifier output
DEHUM_START	Enable signal to dehumidifier
DEHUMAIR_DEWPOINT	Off dehumidification AHU air dewpoint sensor
DEHUMAIR_HUMIDITY	Calculated Off dehumidification AHU humidity
DEHUMAIR_PRESS	Off dehumidification AHU air pressure sensor
DEHUMAIR_TMP	Off dehumidification AHU air temperature sensor
E_FAN_DPS	Differential Pressure Switch over extract Fan
E_FAN_FAULT	Fault signal from extract fan / inverter
E_FAN_SPEED	Signal to modulate extract fan speed
E_FAN_START	Enable signal to extract fan
EA_DAMP	Exhaust air damper
EA_DAMP_ES	Exhaust air damper end switch
EXHAUSTAIR_DEWPOINT	Exhaust air dewpoint sensor
EXHAUSTAIR_Enthalpy	Calculated exhaust air enthalpy
EXHAUSTAIR_HUMIDITY	Calculated Exhaust air humidity
EXHAUSTAIR_PRESS	Exhaust air static pressure sensor
EXHAUSTAIR_TMP	Exhaust air temperature sensor
EXHAUSTAIR_GAS	Nitrogen Dioxide Sensor PPM in exhaust air
FA_DAMP	Fresh air damper
FA_DAMP_ES	Fresh air damper end switch
FA_DEWPOINT	Fresh air dewpoint sensor
FA_Enthalpy	Calculated fresh air enthalpy
FA_HUMIDITY	Calculated Fresh air humidity
FA_TMP	Fresh air temperature sensor
FILTER_DPS	Differential Pressure Sensor over filter
HCV	Heating Coil Valve
HUMIDIFIER_FAULT	Fault signal from humidifier
HUMIDIFIER_OUTPUT	Signal to modulate humidifier output
HUMIDIFIER_START	Enable signal to humidifier
LWT	Leaving water temperature
METER_WATER	Water Meter
PRESS_UNIT_FAULT	Fault signal from PRESS_UNIT
PRESS_UNIT_SP	Set point for PRESS_UNIT control
PRESS_UNIT_START	Enable signal to PRESS_UNIT
PRESS_UNIT_WARNING	warning / maintenance signal from PRESS_UNIT
RWT	Return water temperature
S_FAN_DPS	Differential Pressure Switch over supply fan
S_FAN_FAULT	Fault signal from supply fan / inverter
S_FAN_SPEED	Signal to modulate supply fan speed
S_FAN_START	Enable signal to supply fan
SA_DEWPOINT	Supply air dewpoint sensor
SA_FLOW	Supply air flow sensor
SA_HUMIDITY	Calculated supply air humidity
SA_PRESS	Supply air static pressure sensor
SA_TMP	Supply air temperature sensor
THWHEEL_Enthalpy	Enthalpy of air off thermal wheel
THWHEEL_FAULT	Fault signal from thermal wheel
THWHEEL_SPEED	Signal to modulate thermal wheel speed
THWHEEL_START	Enable signal to thermal wheel
UNIT_FAULT	Fault signal from unit
UNIT_SP	Set point for unit control
UNIT_START	Enable signal to unit
UNIT_WARNING	warning / maintenance signal from unit
VAV_AIRFLOW	VAV box airflow signal
VAV_POSITION	VAV box position signal

Acronym	Description	Acronym	Description
ACR	Adjustable Current Relay	IS	Industrial Sensor
AFS	Air Flow Station	LS	Setting of CA, CR or OM low alarm
AI	Analog Input	LQ	Alarm Lockout
AL	Alarm condition	MA	Maintenance Alarm
AO	Analog Output	MAC	Maintained Contact on activation
CAT	Category	MD	Motorized Damper
CA	Cautionary Alarm	MOC	Momentary contact on activation
CR	Closes on rise of the measured variable	MV	Motorized Valve
CR	Critical	N	No
DEL	Delay	NC	Normally Closed
DI	Digital Input	NML	Normal condition
DO	Digital Output	NO	Normally Open
DPT	Differential Pressure Transmitter	OR	Opens on Rise of the measured variable
ET	Energy Totalisation	RFT	Run Time Totalisation
F	Field assigned	SCH	Scheduled
FA	Fire Alarm	VSD	Variable Speed Drive
HI	Setting of CA, CR or OM high alarm	Y	Yes
IC	Industrial Controller	v	Virtual, Duplicated or Calculated point

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group
  - .1    CSA C22.1-12, Canadian Electrical Code 2018, Part 1 (24th Edition), Safety Standard for Electrical Installations.
  - .2    CAN3-C235-19 (R2010), Preferred Voltage Levels for AC Systems, up to 50,000 V.
- .2    CAN/CSA-C22.2 Complete installation in accordance with CSA C22.3 except where specified otherwise.
- .3    Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1    IEEE 100 CD, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition including the current updated version of this document

**1.2            DEFINITIONS**

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

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for all electrical installation materials and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Submit for review single line electrical diagrams
  - .1    Electrical power generation and distribution systems in power plant rooms.
- .4    Shop drawings:
  - .1    Submit drawings, appropriately stamped and signed by professional engineer registered or licensed in Ontario, Canada.
  - .2    Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .3    Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .4    Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

- .5 Submit two number of copies of 600 x 600mm minimum size drawings and product data sheets to the Departmental Representative having jurisdiction.
- .6 If changes are required, notify Departmental Representative of these changes before they are made.
- .5 Certificates:
  - .1 Provide CSA certified equipment / materials
  - .2 Where CSA certified material is not available, submit such material to authority having jurisdiction for 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.
- .6 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

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for all electrical installation equipment for incorporation into manual.
  - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include following:
    - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .4 Post instructions where directed.
  - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
  - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

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

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

## **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 labels for control items in English and French
- .4 Use one label for both languages.

### **2.2 MATERIALS AND EQUIPMENT**

- .1 Provide materials in accordance with Section [01 61 00 - Common Product Requirements.
- .2 Materials to be CSA certified. Where CSA certified equipment is not available, obtain special approval from the 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 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems as shown on mechanical drawings.

## 2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Departmental Representative authority having jurisdiction.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.

## 2.5 WIRING TERMINATIONS

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

## 2.6 EQUIPMENT IDENTIFICATION

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

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

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wordings on labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO." as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

## 2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes numbered, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.



- .4 Use colour coded wires in communication cables, matched throughout system.

## **2.8 CONDUIT AND CABLE IDENTIFICATION**

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

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

## **2.9 FINISHES**

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

## **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 the electrical 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 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### **3.5 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

### **3.6 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1400mm.
  - .2 Wall receptacles:
    - .1 General: 300mm.
    - .2 Above top of continuous baseboard heater: 200mm.
    - .3 Above top of counters or counter splash backs: 175mm.
    - .4 In mechanical rooms: 1400mm.
  - .3 Fire alarm stations: 1500mm.
  - .4 Fire alarm bells: 2100mm.

**3.7 CO-ORDINATION OF PROTECTIVE DEVICES**

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

**3.8 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panel boards 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 motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems: fire alarm
  - .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.

**3.9 SYSTEM STARTUP**

- .1 Instruct Departmental Representative 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.

**3.10 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 This Section includes requirements for selective demolition and removal of electrical components including removal of conduit, junction boxes, and panels to source and incidentals required to complete work described in this Section

**1.2 REFERENCE STANDARDS**

- .1 CSA Group (CSA)
  - .1 CSA S350 M1980 R2003, Code of Practice for Safety in Demolition of Structures

**1.3 DEFINITIONS**

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .3 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Action Submittals: Provide in accordance with Section 01 33 00- Submittal Procedures before starting work of this Section:
  - .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19- Waste Management and Disposal.

**1.5 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for Departmental Representative's continued occupancy requirements during selective demolition with Section 02 41 19.16 - schedule staged occupancy and worksite activities as a defined in the Construction Progress Schedule

**1.6 QUALITY ASSURANCE**

- .1 Regulatory Requirements: Perform work of this Section in accordance with:
  - .1 Provincial/Territorial Occupational Health and Safety Standards and Programs Government of Canada, Labour Program: Workplace Safety

## **1.7 SITE CONDITIONS**

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition[at time of site examination before tendering.
- .2 Existing Hazardous Substances: Departmental Representative have performed a hazardous substances assessment and it is not expected that hazardous substances will be encountered in the propose work areas.
  - .1 Hazardous substances will be removed by a hazardous abatement specialist engaged by Departmental Representative before start of Work.
- .3 Existing Hazardous Substances: Departmental Representative has performed a hazardous substances assessment and identified materials requiring abatement as follows:
  - .1 Hazardous substances are as defined in Hazardous Products Act.
- .4 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform following activities:
  - .1 Refer to Section 01 41 00 - Regulatory Requirements for directives associated with specific material types.
  - .2 Hazardous substances will be as defined in Hazardous Products Act.
  - .3 Stop work in area of suspected hazardous substances.
  - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
  - .5 Hazardous substances will be removed by the Departmental Representative under a separate contract or as a change to Work.
  - .6 Proceed only after written instructions have been received from Departmental Representative.

## **1.8 SALVAGE AND DEBRIS MATERIALS**

- .1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Departmental Representative.
- .2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials in accordance with Section 02 42 00- Removal and Salvage of Construction Materials.
  - .1 Leave main all electrical distribution panel in place; panel can be used for temporary construction power for this and subsequent contracts in accordance with Section 01 51 00 - Temporary Utilities ; coordinate temporary power connections with Departmental Representative.
  - .2 Leave main telephone terminal backboard in place; panel can be used for temporary construction telephone system for this and subsequent contracts in accordance with Section 01 51 00 - Temporary Utilities ; coordinate temporary telephone connections with Departmental Representative.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.
- .2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

**3.2 PREPARATION**

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
  - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
  - .3 Prevent debris from blocking drainage inlets.
  - .4 Protect mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:
  - .1 Prevent debris from endangering safe access to and egress from occupied buildings.
  - .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

**3.3 EXECUTION**

- .1 Coordinate requirements of this Section with information contained in Section 02 4 19.16 - Selective Interior Demolition and as follows:
  - .1 Disconnect only electrical circuits as detailed; maintain electrical service and main distribution panel as is, ready for subsequent Work.

- .2 Remove only luminaires, electrical devices and equipment including associated conduits, boxes, wiring, and similar items as specifically identified.
- .3 Disconnect and remove only existing fire alarm system including associated conduits, boxes, wiring, and similar items, where detailed to be removed to facilitate the removal of existing HVAC plant and the installation of replacement HVAC plant, please refer to specific fire alarm section for further details
- .4 Disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items unless specifically noted otherwise.
- .5 Perform demolition work in a neat and workmanlike manner:
  - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
  - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
- .6 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
- .7 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
- .8 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
- .9 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

### **3.4 CLOSEOUT ACTIVITIES**

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) [except where explicitly noted otherwise for materials being salvaged for re use in new construction in accordance with Section 02 42 00 - Removal and Salvage of Construction Materials].
- .2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances in accordance with requirements of Section 02 81 00- Hazardous Materials .

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group (CSA)
  - .1    CAN/CSA-C22.2 No 18.1 to 18.4, Outlet Boxes, Conduit Boxes and Fittings.
  - .2    CAN/CSA-C22.2 No.65-18 , Wire Connectors (Tri-National Standard with NMX-J-543-ANCE and UL 486A -486B).
- .2    Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1    EEMAC 1Y-2-1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3    National Electrical Manufacturers Association (NEMA)

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3            CLOSEOUT SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

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

**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 Bushing stud connectors: to EEMAC 1Y-2 /NEMA to consist of:
  - .1 Connector body and stud clamp for stranded round copper conductors.
  - .2 Clamp for stranded round copper conductors.
  - .3 Bolts for copper conductors.
  - .4 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2 No.18.

**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 wire and box connectors 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 Remove insulation carefully from ends of conductors cables and:
  - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
  - .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65 Replace insulating cap.
  - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2 NEMA.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

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

**1.2 DELIVERY, STORAGE AND HANDLING**

- .1 Packaging Waste Management: remove for reuse of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal

**Part 2 Products**

**2.1 BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600V insulation of cross-linked thermosetting polyethylene material rated RWU90 XLPE / RW90 XLPE ,Jacketted.

**2.2 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Armour: interlocking type fabricated from galvanized steel strip.
- .3 Type: flame retardant PVC jacket over thermoplastic armour and compliant to applicable Building Code classification for this project.

**2.3 CONTROL CABLES**

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: thermoplastic.
  - .2 Sheath: thermoplastic jacket and armour of closely wound aluminum wire.
- .2 Type: low energy 300 V control cable: annealed copper conductors sized as indicated  
LVT: 2 soft annealed copper conductors, sized as indicated:

**Part 3 Execution**

**3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests before energizing electrical system.

### **3.2 GENERAL CABLE INSTALLATION**

- .1 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 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.
- .7 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .8 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

### **3.3 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
  - .2 In surface and lighting fixture raceways in accordance with Section 26.05.33.01

### **3.4 INSTALLATION OF ARMOURED CABLES**

- .1 Group cables wherever possible on channels.

### **3.5 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in conduit
- .2 Ground control cable shield.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group
  - .1    CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
  - .2    CSA C22.2 No.41-18, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
  - .3    CSA C22.2 No.65-18, Wire connectors (Tri-National Standard, with NMX-J-543-ANCE and UL 486A-486B including update 1 2019).

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for connectors and terminations and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Certificates: obtain inspection certificate of compliance covering high voltage stress from Departmental Representative and include it with as-built drawings /maintenance manuals.

**1.3            CLOSEOUT SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 CONNECTORS AND TERMINATIONS**

- .1 Copper long barrel / short barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.

**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 connectors and terminations 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 Bond and ground as required CSA C22.2No.41

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning

**END OF SECTION**

**Part 1            General**

**1.1            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.2            DELIVERY, STORAGE AND HANDLING**

- .1      Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 01 61 00 - Common Product Requirements.
- .2      Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3      Storage and Handling Requirements:
  - .1          Store materials in a dry location, off ground / indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2          Store and protect hangers and supports from nicks, scratches, and blemishes.
  - .3          Replace defective or damaged materials with newSPEC NOTE: Co-ordinate the following paragraph with Section 01 35 21- LEED Requirements.
- .4      Packaging Waste Management: remove for reuse of all packaging materials as specified in the Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2            Products**

**2.1            SUPPORT CHANNELS**

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

**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 hangers and supports 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 Secure equipment to poured concrete with expandable inserts.
- .2 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .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 threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at 600mm 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.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group (CSA)
  - .1    CSA C22.1-06, Canadian Electrical Code, Part 1, 24th Edition (2018).

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3            DELIVERY, STORAGE AND HANDLING**

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

**Part 2           Products**

**2.1            OUTLET AND CONDUIT BOXES GENERAL**

- .1    Size boxes in accordance with CSA C22.1.
- .2    102 mm square or larger outlet boxes as required.
- .3    Gang boxes where wiring devices are grouped.
- .4    Blank cover plates for boxes without wiring devices.
- .5    347 V outlet boxes for 347 V switching devices.
- .6    Combination boxes with barriers where outlets for more than one system are grouped.

**2.2            GALVANIZED STEEL OUTLET BOXES**

- .1    One-piece electro-galvanized construction.
- .2    102 mm square or octagonal outlet boxes for lighting fixture outlets

**2.3            CONDUIT BOXES**

- .1    Cast aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

**2.4            FITTINGS - GENERAL**

- .1    Bushing and connectors with nylon insulated throats.
- .2    Knock-out fillers to prevent entry of debris.
- .3    Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4    Double locknuts and insulated bushings on sheet metal boxes.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1       Support boxes independently of connecting conduits.
- .2       Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3       Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .4       Vacuum clean interior of outlet boxes before installation of wiring devices.
- .5       Identify systems for outlet boxes as required.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA)
  - .1 CAN/CSA-C22.2 No. 62-93 (R2017), Surface Raceway Systems.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
  - .1 Manufacturer's Instructions: provide manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
- .4 Indicate types of raceways with terminology similar to that used in this Section.

**1.3 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 SURFACE RACEWAY SYSTEM (WIRING PULLED IN)**

- .1 One piece steel, free of sharp edges to CAN/CSA-C22.2 No. 62.
- .2 Corners, pull boxes, elbows, tees, two piece assembly to facilitate site wiring.
- .3 Finish: grey enamel.
- .4 Switch, receptacle, extension boxes, adapters and fittings required for complete installation.

**2.2 SURFACE RACEWAY SYSTEM (WIRING LAID IN)**

- .1 Two piece steel assembly CAN/CSA-C22.2 No. 62.
  - .1 Finish: grey enamel.
- .2 Switch, receptacle, extension boxes, adapters and fittings required for complete installation.

**2.3 CHANNEL RACEWAY**

- .1 Channel type raceway: to CAN/CSA-C22.2 No. 62, steel perforated.

**2.4 LIGHTING FIXTURE RACEWAY**

- .1 Fluorescent fixture support system using channel type raceway with snap-on cover.
- .2 Channel: minimum 1.6 mm thick.
- .3 Clamp hangers with 2 threaded rod.

**2.5 FITTINGS**

- .1 Elbows, tees, supports, connectors couplings and fittings: to CAN/CSA-C22.2 No. 62.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install raceway systems as indicated and in accordance with manufacturer's instructions.
- .2 Install supports, elbows, tees, connectors, fittings, bushings, adaptors as required.
- .3 Keep number of elbows, offsets and connections to minimum.
- .4 Use wiring with mechanical protection in channel raceways.
- .5 Install barriers in raceways for different services where required by code.
- .6 Install wiring after installation of raceway system is complete.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group (CSA)
  - .1    CAN/CSA C22.2 No. 18-01–18.4 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2    CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.
  - .3    CSA C22.2 No. 56-17, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
  - .4    CSA C22.2 No. 83-M1985 (R2017), Electrical Metallic Tubing.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product data: submit manufacturer's printed product literature, specifications and datasheets.
  - .1    Submit cable manufacturing data.
- .3    Quality assurance submittals:
  - .1    Test reports: submit certified test reports.
  - .2    Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3    Instructions: submit manufacturer's installation instructions.

**Part 2            Products**

**2.1            CABLES AND REELS**

- .1    Provide cables on reels or coils.
  - .1    Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2    Each coil or reel of cable to contain only one continuous cable without splices.
- .3    Identify cables for exclusively dc applications.
- .4    Reel and mark shielded cables rated 2,001 volts and above.

**2.2            CONDUITS**

- .1    Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel threaded.
- .2    Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings
- .3    Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal steel.

## **2.3 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
  - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 900mm on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

## **2.4 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.  
Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

## **2.5 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.6 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 rigid hot dipped galvanized steel threaded conduit except where specified otherwise
- .4 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.
- .5 Use flexible metal conduit for connection to surface fluorescent fixtures / connection to motors in dry areas
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

- .7 Minimum conduit size for lighting and power circuits: 19 mm.
- .8 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19 mm diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.

### **3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on surface /suspended channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



Part 1            General

**1.1            REFERENCE STANDARDS**

- .1        CSA Group (CSA)
  - .1        CAN/CSA C22.1 No.126.1-17, Metal Cable Tray Systems.
- .2        National Electrical Manufacturers Association (NEMA)
  - .1        NEMA VE 1-2017, Metal Cable Tray Systems.
  - .2        NEMA VE 2-2018, Cable Tray Installation Guidelines.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3        Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4        Identify types of cable troughs used.
- .5        Show actual cable trough installation details and suspension system.

**Part 2           Products**

**2.1           CABLETROUGH**

- .1        Cable troughs and fittings: to CAN/CSA C22.1 No. 126.1 / 126.2 NEMA FG 1
- .2        Trays: galvanized steel, 62 /457 /152 / 305 / 610 mm wide with depth of 100/40 /152/75mm.
- .3        Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cable trough supplied.
  - .1        Radii on fittings: 305mm minimum.
- .4        Solid covers for complete cable trough system including fittings.
- .5        Barriers where different voltage systems are in same cable trough.
- .6        Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.
- .7        Fire stop system at penetrations of fire separations in accordance with Section 07 84 00 - Fire Stopping

**2.2           SUPPORTS**

- .1        Provide splices, supports for a continuously grounded system as required.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1      Install complete cable trough system in accordance with NEMA VE 2.
- .2      Support cable trough on both sides
- .3      Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

**3.2                CABLES IN CABLE TROUGH**

- .1      Install cables individually.
- .2      Secure cables in cable trough at 3 m centres, with nylon ties.
- .3      Identify cables every 30 m with size 2 nameplates in accordance with existing site standards

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group (CSA)
  - .1    CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2    CAN/CSA C22.2 No.42.1-13 (R2017), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for wiring devices 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 Ontario, Canada

**1.3            CLOSEOUT SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

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

**Part 2            Products**

**2.1            SWITCHES**

- .1      15A,120 V, single pole / double pole, switches to: CSA C22.2 No.55 /CSA C22.2 No.111.
- .2      Manually-operated general purpose AC switches with following features:
  - .1          Terminal holes approved for No. 10 AWG wire.
  - .2          Silver alloy contacts.
  - .3          Urea or melamine moulding for parts subject to carbon tracking.
  - .4          Suitable for back and side wiring.
  - .5          Ivory toggle.
- .3      Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads / heating loads.
- .4      Switches of one manufacturer throughout project.

**2.2            RECEPTACLES**

- .1      Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1          Ivory urea moulded housing.
  - .2          Suitable for No. 10 AWG for back and side wiring.
  - .3          Break-off links for use as split receptacles.
  - .4          Eight back wired entrances, four side wiring screws.
  - .5          Triple wipe contacts and rivetted grounding contacts.
- .2      Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
  - .1          Ivory urea moulded housing.
  - .2          Suitable for No. 10 AWG for back and side wiring.
  - .3          Four back wired entrances, 2 side wiring screws.
- .3      Other receptacles with ampacity and voltage as indicated.
- .4      Receptacles of one manufacturer throughout project.

**2.3            SPECIAL WIRING DEVICES**

- .1      Special wiring devices:
  - .1          Clock hanger outlets, 15 A, 125 V, 3 wire, grounding type, suitable for No. 10 AWG for installation in flush outlet box.

**2.4            COVER PLATES**

- .1      Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2      Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

- .3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .5 Weatherproof spring-loaded [cast aluminum] cover plates complete with gaskets for single receptacles or switches.

## **2.5 SOURCE QUALITY CONTROL**

- .1 Cover plates from one manufacturer throughout project.

## **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 wiring devices 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 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
  - .1 Install suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**3.4 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

**END OF SECTION**

## **General**

### **1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

### **1.2 DELIVERY, STORAGE AND HANDLING**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in a storage cabinet
- .4 Waste Management and Disposal:
  - .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

### **1.3 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Six spare fuses of each type and size installed up to and including 100 A.

## **Part 2 Products**

### **2.1 FUSES - GENERAL**

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

### **2.2 FUSE TYPES**

- .1 Class L fuses.
  - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type L2, fast acting.
- .2 Class J fuses.
  - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Type J2, fast acting.

- .3 Class R -R fuses.
  - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.

**Part 3 Execution**

**3.1 INSTALLATION**

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

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 No.4-16 (R2009 Enclosed and Dead-Front Switches (Tri-National Standard, with NMX-J-162-ANCE 2016 and UL 98).
  - .2 CSA C22.2 No.39-13, Fuse holder Assemblies.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

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

**Products**

**1.4 DISCONNECT SWITCHES**

- .1 Fusible, disconnect switch in CSA enclosure to CAN/CSA-C22.2 No.4 size as indicated.
- .2 Provision for padlocking in off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01 - Fuses - Low Voltage
- .5 Fuse holders: relocatable and to CSA C22.2 No.39 suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.

- .7 ON-OFF switch position indication on switch enclosure cover.

## **1.5 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

## **Part 2 Execution**

### **2.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused 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 the Departmental Representative.

### **2.2 INSTALLATION**

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

### **2.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**END OF SECTION**

Approved: 2008-12-31

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 International Electrotechnical Commission (IEC)
  - .1 IEC 947-4-1-[2002], Part 4: Electromechanical contactors and motor-starters.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide shop drawings: in accordance with Section [01 33 00 - Submittal Procedures].
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in [Province] [Territory], Canada.
    - .2 Provide shop drawings for each type of starter to indicate:
      - .1 Mounting method and dimensions.
      - .2 Starter size and type.
      - .3 Layout and components.
      - .4 Enclosure types.
      - .5 Wiring diagram.
      - .6 Interconnection diagrams.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section [01 78 00 - Closeout Submittals].
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .3 Extra Materials:
  - .1 Provide listed spare parts for each different size and type of starter.
    - .1 [3] contacts, stationary.
    - .2 [3] contacts, movable.
    - .3 [1] contacts, auxiliary.
    - .4 [1] control transformer[s].
    - .5 [1] operating coil.
    - .6 [2] fuses.

.7 [10] % indicating lamp bulbs used.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section [01 61 00 - Common Product Requirements].
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Starters: to IEC 947-4 with AC4 utilization category.

#### **2.2 MANUAL MOTOR STARTERS**

Single / Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One / Three overload heater[s], manual reset, trip indicating handle.
- .2 Accessories:
  - .1 [pushbutton switch heavy duty oil tight labelled as indicated.
  - .2 Indicating light: heavy duty oil tight] type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

#### **2.3 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and [120] V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity..

#### **2.4 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section [26 05 00 - Common Work Results for Electrical].

#### **2.5 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section [26 05 00 - Common Work Results for Electrical].
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install starters and control devices in accordance with manufacturer's instructions.

- .2 Install and wire, starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section [26 05 00 - Common Work Results for Electrical] and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI C82.1-04, Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .IEEE C62.41.2 – 2002 Recommended practice on characterization of surge voltages in low voltage (100v and less) AC power circuits
- .3 ASTM International Inc.
  - .1 ASTM F1137/F1137M-19, Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 CSA Group (CSA)
- .5 ICES-005-07, Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

**1.2            QUALITY ASSURANCE**

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

**1.3            DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse in accordance with Section 01 74 19 - Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.
- .5 Disposal and recycling of fluorescent lamps as per local regulations.
- .6 Disposal of old PCB filled ballasts.

**Part 2            Products**

**2.1            LAMPS**

- .1 Fluorescent lamps to be - T8, Wattage to match the existing installation, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80 ; or as indicated.

## **2.2 BALLASTS**

- .1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic dimmable.
  - .1 Rating: to match the existing installation
  - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
  - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
  - .4 Current crest factor: 1.7 maximum.
  - .5 Harmonics: 10 % maximum THD.
  - .6 Operating frequency of electronic ballast: 20kHz minimum.
  - .7 Total circuit power: to match existing
  - .8 Ballast factor: greater than 0.90.
  - .9 Sound rated: Class

## **2.3 FINISHES**

- .1 Light fixture finish and construction to meet ULC listing and CSA certification related to intended installation.

## **2.4 OPTICAL CONTROL DEVICES**

- .1 As indicated in luminaire schedule.

## **2.5 LUMINAIRES**

- .1 As indicated in luminaire schedule.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

### **3.2 WIRING**

- .1 Connect luminaires to lighting circuits:
  - .1 Install flexible or rigid conduit for luminaires as indicated.

### **3.3 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

### **3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.

- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    CSA Group (CSA)
- .1    CSA C22.2 No.141-15, Emergency Lighting Equipment.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3            CLOSEOUT SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

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

**1.5            WARRANTY**

- .1    For batteries in this Section 26 52 13.13 - Emergency Lighting, 12 months warranty.

**Part 2            Products**

**2.1            EQUIPMENT**

- .1    Emergency lighting equipment: to CSA C22.2 No.141.
- .2    Supply voltage: 120 V, AC.
- .3    Output voltage: 12V DC.

- .4 Operating time: 120 minutes.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnects solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: tungsten minimum output – size to match site standard
- .11 Cabinet: suitable for direct mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Auxiliary equipment:
  - .1 Test switch.
  - .2 Time delay relay.
  - .3 Battery disconnect device.
  - .4 AC input and DC output terminal blocks inside cabinet.
  - .5 Cord and [single twist-lock] plug connection for AC.
  - .6 RFI suppressors

## **2.2 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for emergency lighting 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

## **2.3 INSTALLATION**

- .1 Install unit equipment
- .2 Direct heads

## **2.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

**2.5 PROTECTION**

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

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CSA C22.2 No.141-15, Emergency Lighting Equipment.
  - .2        CSA C860-11(R2016), Performance of Internally Lighted Exit Signs.
- .2        National Fire Protection Association (NFPA)
  - .1        NFPA 101-2015, Life Safety Code.
- .3        International Organization for Standardization (ISO)
  - .1        ISO 3864-1 2011, Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings.
  - .2        ISO 7010 2019 – Graphical symbols Safety colours and safety signs - Registered safety signs.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3        Submit WHMIS SDS - Safety Data Sheets in accordance with Section 02 81 00 - Hazardous Materials.
- .4        Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1        Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures

**Part 2            Products**

**2.1                STANDARD UNITS**

- .1        Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2        Housing: rolled steel minimum 1.0 mm thick, satin aluminum enamel finish extruded aluminum housing, brush aluminum finish.
- .3        Face] plates: die formed cold rolled steel
- .4        Lamps: to match existing site standard
- .5        Operation: designed for 10,000 hours, fluorescent lamps only, 10,000 hours of continuous operation without relamping.

- .6 Letters: 150mm high x 19 mm, with 13 mm thick stroke, green on white glass, reading SORTIE / EXIT.
- .7 Graphics: Green pictogram and white graphical symbol and directional arrows to ISO 3864-1. Dimensions to ISO 7010.
- .8 Face plate to remain captive for relamping.

## 2.2 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish
- .3 Face plates: die formed cold rolled steel.
- .4 Lamps: to match existing
- .5 Operation: designed for 10,000 hours fluorescent lamps only, 10,000 hours of continuous operation without re lamping.
- .6 Letters: 150 mm high x 19mm wide, with 13 mm thick stroke, green on die-cast aluminum face reading EXIT / SORTIE.
- .7 Downlight: translucent acrylic in bottom of unit.
- .8 Face plate to remain captive for re lamping.
- .9 Supply voltage: 120V, ac.
- .10 Output voltage: 12 V dc.
- .11 Operating time: 60 minimum.
- .12 Recharge time: 12 hours
- .13 Battery: sealed, maintenance free.
- .14 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .15 Solid state transfer circuit.
- .16 Signal lights: solid state, for 'High Charge' / 'AC Power ON' condition.
- .17 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
  - .1 Removable or hinged front panel for easy access to batteries.
- .18 Auxiliary equipment
  - .1 Lamp disconnect switch.
  - .2 Test switch.
  - .3 AC/DC output terminal blocks inside cabinet.
  - .4 RFI suppressor.
  - .5 Cord and single twist-lock plug connection for AC power supply.

**2.3 DESIGN (X1)**

- .1 Wall mounting.
- .2 Single face with die-cast face plate to remain captive for relamping

**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 exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Lock exit light circuit breaker in on position.

**3.3 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

Approved: 2010-12-31

**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    Treasury Board of Canada (TBS), Occupational Safety and Health (OSH)
  - .1        Fire Protection Standard-[10].
- .2    Underwriter's Laboratories of Canada (ULC)
  - .1        CAN/ULC-S524-06, Standard for the Installation of Fire Alarm Systems (2016)
  - .2        CAN/ULC-S526-07, Visible Signal Devices for Fire Alarm Systems, Including Accessories.
  - .3        CAN/ULC-S529-09, Smoke Detectors for Fire Alarm Systems.
  - .4        CAN/ULC-S531-02, Standard for Smoke Alarms.
  - .5        CAN/ULC-S537-04, Standard for the Verification of Fire Alarm Systems.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for fire alarm system 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 Ottawa, Canada.
  - .2        Indicate on shop drawings:
    - .1            Detail assembly and internal wiring diagrams for control unit.
    - .2            Overall system riser wiring diagram identifying initiating zone ; identifying terminations, terminal numbers, conductors and raceways.
    - .3            Details for devices.
    - .4            Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
    - .5            Step-by-step operating sequence, cross referenced to logic flow diagram.

**1.3            CLOSEOUT SUBMITTALS**

- .1    Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for fire alarm system for incorporation into manual.
- .3    Include:

- .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
- .2 Technical data - illustrated parts lists with parts catalogue numbers.
- .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
- .4 List of recommended spare parts for system.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

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

- .1 Deliver, store and handle materials in accordance with Section 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 in dry location off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

### **Part 2 Products**

#### **2.1 DESCRIPTION**

- .1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to fire department.
- .3 Modular in design to allow for future expansion.
- .4 Operation of system shall not require personnel with special computer skills.
- .5 System to include:
  - .1 Wiring.
  - .2 Manual and automatic initiating devices.
  - .3 Audible [and visual] signalling devices.
  - .4 End-of-line resistors.
- .6 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .7 Smoke detectors: to CAN/ULC-S529.



- .8 Smoke alarms: to CAN/ULC-S531.
- .9 Regulatory Requirements:
  - .1 To TBS Fire Protection Standard.
  - .2 Subject to Fire Commissioner of Canada (FC) approval.
  - .3 Subject to FC inspection for final acceptance.
  - .4 To Canadian Forces Fire Marshal approval.
  - .5 System components: listed by ULC and comply with applicable provisions of [NBC] [[Provincial Building Code] [Local]], and meet requirements of local authority having jurisdiction.

## **2.2 SYSTEM OPERATION: SINGLE STAGE - SIGNALS ONLY**

- .1 Actuation of any alarm initiating device to:
  - .1 Cause electronic latch to lock-in alarm state at central control unit.
  - .2 Indicate zone of alarm at central control unit display.
  - .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
  - .4 Transmit signal to fire department via master fire alarm box
- .2 Acknowledging alarm: indicated at central control unit.
- .3 Ensure that it is possible to silence signals by "alarm silence" switch at control unit, after 60 seconds period of operation.
- .4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .5 Actuation of supervisory devices to:
  - .1 Cause electronic latch to lock-in supervisory state at central control unit [and data gathering panel/transponder].
  - .2 Indicate respective supervisory zone at central control unit and at [display] [remote annunciator].
  - .3 Cause audible signal at central control unit to sound.
  - .4 Activate common supervisory sequence.
- .6 Resetting alarm device not to return system indications/functions back to normal until control unit has been reset.
- .7 Trouble on system to:
  - .1 Indicate circuit in trouble at central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
- .8 Trouble on system: suppressed during course of alarm.
- .9 Trouble condition on any circuit in system not to initiate alarm conditions.

## **2.3 WIRING**

- .1 Twisted copper conductors: rated 120V.

- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- .3 To signal circuits: 16AWG minimum, and in accordance with manufacturer's requirements.
- .4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

## **2.4 AUTOMATIC ALARM INITIATING DEVICES**

- .1 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature [88] [57] degrees C, rate of rise [8.3] degrees C per minute.
  - .1 Electronics to communicate detector's status to addressable module/transponder.
  - .2 Detector address to be set on detector head in field.
- .2 Smoke detector: photo-electric type.
  - .1 Plug-in type with fixed base.
  - .2 Wire-in base assembly with integral red alarm LED,.
- .3 Addressable smoke detector.
  - .1 Photo-electric type.
  - .2 Electronics to communicate detector's status to addressable module/transponder.
  - .3 Detector address to be set on detector head in field.
- .4 Addressable variable-sensitivity smoke detectors.
  - .1 Photo-electric type.
  - .2 Electronics to communicate detector's status to addressable module/transponder.
  - .3 Detector address to be set on detector head in field.
  - .4 Sensitivity settings: determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
  - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

## **2.5 END-OF-LINE DEVICES**

- .1 End-of-line devices to control supervisory current in alarm circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel [and remotely as indicated].

## **Part 3            Execution**

### **3.1            EXAMINATION**

- .1    Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for fire alarm 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 systems in accordance with CAN/ULC-S524 and TB Fire Protection Standard.
- .2    Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts
- .3    Room detection system.
  - .1       Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
- .4    Connect fire suppression systems to control panel.
- .5    Splices are not permitted.
- .6    Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .7    Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .8    Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

### **3.3            FIELD QUALITY CONTROL**

- .1    Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and CAN/ULC-S537.
- .2    Fire alarm system:
  - .1       Test such device and alarm circuit to ensure detectors transmit alarm to control panel and actuate general alarm / first stage alarm.
  - .2       Check annunciator panels to ensure zones are shown correctly.
  - .3       Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.
  - .4       Addressable circuits system style DCLA:
    - .1           Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single

- open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .5 Addressable circuits system style DCLB:
- .1 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .2 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .3 Provide final PROM program re-burn for system Departmental Representative incorporating program changes made during construction.

### **3.4 PROTECTION**

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

### **3.5 CLOSEOUT ACTIVITIES**

- .1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

**END OF SECTION**