

## Division 21 Fire Suppression

### Common Contract Requirements for Fire Suppression

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### Fire Suppression Sprinkler Systems

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## Division 22 Plumbing

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- 22 05 31 Plumbing Expansion Joints, Anchors, and Guides
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- 22 07 19 Plumbing Piping Insulation

### Facility Water Distribution

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### Facility Sanitary Sewerage

- 22 13 13 Sanitary Drains
- 22 13 16 Sanitary Waste and Vent Piping – Cast Iron and Copper

### Fuel-Fired Domestic Water Heaters

- 22 34 36 Fuel-Fired Domestic Water Heaters

### Plumbing Auxiliary Equipment

- 22 36 13 Plumbing Auxiliary Equipment

### Fire Extinguishers

- 22 37 13 Portable Fire Extinguishers

### Plumbing Fixtures Combined With Drawing Schedule

- 22 44 13 Plumbing Fixtures Combined With Drawing Schedule

## **Division 23 Heating, Ventilating, and Air Conditioning (HVAC)**

### **Common Contract Requirements for HVAC**

- 23 02 41 HVAC Allowances
- 23 02 51 HVAC General Requirements
- 23 02 61 HVAC Occupancy Requirements

### **Common Work for HVAC**

- 23 05 11 General HVAC Work Requirements
- 23 05 21 HVAC Demolition and Renovation
- 23 05 34 Bases, Hangers and Supports (Indoor)
- 23 05 49 Vibration Control Measures
- 23 05 53 Identification of HVAC Services

### **Testing, Adjusting, and Balancing**

- 23 07 11 Testing, Adjusting, and Balancing (TAB) of HVAC Systems

### **Commissioning for HVAC**

- 23 08 11 HVAC Contractor Commissioning Requirements

### **HVAC Insulation**

- 23 10 13 Duct Insulation

### **Facility Fuel Piping**

- 23 11 23 Facility Natural-Gas & Propane Piping

### **HVAC Ducts and Casings**

- 23 31 13 Metal Ducts

### **Air Duct Accessories**

- 23 33 13 Duct Accessories
- 23 33 14 Volume-Control Dampers
- 23 33 16 Fire Dampers
- 23 33 17 Smoke Control Dampers
- 23 33 18 Operating Dampers
- 23 33 46 Flexible Ducts
- 23 33 53 Duct Liners

### **HVAC Fans**

- 23 34 23 Packaged Exhausters

### **Air Terminal Units**

- 23 36 16 Variable-Air Volume Units

### **Air Outlets and Inlets**

- 23 37 13 Diffusers, Registers, and Grilles
- 23 37 23 Louvres, Intakes, and Exhaust

### **Fuel-Fired Heaters**

- 23 55 33 Gas Fired Unit Heaters

### **Air-To-Air Energy Recovery Equipment**

- 23 72 14 Fixed Plate Air-to-Air Heat Recovery Ventilators (Enthalpy)

	<b>Packaged Outdoor HVAC Equipment</b>
23 74 43	Packaged Rooftop HVAC Units
	<b>Decentralized Unitary HVAC Equipment</b>
23 81 26	Wall Hung Split System Air Conditioning

## **Division 25 Integrated Automation**

	<b>Building Automation System</b>
25 20 01	Building Automation System – General Requirements
25 20 02	Building Automation System – Network Architecture and Wiring
25 20 03	Building Automation System – Operator Interface
25 20 04	Controllers
25 20 05	Field Devices and Sensors
25 20 06	Application and Systems Sequences of Operation

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL**

- .1 The following Identified Prices Form must be submitted to the architect and consultant at the time of tender closing. Fire Protection contractors must complete all information requested or tenders may be considered null and void. Should any uncertainty arise as to the proper manner of submitting tenders, the requisite information will be given at the office of the Consultant. Contractor shall sign and date this page and initial and date each page thereafter.

**1.2 CONTRACTOR**

I/We certify that I/We have the authority to bind the company.

\_\_\_\_\_  
COMPANY NAME

\_\_\_\_\_  
AUTHORIZED SIGNATURE

\_\_\_\_\_  
ADDRESS

\_\_\_\_\_  
PRINTED SIGNATURE

\_\_\_\_\_  
CITY

\_\_\_\_\_  
TITLE

\_\_\_\_\_  
TELEPHONE NUMBER

\_\_\_\_\_  
DATE

\_\_\_\_\_  
FAX

**1.3 RELATED SECTIONS**

- .1 This section must be read in association with the following: Division 1 and Electrical Divisions.

**1.4 SEPARATE PRICES (EXCLUDING HST)**

- .1 Separate prices are for work which is not included in the bid price listed on the Official Tender Form but which may be added by the Owner for the price listed.
- .1 For the supply and installation of sprinkler system in the shell space as marked in the plans if requested by the AHJ.

\_\_\_\_\_  
Dollars (\$\_\_\_\_\_) (Dollar amount in writing)

**Part 2            Products**

**2.1            NOT USED**

.1            Not used.

**Part 3            Products**

**3.1            NOT USED**

.1            Not used.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 Conform to Division 1 General Conditions and to all sections of Mechanical Division.
- .2 Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .3 Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .4 The term "Mechanical Contractor" shall remain active and shall mean a "single contractor" performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .5 When quoting as a subcontractor this contractor shall explicitly state the services, they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .6 Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2 INTENT**

- .1 Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for fire protection work.
- .2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.
- .4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.
- .5 Where used, word "provide" shall mean supply and install as each is described above.

**1.3 REGULATIONS, PERMITS, AND FEES**

- .1 All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.
- .2 Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.
- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.

- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Fire protection drawings do not show architectural, structural, plumbing, mechanical and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fitment's.
- .6 Install piping clear structural members and any fireproofing. Locate work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .7 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation.
- .8 Locate all fire protection piping and equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .9 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .10 Relocate equipment and/or material installed but not coordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .11 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.

- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, mechanical, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

## **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local Code and NFPA requirements. Ordinances, and adoptions thereof for all fire protection systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

## **1.7 EXAMINATION**

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## **1.8 SEQUENCING, SCHEDULING, AND COORDINATION**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.



- .2 Coordinate work of various trades in installing interrelated work. Before installation of fire protection items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in Fire Protection Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Fire Protection Division.
- .5 Be responsible for required cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .6 Adjust locations of pipes, equipment, fixtures, etc., to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe prior to fabrication.
  - .1 Make offsets, transitions, and changes in direction of pipes as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
- .7 Slots and openings through floors, walls, and ceilings shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

## **1.9 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant a minimum of two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference

- .8 Photograph of the issue (if applicable)
- .9 Description of the issue
- .10 Contractor's proposed resolution

#### **1.10 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 **Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
- .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .10 Check work described by catalog data with Contract Documents for deviations and errors.
- .11 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances. e.g., access door swing spaces.
- .12 Shop drawings and product data shall be 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 as to current model production.
  - .5 Certification of compliance to applicable codes.

- .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
- .14 Shop drawings shall be submitted electronically as per the following directions:
  - .1 Electronic Submissions:
    - .1 Electronically submitted shop drawings shall be prepared as follows:
      - .1 Use latest software to generate PDF files of submission sheets.
      - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
      - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
      - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
      - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
      - .6 File names shall include consultant project number and description of shop drawing section submitted.
      - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
      - .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
      - .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
    - .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.
    - .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating "1 of 2" and "2 of 2" in email subject line for the case of two messages.
    - .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
    - .5 On site provide one (1) copy of the "reviewed" shop drawings in a binder as noted above.
    - .6 Contractor to print copies of "reviewed" shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

**1.11 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the "Nameplate Data" on the equipment on site.

**1.12 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals' requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit one (1) copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.
  - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as 'Operation and Maintenance Manual' with project name and location. Dividers are to be used for binder organization.
- .4 Make changes as required and re-submit as directed by Consultant.

**1.13 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide two (2) sets of reproducible fire protection drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing fire protection systems, control systems and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.

**1.14 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee fire protection systems to be free from defects that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.

Warranty period shall start from date of ready for takeover. Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .3 Warranty Duration:
  - .1 One (1) year warranty period applies unless otherwise noted.
- .4 Warranty Coverage:
  - .1 Applies to parts and labour.

**1.15 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover:
  - .1 As-Built Drawings
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 Instructions to Owners.

**1.16 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

**1.17 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, chemical, and other environment damaging conditions but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove any damaged materials from site.

## **1.18 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify Consultant.**
- .2 Each Contractor and on site employee of the Contractor shall have "asbestos awareness training".**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 It is the responsibility of the Contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**
- .5 Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.**
- .6 A survey of each building documenting the location and condition of designated substances and/or hazardous containing materials is available for your mandatory review prior to commencing any work on premises.**

## **1.19 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the Contractor of the work required to complete the entire contract.
- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all fire protection systems.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and Consultants for occupancy of completed areas.

## **1.20 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

## **1.21 TESTS**

- .1 Give 48 hours written notice of date for tests.

- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
  - .1 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere.
- .5 Test fire systems in accordance with authorities having jurisdiction (AHJ) NFPA requirements and as specified elsewhere.
- .6 Equipment: test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

#### **1.22 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to all fire protection.

#### **1.23 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems. Follow Electrical Division for installation methods, quality of materials, and workmanship.
  - .2 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

#### **1.24 PIPING AND EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer shall follow the manufacturer's recommendation.
- .2 Piping and equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.

#### **1.25 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.

- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

## **1.26 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe or other fire protection items piercing walls, floors, etc.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
- .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.
- .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
- .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.
- .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.



- .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
- .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.
- .15 Acceptable alternate manufacturers to approval of local authority:
  - .1 Minnesota Mining and Manufacturing
  - .2 Fryesleeve Industries Inc.
  - .3 General Electric Pensil Firestop Systems
  - .4 International Protective Coatings Corp.
  - .5 Rectorseal Corporation (Metacaulk)
  - .6 Proset Systems
  - .7 3M
  - .8 AD Systems
  - .9 Hilti.
- .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

#### **1.27 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.

#### **1.28 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Apply two coats of paint to exposed piping service in mechanical room, electrical, and service rooms. Base colour shall be red.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

**1.29 ACCESS DOORS**

- .1 Provide access doors to concealed fire protection equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable Manufacturers:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

**1.30 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

**1.31 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

**1.32 CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to owner.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

**1.33 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.

**1.34 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-ray and/or scan of the existing buried services in wall and/or floors prior to starting any work in the affected area.
- .2 Failure to locate existing piping, conduit rebar etc. shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

**1.35 INTEGRATED LIFE SAFETY SYSTEMS TESTING**

- .1 Fire protection systems in this building, including but not limited to flow switches, valves, fire pumps, etc. will be subject to Integrated Life Safety Systems testing.
- .2 The Fire Protection Contractor shall co-ordinate with the Integrated Life Safety Systems Testing Agent as follows:
  - .1 Confirm which fire protection systems are to be included as part of the testing process.
  - .2 Verify in writing to the Integrated Life Safety Systems Testing Agent that fire protection commissioning of the affected systems/devices is complete prior to the scheduled testing date(s).
  - .3 Participate in the Integrated Life Safety Systems Testing to confirm proper operation of all associated systems.
  - .4 This Contractor shall work with the Integrated Life Safety Systems Testing Agent to reset all systems back to normal operating mode after the testing is complete.
- .3 Include all costs associated with Integrated Life Safety System Testing in the tender value.
- .4 Refer to Division 1/Division 26 Integrated Life Safety Systems Testing specifications for additional information/requirements.

**1.36 IDENTIFICATION OF 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 Background colour marking and legends for piping systems:

CONTENTS	BACKGROUND COLOUR	
	MARKING	LEGEND
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

### 1.37 FUNCTIONAL PERFORMANCE TESTS

- .1 This Contractor shall be responsible for the Functional Performance Tests. These tests ensure that all equipment and systems operate in accordance with design intent. Test the systems through all possible modes of operation.
- .2 The function performance test shall be:
- .1 Test piping systems.
  - .2 Test all valves and flow switches.
  - .3 Test flow and record flow from end of inspector's test port.
  - .4 Test flow through all backflow preventors.
  - .5 Other test that maybe a requirement of NFPA.
- .3 All tests shall be recorded and presented to the Consultant and Owner.
- .4 Include all test results in the Operation and Maintenance Manuals.

**Part 2 Not Used**

**Part 3 Not Used**

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 NFPA 13 latest edition, Installation of Sprinkler Systems.
- .3 Ontario Fire Code.
- .4 Ontario Building Code.
- .5 Factory Mutual guidelines.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements in accordance with NFPA 13, working plans and design requirements.
- .2 Shop drawings shall be approved by authority having jurisdiction prior to submission.
- .3 Submit to Consultant for general review and information only.
- .4 Submitted drawings shall be reproducible. Do not submit marked up prints.
- .5 Drawings shall be in AutoCad format.

**1.3            SAMPLES**

- .1 Submit samples in accordance with general requirements.
- .2 Submit samples of following:
  - .1 Each type of sprinkler head.
  - .2 Signs.

**1.4            ENGINEERING DESIGN CRITERIA**

- .1 Design system in accordance with Ontario Fire Marshall, local authority having jurisdiction, Owner's underwriters as required, and NFPA 13, NFPA 20, and NFPA 45 using following parameters:
  - .1 To suit occupancy as indicated.
  - .2 Pipe size and layout: Hydraulic design.
  - .3 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13. Indicate location and flow on shop drawings.
  - .4 System zoning as indicated in accordance with NFPA 13.
  - .5 Provide complete drawings and calculations stamped by a qualified professional engineer registered in the Province of Ontario.
  - .6 Professional Engineer shall provide on site review and certification for local building code review.
- .2 System shall be approved by Ontario Fire Marshall, local authority, and Owner's underwriter prior to shop drawing submission.

**1.5 COMMISSIONING & INTEGRATED TESTING OF FIRE PROTECTION & LIFE SAFETY SYSTEMS**

- .1 Sprinkler Contractor to perform services with the Fire Commissioning Agent (FCA) to meet their requirements for administration, verification, and final sign-off.
- .2 The Fire Commissioning Agent (FCA) is being retained by the Electrical Contractor, however; this Contractor's work to satisfy the FCA requirements shall be included in the tender price.
- .3 The Sprinkler Contractor at a minimum must include for:
  - .1 Providing FCA with all documentation of design and shop drawings.
  - .2 Provide documents for sequence of operation and maintenance of system.
  - .3 Movement of all valves and accessories to confirm Alarm/Supervisory/Trouble at the fire panel.
  - .4 Create flow at all initiating devices to verify detection at the fire panel.
  - .5 Testing and operation of any fire pumps.
  - .6 Other items that may be requested by the FCA.
  - .7 Re-commissioning of any items that may have failed.
  - .8 Putting the system back into proper operation after tests are completed.
- .4 All work is to be performed in accordance with NFPA 3 2010 Edition. Special consideration to be given to Figure A3.3.16 (b) for Sequence of Operation Form required to be completed in conjunction with the FCA and submitted to the Consultant's prior to occupancy.
- .5 The work to be performed by this Contractor is also described in NFPA 3 table A.5.1.1 as labelled "Construction Stage" and "Occupancy Stage".

**1.6 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.7 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with general requirements.
- .2 Provide spare sprinklers and tools as required by NFPA 13.

**1.8 QUALIFICATIONS**

- .1 Contractor to be specialist in performing work of this section and have **at least 3 years'** successful experience in this size and type of project.

**1.9 PERMITS AND FEES**

- .1 Obtain and pay for all permits, fees, and inspections as required by authority having jurisdiction.

**1.10 EQUIPMENT**

- .1 ULC listed and labeled.

**1.11 STORAGE**

- .1 Store in original packaging with manufacturers' labels and seals intact.
- .2 Store in dry secure location.
- .3 Damaged material and/or equipment shall be replaced.

**1.12 INSURANCE**

- .1 Confirm with owner prior to submitting quote.

**1.13 UNDERWRITERS REQUIREMENTS**

- .1 Confirm with owner insurance underwriters prior to submitting quote.

**Part 2 Products**

**2.1 PIPE, FITTINGS, AND VALVES**

- .1 Pipe and Fittings:
  - .1 25 mm (1"): Schedule 40 steel pipe with screwed fittings.
  - .2 32 mm (1¼") to 50 mm (2"):
    - .1 Schedule 40 steel pipe with screwed fittings or,
    - .2 Schedule 10 steel pipe with roll grooved fittings.
  - .3 65 mm (2½") and larger: Schedule 10 steel pipe with roll grooved fittings.
- .2 Valves:
  - .1 ULC listed for fire protection service.
  - .2 Up to NPS 2: bronze, screwed ends, OS&Y gate.
  - .3 NPS 2 1/2 and over: cast iron, flanged or roll grooved ends, indicating butterfly valve.
  - .4 Swing check valves.
  - .5 Ball drip.
- .3 Pipe hangers:
  - .1 ULC listed for fire protection services.
- .4 End switches:
  - .1 Provide on all isolating valves.
  - .2 Coordinate voltage and location with Fire Alarm Contractor.
- .5 Flow switches:
  - .1 Provide where indicated and required.
  - .2 Coordinate voltage and location with Fire Alarm Contractor.

**2.2 SPRINKLER HEADS**

- .1 General: to NFPA 13 and ULC listed for fire services.

- .2 Indicate type and location of sprinkler heads on drawings. Co-ordinate sprinkler heads location with other trades.
- .3 Locate sprinkler heads in acoustic tile ceiling in centre of tile.
- .4 Provide sprinkler heads as follows:
  - .1 Upright bronze: exposed with no ceilings.
  - .2 Concealed fusible link type brass pendent with ring and cup in ceiling and brass coverplate. Coverplate finish selected by Consultant. Concealed heads installed in unsupervised areas (corridors, washrooms).
  - .3 White semi-recessed fusible link type brass pendent with adjustable, recessed escutcheon ring and cup. Sprinkler and escutcheon cup. Finish selected by Consultant. Semi-recessed heads installed in supervised areas (classrooms, offices, seminar rooms etc.).
  - .4 Sprinkler heads with O-ring design shall not be used.
  - .5 Provide guards on upright sprinkler heads in all storage rooms, in the gymnasium and on heads below 1800 mm AFF.
- .5 Provide sprinkler heads under all equipment/ductwork over 1200 mm wide.

## **2.3 WATERFLOW DETECTORS (WFD)**

- .1 Provide, where shown, waterflow detectors, complete with vane type sensor to actuate two single pole, double throw snap action switches when waterflow exceeds a sustained 0.63 L/s (10 gpm) flow.
- .2 Provide a built-in pneumatic retard device, with automatic reset to reduce false alarms. The time delay shall be field adjustable from 0 to 70 seconds.
- .3 Provide local wiring at WFD. Refer to Electrical Division for alarm wiring to fire alarm system.
- .4 WFD shall be suitable for 1750 kPa (250 psig) service pressure.

## **2.4 SUPERVISORY SWITCHES**

- .1 General: to NFPA 13 and ULC listed for fire service.
- .2 Valves:
  - .1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.
- .3 Flow switch type:
  - .1 With normally open and normally closed contacts and supervisory capability.
- .4 Pressure alarm switch:
  - .1 With normally open and normally closed contacts and supervisory capability.

## **2.5 FIRE DEPARTMENT CONNECTION**

- .1 To NFPA 13 and ULC listed, siamese type, location as indicated. Thread specifications to be compatible with local fire department.



**2.6 PRESSURE GAUGES**

- .1 ULC listed.
- .2 Shall have maximum limit of not less than twice normal working pressure at point where installed.

**2.7 SIGNS**

- .1 Signs for control drain and test valves: to NFPA 13.
- .2 Provide exterior signage for Fire Department connection. Location of signage and text shall be to the approval of the local authority having jurisdiction.

**2.8 SPARE PARTS CABINET**

- .1 For storage of maintenance materials, spare sprinkler heads and special tools.
- .2 Include all types and temperature ratings of sprinkler heads installed.
- .3 Construct to sprinkler head manufacturers standard.
- .4 Install where directed on site or next to alarm valve.

**2.9 DOUBLE CHECK VALVE ASSEMBLY (DCVA)**

- .1 The double check backflow preventer shall be ASSE 1015 approved, and supplied with full port gate valves. The main body and access covers shall be epoxy coated cast iron (ASTM A126 Class B), the seat ring and check valve shall be cast bronze (ASTM B584), the stem shall be stainless steel (ASTM A276) and the seat disc elastomers shall be EPDM.
- .2 The checks shall be accessible for maintenance without removing the device from the line.
- .3 Complete with supervisory switches for connection and monitoring by the fire alarm.
- .4 Install to manufacturer's requirements and not higher than 1200 mm (4'-0") AFF.
- .5 Acceptable Manufacturers:
  - .1 Watts 709 2½" - 10"
  - .2 Wilkins 950 2" - 10", 350 4" - 6"
  - .3 Conbraco 40-100 Series

**2.10 INSPECTORS TEST CONNECTIONS**

- .1 Provide where indicated and to requirements of local authority.
- .2 Discharge to building exterior to acceptance of Consultant.
- .3 Provide suitable signage to satisfaction of authority having jurisdiction and Consultant.

**2.11 DOCUMENTATION**

- .1 Prepare documentation as indicated.
- .2 Provide documentation based on tender documents. Coordinate sprinkler drawings with all trades.

- .3 Provide one hard copy and one electronic copy of As Built drawings acceptable to Consultant prior to final payment.

## **2.12 UNIT PRICES**

- .1 Provide unit prices as follows.
  - .1 Additional sprinkler head including hangers, 3.6 M piping and two elbows.
  - .2 Delete sprinkler head including hangers, 3.6 M piping and two elbows.

## **2.13 UNDERWRITERS APPROVED GATE VALVE**

- .1 NPS 65 – 350 mm (2 1/2" - 14"), OS&Y:
  - .1 Approvals: UL and FM approved for fire service.
  - .2 UL and FM Label: on valve yoke.
  - .3 Body, Bonnet: cast iron to ASTM A 126 Class B. Wall thicknesses to ANSI B 16.1 and ULC 262(B).
  - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
  - .5 Packing gland: bronze.
  - .6 Stem: manganese bronze. Diameter to ULC C-262(B).
  - .7 Stuffing box dimensions, gland bolt diameter: to ULC C 262(B).
  - .8 Bosses for bypass valve, drain: on NPS 100 mm (4") and over.
  - .9 Disc: solid taper wedge. Up to NPS 80 mm (3"): bronze. NPS 100 mm (4") and over: cast iron with bronze disc rings.
  - .10 Disc seat ring: self-aligning, Milwood undercut on NPS 80 mm (3").
  - .11 Pressure rating:
    - .1 NPS 65 – 300 mm (2-1/2" - 12"): 1.7 MPa (250 psi) CWP
    - .2 NPS 350 mm (14"): 1.2 MPa (175 psi) CWP
  - .12 Operator: Handwheel.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and FC 403.
- .2 Install excess pressure pump across alarm valve in accordance with manufacturer's instructions.
- .3 Pipe a bypass complete with indicating valve, between Fire department connection and sprinkler main downstream of DCVA. Bypass shall be sized to allow flow test of system demand as per NFPA 13 forward flow test thru the backflow preventor.
- .4 Testing to be witnessed by authority having jurisdiction.
- .5 Space hangers and support of sprinkler piping in accordance with N.F.P.A. regulations.
- .6 Hydrostatically test systems at 350kPa in excess of normal working pressure, but not less than 1.4 MPa for two hours without loss under supervision of authority having jurisdiction and NFPA requirements.

- .7 Provide hydraulic pump, temporary connections and labour required for tests.
- .8 Protect exposed work, in accordance with 'Painting' section.
- .9 Do not cover or conceal piping accessories or work prior to inspection and approval by authorities having jurisdiction.
- .10 Adjust equipment to satisfaction of authority having jurisdiction and Consultant.
- .11 Protect equipment during painting. Replace damaged and painted components.
- .12 Co-ordinate the sprinkler piping and equipment with that of other trades on the job. Mains and branches shall be run so as not to interfere with building's structure, mechanical, or electrical installations. Branch piping above ceilings is to run in joist space or minimum 300 mm above ceiling. Provide drops at head locations only. All exposed piping to run in joist space.
- .13 Guarantee that the systems and equipment be installed in accordance with all Local and Provincial by-laws and the rules and regulations of the Insurance Underwriters and the Building Code of Ontario.
- .14 Provide a flow test for each system on the remote inspectors test connection using methods approved by the local fire department and local water commission. Report the test results in writing to the Consultant.

### **3.2 WATER FLOW TEST**

- .1 Provide a flow test to approval of local fire department and local water commission at nearest fire hydrant adjacent to building to determine water flow rate and pressure. Provide written test results with shop drawing submission.
- .2 Provide a forward flow test thru the bypass to prove system demand can be provided thru the backflow preventer.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 This section covers items common to all sections of Plumbing Division.
- .2 Conform to Division 1 General Conditions.
- .3 Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .4 Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .5 The term "Mechanical Contractor" shall remain active and shall mean a "single contractor" performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .6 When quoting as a subcontractor this contractor shall explicitly state the services they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .7 Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2 INTENT**

- .1 Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for plumbing work.
- .2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.
- .4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.
- .5 Where used, word "provide" shall mean supply and install as each is described above.

**1.3 REGULATIONS, PERMITS, AND FEES**

- .1 All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.
- .2 Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.

- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.
- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Plumbing and Mechanical Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes, ducts, conduits and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping, ductwork, heating units, registers, diffusers, fixtures and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fittings.
- .6 Plumbing and Mechanical Drawings indicate general location and route of pipes, ducts and conduits which are to be installed. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Follow building lines, conceal piping, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .7 Install piping and ductwork to clear structural members and any fireproofing. Locate plumbing work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .8 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation. Verify existing/municipal services.

- .9 Locate all plumbing, mechanical, and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .10 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .11 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .12 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, mechanical, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

#### **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local Plumbing Code, Gas Ordinances, and adoptions thereof for all plumbing systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

#### **1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout Plumbing and Mechanical Division are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment. Submitted Bids shall be based on the supply of named articles and or products as specified in the Bid Documents.

- .2 Each bidder may elect to use "Alternate Equipment" from lists of Alternates where listed. Include for any additional costs including all costs for revisions to electrical contract to suit Alternate used. Prices are not required in Tender for Alternates listed except where specifically noted as "Separate Price". Complete the Supplementary Tender Form.
- .3 When two or more suppliers/manufacturers are named in the Bid Documents, only one supplier/manufacturer of the products named will be acceptable; however, it is the responsibility of this Division to ensure "Alternate Equipment" fits space allocated and gives performance specified. If an "Alternate Equipment" nor "equal" specified product unit is proposed and does not fit space allotted in Consultant's opinion, supply of specified described equipment will be required without change in Contract amount. Should electrical characteristics for "alternate" or "equal" equipment differ from equipment specified it shall be the responsibility of the equipment manufacturer to pay all costs associated with the revisions to the electrical contract. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .4 If item of material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.
- .5 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

## 1.8 EXAMINATION

- .1 Site Reviews
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Plumbing and Mechanical Drawings show general arrangement of piping, ductwork, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Plumbing, Mechanical, and Fire Protection Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## **1.9 SEQUENCING SCHEDULING AND COORDINATION**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of plumbing items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in Plumbing Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by Plumbing Division unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Plumbing Division.
- .5 Be responsible for required excavation, backfilling, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
  - .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.



- .6 Adjust locations of pipes, ducts, equipment, fixtures, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and duct prior to fabrication.
  - .1 Make offsets, transitions, and changes in direction of pipes, ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
  - .2 Furnish and install traps, air vents, sanitary vents, pull boxes, etc, as required to effect these offsets, transitions, and changes in direction.
- .7 Slots and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

#### **1.10 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference
  - .8 Photograph of the issue (if applicable)
  - .9 Description of the issue
  - .10 Contractor's proposed resolution

#### **1.11 CONTRACT BREAKDOWN**

- .1 Provide breakdown of contract exclusive of HST to acceptance of consultants prior to first draw submission.
- .2 Provide labour and material cost for each item.
- .3 Breakdown shall indicate total contract amount.
- .4 Contract breakdown shall be as follows as a minimum.
  - .1 Mobilization and shop drawings (max. \$15,000.00)
  - .2 Demolition
  - .3 Inside buried plumbing and drainage
  - .4 Above grade rough-in plumbing and drainage
  - .5 Roof drainage system
  - .6 Plumbing Fixtures

- .7 Plumbing Equipment
- .8 Piping Insulation
- .9 Firestopping
- .10 Plumbing contractor closeout requirements (min. of 3%).
- .5 Progress claims, when submitted are to be itemized against each item of the contract breakdown, this shall be done in table form showing contract amount, work complete to date, previous draw, amount this draw and balance.
- .6 **Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

#### **1.12 COMMISSIONING CONTRACT BREAKDOWN**

- .1 This contractor shall work with the plumbing and HVAC system commissioning contractor as specified elsewhere.

#### **1.13 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 **Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
- .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .10 Check work described by catalog data with Contract Documents for deviations and errors.

- .11 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances. e.g., access door swing spaces.
- .12 Shop drawings and product data shall be 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 as to current model production.
  - .5 Certification of compliance to applicable codes.
- .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
- .14 Shop drawings shall be submitted electronically as per the following directions:
  - .1 Electronic Submissions:
    - .1 Electronically submitted shop drawings shall be prepared as follows:
      - .1 Use latest software to generate PDF files of submission sheets.
      - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
      - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
      - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
      - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
      - .6 File names shall include consultant project number and description of shop drawing section submitted.
      - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
      - .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
      - .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
    - .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.

- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating "1 of 2" and "2 of 2" in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the "reviewed" shop drawings in a binder as noted above.
- .6 Contractor to print copies of "reviewed" shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.14 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the "Nameplate Data" on the equipment on site.

#### **1.15 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals' requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit one (1) copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.
  - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as 'Operation and Maintenance Manual' with project name and location. Dividers are to be used for binder organization.
- .4 Make changes as required and re-submit as directed by Consultant.
- .5 Operation data to include:
  - .1 Control schematics for each system including environmental controls.

- .2 Description of each system and its controls.
- .3 Operation instruction for each system and each component.
- .4 Description of actions to be taken in event of equipment failure.
- .5 Valves schedule and flow diagram.
- .6 Colour coding chart.
- .7 Spare parts equipment list.
- .8 Manufacturers standard or extended warranty information.
- .6 Maintenance data shall 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.
- .7 Performance data to include:
  - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified elsewhere.
  - .4 Testing, adjusting and balancing reports as specified in Testing, Adjusting and Balancing Section.
  - .5 Copy of all substantial performance final certificates.
- .8 Miscellaneous data to include:
  - .1 Letter of contractor's warranty and guarantee.
  - .2 Index sheet.
  - .3 Tabbed format for each section.
  - .4 Manufacturers approved shop drawings.
  - .5 Spare parts list and source.
  - .6 List of Manufacturers and suppliers address for each piece of equipment.
- .9 Final Submittals:
  - .1 Upon acceptance of Operation and Maintenance Manual by the Consultant provide the following:
    - .1 Provide two (2) copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one (1) USB stick is to be provided containing both the approved manual and as-built drawings.

## **1.16 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide two (2) sets of reproducible plumbing drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing plumbing systems, control systems, and low voltage control wiring.

- .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW PLUMBING SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 TAB to be performed using as-built drawings.
    - .1 Submit copy to Consultant for approval. When returned, make corrections as directed.
    - .2 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

#### **1.17 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.
- .4 Warranty Duration:
  - .1 One (1) year warranty period applies unless otherwise noted.
- .5 Warranty Coverage:
  - .1 Applies to parts and labour.

#### **1.18 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-Built Drawings
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 TAB Reports
  - .5 Plumbing Systems Commissioning
  - .6 Instructions to Owners

**1.19 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

**1.20 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or environmental damages but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove all damaged materials from site.

**1.21 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 **If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.**
- .2 **Each contractor and on site employee of the contractor shall have "asbestos awareness training".**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**
- .5 **Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.**
- .6 **A survey of each building documenting the location and condition of designated substances and/or hazardous materials -containing materials is available for your mandatory review prior to commencing any work on premises.**

**1.22 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the contractor of the work required to complete the entire contract.

- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all plumbing services and fire protection.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and consultants for occupancy of completed areas.

**1.23 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

**1.24 ENERGY EFFICIENCY**

- .1 The systems of this building must achieve the energy efficiency levels by conforming to ANSI/ASHRAE/IESNA 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Chapter 2 of Division 3 of SB-10 prescriptive method from the Ontario Building Code.
- .2 All equipment, products, and installations must conform to the Codes and Standards.

**END OF SECTION**



**Part 1            General**

**1.1            OCCUPANCY REQUIREMENTS**

- .1        The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1        Final Certificates (required prior to consultant's release of conformance letter).
    - .1        Potable Water Test (Refer to domestic water piping – Copper section – Part 3)
    - .2        Backflow Test Certificate (for all testable devices)

**Part 2            Not Used**

**Part 3            Not Used**

**END OF SECTION**

**Part 1 General**

**1.1 TESTS**

- .1 Give 48 hours written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
- .5 Piping:
  - .1 General: maintain test pressure without loss for 4 h unless otherwise specified.
  - .2 Test drainage, waste and vent piping to Ontario Building Code and authorities having jurisdiction.
  - .3 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 860 kPa (124.8 psi), whichever is greater.
- .6 Equipment: test as specified in relevant sections.

**1.2 SYSTEM START UP**

- .1 **Provide adjusting testing and start up of all equipment prior to testing and balancing (TAB) specified elsewhere.**
- .2 **Provide consultant with written notice verifying all equipment operation and installation is complete.**
- .3 **Start up shall be in presence of the following: owner or representative, contractor, building automation systems (BAS) contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.**
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 Arrange with all parties and provide 72 hours notice for start up procedure.
- .6 Arrange with building automation systems contractor to sequence all components and ensure system operation.

**1.3 COMMISSIONING**

- .1 **Co-ordinate and direct each step of the commissioning process and recommend acceptance or non-acceptance to the Owner/Owner's Representative.**
- .2 **Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to consultant and Owner/Owner's Representative.**
- .3 **The Commissioning Process is detailed in *ASHRAE Guideline 1-1996 HVAC Commissioning Process*. The commissioning plan may be modified to reflect the actual construction schedule and design.**

- .4 Provide a pre-functional test of all plumbing system and sub-system elements, including control devices, shall be checked for the following:**

  - .1 Verify that each element has been properly installed, properly identified, and that all connections (including electrical) have been made correctly.**
  - .2 Verify that each element has been checked for proper lubrication, drive rotation, belt tension, control sequence, flow direction, or other conditions which may cause damage or reduce system performance.**
  - .3 Verify that tests, meter readings, and specific plumbing/mechanical/electrical performance characteristics agree with those required by equipment or system manufacturer.**
  - .4 Controls calibration to be completed in accordance with the specification.**
  - .5 The TAB shall be done in accordance with the specifications.**
- .5 Reports:**

  - .1 The contractor shall be responsible for recording, documenting, and maintaining detailed inspection and testing data on the test documentation reports. The data record shall be comprehensive and concise.**
  - .2 All data must be recorded as soon as possible during the course of the inspection and testing.**
  - .3 All documentation shall have the date, time, and names of persons participating in the inspection and testing.**
- .6 Plumbing System Execution:**

  - .1 Operate equipment and systems shall be tested in the presence of the owner's representative and the consultant to demonstrate compliance with specified requirements. To minimize the time of Commissioning Team members, testing shall be done in four seasonal single blocks of time insofar as possible.**
  - .2 Notify the consultant, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.**
  - .3 Testing shall be conducted under specified design operating conditions as recommended or approved by the consultant.**
  - .4 All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.**
  - .5 All special testing materials and equipment shall be provided by the appropriate contractor.**
  - .6 Provide three copies of all test reports and records to the consultant.**
- .7 The verification testing procedures shall address all operating characteristics of all plumbing equipment and systems.**

**1.4 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTION**

- .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 Plumbing contractor to schedule and coordinate the demonstration all on the same day, starting at a pre-approved time and continuing consequently until complete.
- .3 Where specified elsewhere in this Division, qualified manufacturers' representatives who are knowledgeable about the project to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Where deemed necessary, Consultants may record these demonstrations on video tape for future reference.

**1.5 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
  - .1 Domestic water
  - .2 Plumbing and drainage.

**1.6 DEFICIENCIES**

- .1 During the course of construction, the consultants will monitor construction and provide written reports of work progress, discussions, and instruction to correct work.
- .2 Instruction to correct work shall be done within the work period before the next review.
- .3 The contractor shall not conceal any work until inspected.
- .4 The contractor shall expedite 100% complete rough-in work and have inspected prior to concealing services and equipment especially above ceiling.
- .5 Upon completion of the project the consultant will do a final review. Upon receiving the final inspection report, the contractor must correct and sign back the inspection report indicating the deficiencies are completed. A re-inspection will only be done once consultant receives this in writing.

**1.7 EQUIPMENT INSTALLATIONS**

- .1 Unions or flanges: provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: pipe to floor drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

**1.8 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install plumbing equipment at following heights unless indicated otherwise.
  - .1 Standard water closets 350 (14") to top of bowl
  - .2 Barrier-free water closets 400 (16") to top of bowl
  - .3 Barrier-free water closets 450 (18") to top of seat lid
  - .4 Wall hung lavatory 787 (31") to rim
  - .5 Barrier-free wall hung lavatory 840 (33") max to top of rim  
737 (29") min underside of rim front  
685 (27") clear at 400 (8") from basin front  
350 (14") min clear under waste trap
  - .6 Urinals (Adult) ± 600 (24)  
Urinals (Barrier-free) 425 (17") to rim  
Urinals (Barrier-free) 1000 (40") to flush lever or sensor
  - .7 Hose bibbs +/- 600 (24")
  - .8 Shower heads (Standard) 2.0 m (6' – 6") to bottom of head  
Shower heads (Barrier-free)  
adjustable from 1200 (48") to 2030 (80")
  - .9 Barrier-free shower seat +/- 470 (18.5")
  - .10 Barrier-free drinking fountains 840 mm (33") to rim  
Not less than 686 (27") under unit
  - .11 **Backflow preventors 900 – 1200 (3'– 4') to centerline of unit**

Also follow direction of architectural drawings and where discrepancies occur clarify prior to rough-in.

**1.9 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply anchor bolts and templates for installation by other Divisions.

**1.10 PROTECTION OF OPENINGS**

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

**1.11 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Supplier and installer responsibility and related plumbing responsibility is indicated in Equipment Schedule on plumbing/mechanical and/or electrical drawings.

- .2 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems. Follow Electrical Division for quality of materials and workmanship.
- .3 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

#### **1.12 CONTROL WIRING**

- .1 Furnish and install all components, devices, and control wiring for all plumbing, fire protection, HVAC equipment, HVAC systems, lighting, and other electrical loads to make all equipment operable to satisfaction of owner and consultant and to manufacturer's requirements and recommendations.
- .2 All electrical wiring and installations shall comply with local and national electrical codes.
- .3 Supply and install wiring as required for all devices and systems. Install wiring in EMT conduit and otherwise comply with all requirements of the Electrical Division. Approved plenum wire may be used for sensor and network communication wiring where it complies with appropriate building codes and regulatory authorities.
- .4 All wiring concealed in walls and chases, and all exposed wiring shall be run in conduit.
- .5 Provide recessed conduit and backer boxes where controls are wall mounted. Surface mounted boxes and conduit are acceptable in service rooms.
- .6 Free-run plenum rated cable shall be run in cable hangers where provided by Electrical Division or tied neatly to pipe and duct hangers in the ceiling. Avoid wiring that droops. Follow building lines and do not run wiring "as the crow flies".

#### **1.13 MOTORS**

- .1 Provide high efficiency motors for plumbing equipment.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W, (1/2 hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, voltage as indicated.
- .4 Motors 373 W, (1/2 hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated.

#### **1.14 PIPING AND EQUIPMENT SUPPORTS**

- .1 Fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.
- .2 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. Concrete specified elsewhere.

- .3 Where housekeeping pads incorporate existing pads provide 10 mm dowels into existing pads. New pad height shall match existing.

#### **1.15 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

#### **1.16 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe(s) or other equipment at all wall, floor, or ceiling penetrations.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
- .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

- .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
- .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.
- .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.
- .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
- .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.
- .15 Acceptable Alternate Manufacturers to approval of local authority:
  - .1 Minnesota Mining and Manufacturing
  - .2 Fryesleeve Industries Inc.
  - .3 General Electric Pensil Firestop Systems
  - .4 International Protective Coatings Corp.
  - .5 Rectorseal Corporation (Metacaulk)
  - .6 Proset Systems
  - .7 3M
  - .8 AD Systems
  - .9 Hilti
- .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

#### **1.17 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.



**1.18 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Apply two coats of paint to exposed piping service in service room(s). Base colour as specified in Pipe Identification Section.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

**1.19 ACCESS DOORS**

- .1 Provide access doors to concealed plumbing equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable Manufacturers:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

**1.20 DIELECTRIC COUPLINGS**

- .1 General:
  - .1 To be compatible with and to suit pressure rating of piping system.
  - .2 Where pipes of dissimilar metals are joined.
- .2 Pipes NPS 50 mm (2") and under: isolating unions.
- .3 Pipes NPS 65 mm (2 1/2") and over: isolating flanges.

**1.21 DRAIN VALVES**

- .1 Locate at low points and at section isolating valves unless otherwise specified.
- .2 Minimum NPS 20 mm (3/4") unless otherwise specified: bronze, with hose end male thread and complete with vacuum air breaker and chain with cap.
- .3 Drain valves on potable water systems shall be complete with vacuum breaker.

**1.22 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

**1.23 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

**1.24 CLEANING**

- .1 Clean interior and exterior of all systems including strainers.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

**1.25 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

**1.26 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.

**1.27 DEMOLITION**

- .1 **The general requirements are indicated on the drawings and on the outline specification in Division 1.**

- .2 The general execution of the demolition is to be carried out in a clean and efficient manner.**
- .3 All openings or holes created by removal of existing plumbing systems which are not being reused are to be patched with the same material surrounding surfaces.
- .4 All new holes and openings to facilitate plumbing systems are to be patched to match surrounding surfaces.
- .5 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .6 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .7 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .8 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Divisions.

#### **1.28 VIDEO RECORDING OF NEW & EXISTING UNDERGROUND SERVICES**

- .1 Prior to final acceptance of the new underground plumbing system and prior to pouring the floor this contractor shall retain a qualified contractor to video tape the new, existing and revised sanitary and storm drainage piping and branch piping. Transfer all videotape information to USB.**
- .2 This contractor shall flush the new and existing storm and sanitary system to remove all debris prior to final video taping of systems.**
- .3 Provide 1 copy of USB.**
- .4 Identify video routing on As-built drawings.**

#### **1.29 LOCATION OF EXISTING UNDERGROUND SERVICES**

- .1 This contractor shall locate existing services prior to starting any work in the affected area.**
- .2 This contractor shall use a video camera for the existing storm and/or sanitary drainage at the indicated connection point to confirm location, size and invert of the existing piping.**

#### **1.30 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-ray and/or scan of the existing buried services in wall and/or floors prior to starting any work in the affected area.**

- .2 Failure to locate existing piping, conduit rebar etc., shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

**1.31 EXCAVATING AND BACKFILLING**

- .1 Provide all excavating and backfilling inside and outside the building for plumbing pipes, drains and equipment. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150 mm (6") layer to the satisfaction of the Consultant.
- .2 Provide excavating and backfilling outside the building with granular A brought in specifically for backfilling to a minimum of 450 mm (18") over the pipe. Backfilling outside building over and above the 450 mm (18") backfill as previously specified herein shall be by the Plumbing Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2 the plumbing contractor shall provide new clean granular 'A' fill to grade level.
- .3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150 mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.
- .4 Should water be encountered during excavation, the plumbing contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300 mm (12") base of compacted 50 mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.
- .5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.
- .6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450 mm (18") bedding material.

**1.32 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

**1.33 EXISTING SYSTEM DRAINAGE**

- .1 Drain all existing piping and drainage systems including all related equipment as required to facilitate system renovations.
- .2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

**1.34 DOMESTIC HW SYSTEM BALANCING**

- .1 Meet all requirements as specified for balancing of hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device.
- .3 At each circuit setter balancing valve.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

**1.35 BALANCING OTHER PLUMBING SYSTEM**

- .1 Plumbing systems:
  - .1 Pressure booster systems: test for capacity and pressures under all conditions and at all times.
- .2 Recirculating Systems pump flows, pressures
- .3 Pumped sanitary and storm water systems: test for proper operation at all possible flow rates.

**1.36 COOPERATION WITH OTHER TRADES**

- .1 Give full cooperation to other trades and furnish in writing to other trades, with copies to the engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- .2 Where plumbing work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. Prepare composite working drawings and sections at a suitable scale, not less than ¼ inches = 1-foot – 0-inches, clearly showing how the plumbing work is to be installed in relation to the work of other trades. If work is installed before coordinating with other trades, or if it causes any interference with work of other trades, make the necessary changes in the work to correct the conditions and bear all costs.
- .3 Furnish to other trades necessary templates, patterns, setting drawings, and shop details for the proper installation of work and for coordinating adjacent work.

**1.37 WATERPROOFING SEAL MATERIALS**

- .1 Modular, expanding mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Standard of quality assurance manufacturers are:
  - .1 Thunderline Corp. (Power Plant Supply Co.) "Link Seal" Model S-316
  - .2 The Metraflex Co. "MetraSeal" type ES
  - .3 Or approved equivalent.

**1.38 SLEEVE, CUT, AND FORMED OPENING LOCATION DRAWINGS**

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses, and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

**1.39 SUSTAINABLE CONSTRUCTION**

- .1 Construction Waste Management:
  - .1 Recycle all waste materials to avoid land fill sites where possible.
  - .2 All metal contents shall be recycled.
  - .3 All cardboard and paper shall be recycled.
  - .4 All plastic packaging shall be recycled.
  - .5 All wood shall be directed to the appropriate recycled wood section at the landfill site.
- .2 This contractor is responsible for their own waste management system and cost associated with the disposal. This can be their own on site system, daily removal, back to shop, or a communal system shared with other contractors on site.
- .3 In all cases the cost to remove materials on site are the cost of this contractor.

**1.40 FREEZE PROTECTION**

- .1 Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

**1.41 SCAFFOLDING, RIGGING, AND HOISTING**

- .1 Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 Conform to the General Provisions of General Requirements Section.
- .2 This project is one of a retrofit nature in part, and which will require some demolition.
- .3 Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

**1.2 RELATED WORK SPECIFIED ELSEWHERE**

- .1 Electrical Division.

**1.3 SCOPE OF WORK**

- .1 The scope of work is essentially the selected disconnection and/or removal of services and/or equipment, piping, ductwork, etc. as indicated or required to complete the work.

**Part 2 Products**

**2.1 GENERAL**

- .1 This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the Owner.
- .2 This Division is to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

**Part 3 Execution**

**3.1 GENERAL**

- .1 The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2 The general execution of the demolition is to be carried out in a clean and efficient manner.
- .3 Demolition of existing ceilings, walls, etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.
- .4 All openings or holes created by removal of existing plumbing systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate plumbing systems are to be patched to match surrounding surfaces.
- .6 Protect all existing furnishings, materials, and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.

- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitate changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .10 Disconnect and/or remove equipment, piping, ductwork, etc. as indicated.
- .11 Cap and conceal all redundant and obsolete connections.
- .12 Provide a list of equipment to be removed to the Owner, for their acceptance of same. Remove all equipment from site which the Owner does not retain.
- .13 Maintain equipment to be retained by Owner on site where directed by Consultant.
- .14 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.
- .15 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.
- .16 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.
- .17 Co-ordinate making safe electrical devices, capping plumbing and removal of fixtures prior to commencement of demolition.
- .18 All piping and equipment to be removed and/or abandoned shall be drained prior to capping and/or abandoning. Disposal of all liquids shall be to the approval of authority of having jurisdiction and/or provincial regulations.

### **3.2 EXISTING SYSTEM DRAINAGE**

- .1 Drain all existing piping systems including all related equipment as required to facilitate system renovations.
- .2 Disposal of existing system shall be to the requirements of the local and/or provincial regulations.

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American Society for Testing and Materials
  - .1 ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .2 ASTM A105/A105M, Specification for Carbon Steel Forgings for Piping Applications.
  - .3 MSS SP 58 (Manufacturers Standardization Society of the Valve and Fitting Industry – Pipe Hangers and Supports, Materials, Design and Manufacture).

**1.2 DELEGATED ENGINEERING DESIGN AND PRODUCT SUBMITTAL**

- .1 Provide a delegated engineering design for all hydronic and domestic water risers to good engineering practice.
  - .1 Design Limitation: No more than 1,800 lbs shall be point loaded per core slab plank per floor.
- .2 The design shall include analysis documentation signed and sealed by a licensed Professional Engineer with a minimum of five (5) years of experience in the design of piping risers and associated support systems.
- .3 Submittal Requirements:
  - .1 Submit detailed calculations addressing thermal expansion, and where applicable to project location, seismic restraint requirements for the piping systems.
  - .2 Submit schematic drawing of the installed Riser system indicating components used and locations.
  - .3 Submit maximum anchor reaction loads for review and approval by the Structural Engineer of Record.
  - .4 Provide detailed drawings for each anchor, including dimensions and attachment method to the building structure.
  - .5 Provide detailed drawings and specifications for field assembly and structural attachment of pipe alignment guides.
  - .6 Provide product submittals for each required guide, anchor and expansion device.
    - .1 Manufacturer, model number, line contents, pressure and temperature rating.
    - .2 Movement handled; axial, lateral, angular and the amounts of each.
    - .3 Nominal size and dimensions including details of construction and assembly.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data in accordance with general requirements.
- .2 Submit sign off letter from Professional Engineer who completed the expansion compensation design.
- .3 Data to include:
  - .1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

**Part 2 Products**

**2.1 ACCEPTABLE MATERIALS**

- .1 All materials furnished under this section shall be from a single supplier, designed and engineered as a complete system:
  - .1 Mason Industries
  - .2 Kinetics Noise Control Inc.
  - .3 Flex Pression Ltd.

**2.2 ANCHORS AND GUIDES**

- .1 Anchors:
  - .1 Provide as indicated in expansion compensation design drawings.
- .2 Alignment guides:
  - .1 Provide as indicated in expansion compensation design drawings.
  - .2 To accommodate specified thickness of insulation.
  - .3 Vapour barriers, jackets to remain uninterrupted.

**2.3 ALIGNMENT GUIDES**

- .1 Wall Mounted:
  - .1 Spider type, designed to maintain axial alignment of piping.
  - .2 Guides shall not carry dead weight loads.
  - .3 Guides shall allow for movement of insulation with pipe.
- .2 Floor Mounted:
  - .1 Anchored to floor or ceiling and designed to maintain axial alignment of piping.
  - .2 Guides shall be provided with plastic inserts.
  - .3 Guides shall not carry dead weight loads.
  - .4 Guides shall allow for movement of insulation with pipe.

**2.4 SLIP TYPE EXPANSION JOINTS**

- .1 Application: For axial pipe movement, as indicated.
- .2 Repacking: Under full line pressure.

- .3 Body and packing housings: Class 150, 1Mpa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe and with raised face slip-on flanges to match pipe. One-piece body construction.
- .4 Slip or traverse sleeves: Carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: Construction steel, welded to body.
- .6 Guides (internal and external): Embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: Stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, P7FE (teflon) or graphite impregnated non-asbestos fiber.
- .9 Thermal plastic packing: P7FE (teflon) or graphite impregnated non-asbestos fiber slug supplied loose.
- .10 Lubricating fittings: Pet cocks with grease nipple.
- .11 Plunger body and plunger:
  - .1 Plunger body: heavy wall carbon steel welded to body.
  - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: To manufacturer's recommendations.
- .13 Lubricant gun: Complete with hose assembly.
- .14 Drip connection: 20 MPa (2900 psi) forged steel to ASTM A105. Include half coupling with drain plug.
- .15 Lubricant fittings, plunger, gun not required for low friction self lubricating packing.

## 2.5 EXPANSION LOOPS

- .1 Steel braided hoses, U-loop assembly.
- .2 Corrugated metal inner hoses, braided outer sheaths, braid retaining collar and 90 degree elbows.
- .3 321 or 316 stainless steel corrugated hose
- .4 304 or 316 stainless steel braid and braid collar
- .5 Operating conditions:
  - .1 Working pressure: 1034 kPa (150 psi).
  - .2 Working temperature: 250°C (482°F).
  - .3 To match system requirements.

## 2.6 FLEXIBLE CONNECTIONS

- .1 Application: To suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: Stainless steel corrugated.

- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: As indicated.
- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa (150 psi).
  - .2 Working temperature: 250°C (482°F).
  - .3 To match system requirements.

## **2.7 EXPANSION COMPENSATORS (EXP)(2"-4")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Provide model HP3 for steel pipe and model HBFF3 for copper pipe.
- .4 Movement capability of 4" axial. Welded ends.
- .5 Material to match piping system.
- .6 Acceptable Manufacturers:
  - .1 Metraflex HP
  - .2 Mark David Canada
  - .3 Senior Flexonics
  - .4 Flexi-craft

## **2.8 EXPANSION COMPENSATORS (6"-16")**

- .1 All welded packless guided construction complete with multi ply stainless steel bellows.
- .2 Operating temperature (700°F).
- .3 Movement capability of 4" axial. Welded ends.
- .4 Material to match piping system.
- .5 Acceptable Manufacturers:
  - .1 Metraflex Metragator
  - .2 Mark David Canada
  - .3 Senior Flexonics
  - .4 Flexi-craft

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install expansion joints with cold setting, as indicated as instructed by Consultant. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

- .4 All isolators shall be adjusted to the preset dimensions provided as part of the engineered expansion system design prior to system filling.
- .5 Once the system is filled and loaded and operating at its normal temperature all restrained spring isolators shall be inspected and where/if they remain preloaded, the nuts shall be backed off the minimum amount to ensure contact with preloaded screws no longer exists.
- .6 No rigid connections shall be made between the system and structure where it will degrade either the seismic or expansion performance of the engineered system.

### **3.2 SITE REVIEW**

- .1 The Professional Engineer who stamps the submitted expansion compensation shop drawings shall be responsible to conduct periodic site reviews of the installed systems.
- .2 The Professional Engineer shall provide written confirmation that the systems are installed to manufacturer recommendations and their design prior to project closeout.

### **3.3 APPLICATION**

- .1 Provide on all vibration isolated equipment.
- .2 Provide where requested by equipment manufacturers installation manuals.
- .3 Install in accordance with manufacturer's recommendations.

### **3.4 THERMAL EXPANSION**

- .1 Provide in long runs of hot water mains exceeding 100 ft. in length.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture Selection, Application, and Installation.

**1.2 DESIGN REQUIREMENTS**

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

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 All bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

**1.4 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products****2.1 GENERAL**

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

**2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: to ANSI & ULC requirements
  - .2 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: Suspension from upper flange of I-Beam or joist.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 10 mm (3/8") UL listed
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed & FM approved.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
  - .1 Cold piping NPS 50 mm (2") maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.
  - .2 Cold piping NPS 65 mm (2 1/2") or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nuts.
- .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 (1/4") minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed.  
Note: Rapidex and Siporex are not considered concrete. Should one of these systems be encountered, piping/ductwork and/or equipment shall be supported from adjacent walls or from supplemental steel provided by this contractor attached to the adjacent walls/structure.
- .5 Shop and field-fabricated assemblies.
  - .1 Trapeze hanger assemblies: ASME B31.1.
  - .2 Steel brackets: ASME B31.1.
- .6 Hanger rods: threaded rod material to MSS SP-58.
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.

- .7 Pipe attachments: material to MSS SP-58.
  - .1 Attachments for steel piping: carbon steel.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for all piping.
  - .4 Oversize pipe hangers and supports to accommodate thermal insulation. Provide 1.5 mm (16 gauge) saddles.
- .8 Adjustable clevis: material to MSS SP-58 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.

## **2.3 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>2</sup> (13.12 lbs/ft<sup>2</sup>) density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m (10') span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm (12") long, with edges turned up, welded-in centre plate for pipe sizes NPS 300 mm (12") and over, carbon steel to comply with MSS SP-58.

## **2.4 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of miscellaneous metals, specified herein. Submit calculations with shop drawings.

## **2.5 OTHER EQUIPMENT SUPPORTS**

- .1 From structural grade steel meeting requirements of structural steel section specified herein.
- .2 Submit structural calculations with shop drawings.

## **2.6 MANUFACTURER**

- .1 Acceptable Manufacturers:
  - .1 Grinnell
  - .2 Anvil
  - .3 Myatt
  - .4 Taylor



**Part 3 Execution****3.1 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 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 be to industry standards.
  - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: Install below joint.
- .3 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

**3.2 HANGER SPACING**

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
- .2 Copper piping: up to NPS 15 mm (1/2"): every 1.5 m (5').
- .3 Within 300 mm (12") of each elbow and:

Maximum Pipe Size: NPS	Spacing Steel	Maximum Spacing Copper
up to 32 mm (1 1/4")	2.1 m (7')	1.8 m (6')
40 mm (1 1/2")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2 1/2")	3.6 m (12')	3.0 m (10')
80 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3 1/2")	3.9 m (13')	3.3 m (11')
100 mm (4")	4.2 m (14')	3.6 m (12')
125 mm (5")	4.8 m (16')	
150 mm (6")	5.1 m (17')	

**3.3 HANGER INSTALLATION**

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

- .4 Do "NOT" support piping, ductwork and equipment from roof deck, on bottom chord of floor and/or roof joist and/or from OWSJ bridging. Provide structural member between joist.

### **3.4 HORIZONTAL MOVEMENT**

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4mm (5/32") from vertical.
- .2 Where horizontal pipe movement is less than 15 mm (1/2"), offset pipe hanger and support so that rod hanger is vertical in the hot position.

### **3.5 FINAL ADJUSTMENT**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Canadian Standards Association (CSA)
  - .1 Natural Gas and Propane Installation Code CSA B149.1.
- .4 National Fire Protection Association
  - .1 NFPA 13, Installation of Sprinkler Systems.
  - .2 NFPA 14, Standpipe and Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with General Requirements.
- .2 Product data to include paint colour chips, all other products specified in this section.

**1.3 PRODUCT LITERATURE**

- .1 Submit product literature in accordance with General Requirements.
- .2 Product literature to include nameplates, labels, tags, lists of proposed legends.

**Part 2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

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

**2.2 SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

**.3 Sizes:****.1 Conform to following table:**

Size	No. of Sizes mm (")	Height of Line mm (")	Letters mm (")
1	10 x 50 (3/8" x 2")	1 (3/64")	3 (1/8")
2	15 x 75 (1/2" x 3")	1 (3/64")	6 (1/4")
3	15 x 75 (1/2" x 3")	2 (5/64")	3 (1/8")
4	20 x 100 (3/4" x 4")	1 (3/64")	10 (3/8")
5	20 x 100 (3/4" x 4")	2 (6/64")	6 (1/4")
6	20 x 200 (3/4" x 8")	1 (3/64")	10 (3/8")
7	25 x 125 (1" x 5")	1 (3/64")	15 (1/2")
8	25 x 125 (1" x 5")	2 (5/64")	10 (3/8")
9	32 x 200 (1 1/4" x 8")	1 (3/64")	20 (3/4")

**.2 Use maximum of 25 letters/numbers per line.****.4 Locations:****.1 Equipment in Mechanical Rooms: Use size #9.****.2 Equipment above ceiling: use size #1 riveted to ceiling suspension system.****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.****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 Legend:****.1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.****.3 Arrows showing direction of flow:****.1 Outside diameter of pipe or insulation less than 75 mm (3"): 100 mm (4") long x 50 mm (2") high.****.2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150 mm (6") long x 50 mm (2") high.****.3 Use double-headed arrows where flow is reversible.****.4 Extent of background colour marking:****.1 To full circumference of pipe or insulation.****.2 Length to accommodate pictogram, full length of legend and arrows.****.5 Materials for background colour marking, legend, arrows:****.1 Pipes and tubing 20 mm (3/4") and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.**

- .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395°F).
- .6 Colours and Legends:
- .1 Where not listed, obtain direction from Consultant.
- .2 Colours for legends, arrows: To following table:
- |                    |         |         |
|--------------------|---------|---------|
| Background colour: | Legend: | Arrows: |
| Yellow             | White   | Black   |
| Green              | White   | Black   |
| Red                | White   | Black   |
- .7 Pictograms:
- .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .8 Background colour marking and legends for piping systems:

CONTENTS	BACKGROUND COLOUR	
	MARKING	LEGEND
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HW recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Domestic tempered supply	Green	DOM. TEMPERED
Trap Primer	Green	TRAP PRIMER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT

## 2.5 VALVES, CONTROLLERS

- .1 Brass tags with 15 mm (1/2") 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.
- .3 Provide adhesive coloured tab (max. size 15 mm) indication on ceiling to locate valves/equipment above. Same applies to grid. Colour to be approved by consultant.

## 2.6 LANGUAGE

- .1 Identification to be in English.

**Part 3 Execution**

**3.1 TIMING**

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

**3.2 INSTALLATION**

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

**3.3 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 in any way.

**3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 1.7 m (5'-8") 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, other confined spaces, at entry and exit points, and at each access opening.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

**3.5 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, 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 Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

- .3 Number valves in each system consecutively. Where existing numbering system is installed start new numbering system at 100.

**END OF SECTION**

**Part 1 General**

**1.1 SHOP DRAWINGS AND AS-BUILT DRAWINGS**

- .1 Conform to General Requirements Section for shop drawings and as-built drawings requirements.

**1.2 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION**

- .1 The Plumbing Contractor shall co-ordinate with the Consultant who will inspect the plumbing installation.
- .2 The Plumbing Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - Manufacturers name, address and telephone number
  - Distributors name, address and telephone number
  - Make, model number and serial number
  - Pumps - RPM, impeller sizes, rated flow
  - Electrical - volts, amps, fuse size, overload size
  - Any other special characteristics.

**1.3 PLUMBING AND DRAINAGE SYSTEM TESTING**

- .1 The plumbing and drainage system shall be tested in accordance with the Plumbing Code under the Ontario Water Resources Act and the specification.
- .2 The Mechanical Contractor shall notify the Building Inspector when systems are available for testing. The Mechanical Contractor shall document all tests performed and shall arrange for the Building Inspector to sign for tests completed. The forms shall be forwarded to the Consultant.

**1.4 THE CONTRACTOR'S TESTING OF PIPING SYSTEMS**

- .1 Test all piping systems in accordance with all applicable plumbing codes and General Requirements section.
- .2 All tests for the systems shall be performed in the presence of the Consultant or Commissioning Consultant. Complete the testing forms and forward to the Consultant.

**1.5 THE INDEPENDENT CONTRACTORS TESTING AND BALANCING OF WATER SYSTEMS**

- .1 Conform with the specification section, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by the plumbing contractor and shall report to the Commissioning Consultant.

**1.6 CLOSEOUT SCHEDULE**

- .1 The Plumbing Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 All testing forms and reports associated with the plumbing systems shall be directed to the Consultant with copies to the Owner and Consultant.



.3 The forms and reports to be issued shall include:

- Shop drawings, issued and accepted
- Equipment verification forms
- Testing forms
- Reports resulting from tests
- Testing schedule
- Equipment Start-up Forms

## **1.7 OPERATION AND MAINTENANCE MANUAL**

.1 Conform to General Requirements section for the Operating and Maintenance Manual requirements.

## **1.8 OPERATOR TRAINING**

.1 Conform to General Requirements section for requirements for Instruction to Operating Staff.

.2 The training shall be conducted in a classroom and at the equipment or system.

.3 Training will begin when the operating and maintenance manuals have been delivered to The Owner and approved by the Consultant.

.4 Each training session shall be structured to cover:

- The operating and maintenance manual
- Operating procedures
- Maintenance procedures
- Trouble-shooting procedures
- Spare parts required
- Submit a course outline to the Consultant before training commences. Provide course documentation for up to eight people.

.5 The training sessions shall be scheduled and co-ordinated by the Plumbing Contractor.

.6 Training shall be provided for the following systems:

<u>System</u>	<u>Minimum Training Times</u>
Pumps	1 hours
Water Heaters	1 hours

## **1.9 COMMISSIONING CONSULTANT**

.1 A Commissioning Consultant (CC) reports to the Owner.

.2 The CC responsibilities shall include:

- preparing the commissioning plan
- co-ordinating with the contractor to schedule tests
- preparing a test form manual
- witnessing selected tests
- receiving all test forms
- conducting performance test
- co-ordinating the contractors training
- chair commissioning meetings

- .3 The Plumbing Contractor shall co-operate with the CC.
- .4 The Plumbing Contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.
- .5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

#### **1.10 PLUMBING SYSTEM DEMONSTRATION AND TURNOVER**

- .1 Refer to General Requirements section, Mechanical Project Completion.
- .2 The system demonstration and turnover to The Owner shall occur when:
  - The installation is complete
  - The acceptance test conducted by the Mechanical Consultant has been completed successfully
  - The Commissioning Consultant system performance testing has been completed successfully
  - Training has been completed
  - Operating and Maintenance Manuals have been accepted
  - Shop-drawings have been updated
  - As-built drawings have been completed
- .3 The systems demonstration shall be conducted by the Mechanical Contractor and the manufacturers. The demonstration shall cover a demonstration of equipment installation and operation.

#### **1.11 WARRANTIES**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Owner.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the general conditions specification section for the requirements during the warranty period.

#### **1.12 CLOSEOUT PROCESS ALLOCATION**

- .1 The mechanical contractor closeout process shall be as follows:
  - .1 3% for the first \$500,000 of contract value.
  - .2 1% of the contract value for value between \$500,000 to \$5,000,000.
  - .3 0.5% of contract value for the value in excess of \$5,000,000.
  - .4 Minimum Allocation for Close Out Documents is \$5,000.
- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.

- .3 The monies shall not be paid out until the performance testing, O & M manuals, systems demonstration, and training including all required paperwork have been completed to the satisfaction of the consultant. Refer to General Requirements section for contract breakdown.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .2 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .3 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM C547, Type I and IV, Standard Specifications for Mineral Fibre Pipe Insulation.
  - .2 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .3 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
  - .4 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .5 ASTM C 921, Practice for Determining the Properties Jacketing Materials for Thermal Insulation.
  - .6 ASTM C1695, Standard Specification for Fabrication of Flexible, Removable, and Reusable Blanket Insulation for Hot Service.
  - .7 ASTM C1729 Standard Specification for Aluminium Jacketing for Insulation.
  - .8 **ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.**
  - .9 **ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.**
  - .10 **ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.**
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC), North American Commercial and Industrial Insulation Standards.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves, and jointing recommendations.
- .3 Submit properly completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specific section.

**1.3 INSTALLATION INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with general requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

**1.4 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be specialist in performing work of this section and have at least three (3) years successful experience in this size and type of project, qualified to standards of TIAC.

**1.5 DELIVERY, STORAGE AND HANDLING**

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

**1.6 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.

**Part 2 Products**

**2.1 MATERIAL LIMITATIONS**

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.

**2.2 FIRE AND SMOKE RATING**

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

**2.3 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335, ASTM C177 or ASTM C518.
- .3 Type A-1: Rigid moulded or wound mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to ASTM C547 Type I and IV.
  - .2 Jacket: to ASTM C1136, Type I, II, III, IV, X.
  - .3 Maximum "k" factor: to ASTM C547.
- .4 Type A-2: Mineral fibre faced with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52 Ma.
  - .3 Maximum "k" factor: to ASTM C553.
- .5 Type A-5: Fiberglass pipe and tank insulation:
  - .1 Segmented, flexible fiberglass board bonded to laminated vapor retarder, ASJ or FSK.
  - .2 Complying with ASTM C1393, Type II or Type III Category 2.
  - .3 Maximum "k" value: 0.037W/M (or less) x C°@100°F (38°C) is 0.26BTU x IN/H FT² x °F
  - .4 Jacket: specified in 'Factory-Applied Jackets' Article
- .6 Materials:
  - .1 All materials must be supplied by the same manufacturer.
  - .2 Acceptable Manufacturers:
    - .1 Johns Manville
    - .2 Knauf
    - .3 Manson
    - .4 Owens Corning

**2.4 INSULATION SECUREMENT**

- .1 Tape: Self-adhesive, aluminum, reinforced, 50 mm (2") wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.

**2.5 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 Hydraulic setting or Air drying on mineral wool, to ASTM C 449M.

**2.6 VAPOUR RETARDER LAP ADHESIVE**

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

**2.7 INDOOR VAPOUR RETARDER FINISH**

- .1 Compatible with insulation.

**2.8 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 Minimum thickness: 20 mm (0.020")
  - .2 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .3 Colours: white.
  - .4 Minimum service temperatures: -29°C (-20°F).
  - .5 Maximum service temperature: 65°C (150°F).
  - .6 Moisture vapour transmission: 0.05 perm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks are not to be used below ambient temperature (cold) operating systems.
    - .3 Pressure sensitive vinyl tape of matching colour.

**2.9 CAULKING FOR JACKETS**

- .1 Caulking: Silicone clear caulking.

**Part 3 Execution**

**3.1 PRE-INSTALLATION REQUIREMENT**

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

### **3.2 INSTALLATION**

- .1 Install in accordance with TIAC, North American Commercial and Industrial Insulation Standards.
- .2 Apply materials in accordance with manufacturers' instructions and this specification.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .5 Below ambient/chilled water installation:
  - .1 All pipes, valves, strainers, flanges, unions, and other pipe system components and spec must be properly insulated with correctly completed vapor retarder applied.
  - .2 All insulation material must have properly installed and sealed vapor retarding jacket, including circumferential and longitudinal seams.
  - .3 All penetrations, tears, and punctures must be repaired and sealed with a vapor retarding material with a 0.02 or lower perm rating.
  - .4 Vapor stops must be installed at 18' intervals at all pipe insulation termination points including fittings, flanges, and other changes in direction or other types of piping specialties.
  - .5 All fitting insulation must be of the same type, thickness, and density of the pipe insulation, be premoulded insulation covers or fabricate from the same material as the pipe insulation. Full thickness must be maintained over all fitting surfaces. Blanket insulation with a factory applied vapor retarder facing is unacceptable.
  - .6 A complete vapor retarder must be installed on insulation over fittings before applying final finish. Vapor retarder must extend onto and be sealed to the vapor retarder of the pipe insulation.
  - .7 Additional fitting covers, PVC, or metal must have a vapor retarder seal applied to all longitudinal and circumferential seams in addition to the vapor retarder applied to the fitting insulation.
  - .8 Additional field applied to jackets must not use staples, screws, tacks, or rivets for attachment to avoid puncturing vapor retarder underneath.
  - .9 Insulating support inserts are to be high compressive strength insulation with a rigid shield. No calcium silicate is to be used for insulation on below-ambient operation piping.

### **3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: At expansion joints, valves, primary flow measuring elements, flanges, and unions at equipment.
- .2 Flexible removable blanket insulation covers are not acceptable for below-ambient (cold) operation piping systems. Rigid removable insulation jackets that are vapor retarder exterior material, that can be vapor sealed at the seams, are acceptable on below-ambient (cold) operation piping systems.



- .3 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

- .4 Insulation:

- .1 Insulation, fastenings and finishes: same as system.  
.2 Jacket: As per adjacent insulation.

### 3.4 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry at all times. Overlaps to manufacturers instructions. Ensure tight joints.  
.2 Provide vapour retarder as recommended by manufacturer.

### 3.5 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, and fittings unless otherwise specified.  
.2 Install insulator and jackets to applicable TIAC codes.  
.3 Insulate ends of capped piping with type and thickness indicated for capped service.  
.4 Thickness of insulation to be as listed in following table:  
.1 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.  
.2 All storm piping including all vertical and horizontal piping shall be insulated.

Application	Type	Pipe sizes through (NPS) and insulation thickness mm (")				
		to 25 (1")	32 (1¼") 40 (1½")	50 (2") 80 (3")	105 (4") 150 (6")	200 (8") & over
Domestic Water Piping	A-1	25 (1")	25 (1")	40 (1½")	40 (1½")	40 (1½")
Storm Piping	A-1/A-5	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Cooling Coil cond. Drain	A-1	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Roof Drain sumps	A-2/A-5	25 (1")	25 (1")	25 (1")	25 (1")	25 (1")
Trap Primer Piping	A-1	15 (½")	15 (½")	25 (1")		

- .5 Finishes: Conform to the following table:

Application	Piping	Valves & Fittings
Exposed indoors	PVC	PVC
Exposed in mech. rooms	PVC	PVC
Concealed indoors	N/A	PVC

- .6 Connection: To appropriate TIAC code.  
.7 Finish attachments: SS bands, @ 150 mm (6") oc. seals: closed.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings, Classes 125 and 250.
- .3 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .5 ANSI B16.24, Cast Copper Alloy, Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
- .6 ASTM B88M, Specification for Seamless Copper Water Tube (Metric).
- .7 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
- .8 MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- .9 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
- .10 **ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.**
- .11 **ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.**
- .12 **ASTM F1545, Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.**
- .13 **CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.**
- .14 **MSS-SP-67, Butterfly Valves.**

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawing data in accordance with general requirements.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 PIPING**

- .1 Domestic hot, cold and recirculation systems, within building.
  - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
  - .2 **Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.**

**2.2 FITTINGS**

- .1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI B16.24.
- .2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 Tee drill NPS 25 mm (1") and larger.

**2.3 JOINTS**

- .1 Solder: 95/5.
- .2 Teflon tape: for threaded joints.
- .3 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F1545, complete with thermoplastic liner.
- .4 Tee drill fittings shall be brazed with silver solder, 45% Ag - 15% Cu or copper phosphorous, 95% Cu, 5% P and non-corrosive flux.
- .5 **Rubber gaskets, 1.5 mm (16 gauge) thick: to ANSI/AWWA C111/A21.11.**

**2.4 VALVES**

- .1 All valves shall be of commercial grade and of same manufacturer, Lead-Free.
- .2 Acceptable Manufacturers:
  - .1 Milwaukee
  - .2 Crane
  - .3 Kitz
  - .4 Apollo

**2.5 BALL VALVES**

- .1 All valves shall be of commercial grade and of same manufacturer.
- .2 NPS 80 mm (3") and under, soldered:
  - .1 To ANSI B16.18, Class 150.
  - .2 Bronze body, full port stainless steel ball, PTFE Teflon adjustable packing, brass gland and PTFE Teflon seat, steel lever handle, with NPT to copper adaptors.

**2.6 GATE VALVES**

- .1 NPS 50 mm (2") and under, screwed:
  - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, screw-in bonnet, solid wedge disc.

**2.7 SWING CHECK VALVES**

- .1 NPS 50 mm (2") and under, soldered:
  - .1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, bronze swing disc, screw in cap, regrindable seat.

- .2 NPS 50 mm (2") and under, screwed:
  - .1 To MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, bronze swing disc, screw in cap, regrindable seat.

## **2.8 BALANCING VALVES**

- .1 Provide brass balancing valves suitable for potable water.
- .2 Brass body, EDPM O-Ring, Polytetrafluoroethylene slip washer and stainless steel spring.
- .3 Connect with dielectric connections.

## **2.9 CIRCUIT SETTER DOMESTIC WATER RECIRCULATING VALVE**

- .1 Acceptable Manufacturers:
  - .1 ThermOmegaTech Inc.
  - .2 CircuitSolver® Models CS, CSU, CSUA, CSUAS, CSUTD-D as well as associated accessories such as Model CSA and CSUATD-D and models with optional thermometer PEX ends or ProPress ends.
- .2 Components
  - .1 Thermostatic Balance Valve
    - .1 The valve shall be certified lead free according to NSF/ANSI 61 standards.
    - .2 The valve body shall be constructed out of stainless steel.
    - .3 The valve shall be rated for 200 PSIG working pressure and 250°F max. temperature.
    - .4 The valve shall have a fixed, non-adjustable (tamper proof) temperature setpoint; temperature setpoints range from 80°F (27°C) to 170°F (27°C) in 5°F (2.8°C) increments.
    - .5 The valve shall have a temperature accuracy of ±3.0°F (±1.7°C).
    - .6 The valve shall have a wax thermostatic element.
    - .7 The valve shall come in six (6) sizes: 1/2"; 3/4"; 1"; 1 1/4"; 1 1/2"; 2".
- .3 Accessories
  - .1 PEX or ProPress ends as required.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.
- .3 Assemble all piping using fittings manufactured to ANSI standards.
- .4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

- .5 Install CWS piping below and away from HWS and HWC and all other hot piping so as to maintain temperature of cold water as low as possible.
- .6 Connect to fixtures and equipment in accordance with manufacturers instructions unless otherwise indicated.
- .7 Bent tubing is not acceptable.
- .8 **Buried tubing:**
  - .1 **Lay in well compacted washed sand in accordance with AWWA Class B bedding.**
  - .2 **Bend tubing without crimping or constriction. Minimize use of fittings.**

### **3.2 VALVES**

- .1 Isolate equipment, fixtures and branches with ball valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

### **3.3 PRESSURE TESTS**

- .1 Conform to requirements of general requirements.
- .2 Test pressure: greater of 1½ times maximum system operating pressure or 860 kPa (125 psi).

### **3.4 FLUSHING AND DISINFECTING**

- .1 Maintain testable RP backflow preventor between municipal water and new plumbing system.
- .2 Ensure a minimum of 90% of plumbing fixtures are installed.
- .3 Flush water mains through available outlets with a sufficient flow of potable water to produce a velocity of 1.5 m/s, within pipe for 10 min, or until foreign materials have been removed and flushed water is clear with backflow protection.
- .4 Provide connections and pumps for flushing as required.
- .5 Open and close valves, and operate fixtures to ensure thorough flushing.
- .6 When flushing has been complete to satisfaction of Consultant introduce a strong solution of Chlorine into water system and ensure that it is distributed throughout entire system.
- .7 Rate of chlorine application to be proportional to rate of water entering pipe.
- .8 Chlorine injection to be close to point of filling water main or at building water service and to occur simultaneously.
- .9 Confirm adequate chlorine residual not less than 50 ppm has been obtained, leave system charged with chlorine solution for 24 h. After 24 h, further samples shall be taken to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.
- .10 Upon 10 ppm confirmation and 24 hr elapsed time flush line to remove chlorine solution.

- .11 Measure chlorine residuals at extreme end of pipe-line being tested.
- .12 Perform bacteriological tests on water main, after chlorine solution has been flushed out. Take samples daily for minimum of two days. Should contamination remain or reoccur during this period, repeat disinfecting procedure. Specialist contractor shall submit certified copy of test results.
- .13 Take water samples at remote fixtures and service connections.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 PDI-WH201, Water Hammer Arresters.
- .5 CAN/CSA-B64 Series, Backflow Preventers and Vacuum Breakers.
- .6 **ANSI/AWWA C700, Cold Water Meters-Displacement Type, Bronze Main Case.**
- .7 **ANSI/AWWA C701, Cold Water Meters-Turbine Type, for Customer Service.**
- .8 **ANSI/AWWA C702, Cold Water Meters-Compound Type.**
- .9 **CSA-B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.**

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

**Part 2 Products****2.1 NON FREEZE WALL HYDRANTS (SURFACE, EXPOSED)**

- .1 Surface mount, exposed, all bronze construction, anti-syphon, non freeze wall hydrant with non-turning operating rod, free floating compression valve, integral vacuum breaker, self draining, replaceable seat and seat washer. Stainless steel or chrome plated face with operating key lock. NPS 20 mm ( $\frac{3}{4}$ " ) hose outlet.
- .2 Acceptable Manufacturers:
  - .1 Zurn Z-1310
  - .2 Mifab MHY-10

- .3 Watts HY-420
- .4 Jay R. Smith 5509QT-NB

## **2.2 NON FREEZE WALL HYDRANTS (RECESSED, ENCASED)**

- .1 Recessed, encased, all bronze construction, anti-syphon, non freeze wall hydrant with non-turning operating rod, free floating compression valve, integral vacuum breaker, self draining, replaceable seat and seat washer. Nickel bronze box and hinged cover with operating key lock. NPS 20 mm (¾") hose outlet.
- .2 Acceptable Manufacturers:
  - .1 Zurn Z-1300
  - .2 Mifab MHY-20
  - .3 Ancon HY-725
  - .4 Contour C7100

## **2.3 INTERIOR HOSE BIBB**

- .1 20 mm (¾") diameter brass construction, 200 psi, 180°F pressure and temperature limits, complete with hose connection, and wheel handle straight/angle pattern to suit.
- .2 Provide vacuum breaker complete with hose connection.
- .3 Acceptable Manufacturers:
  - .1 Exposed on wall; Watts BD series
  - .2 Surface mounted (piping in wall); Watts SC-3 series
  - .3 Delta
  - .4 Waltec
  - .5 Wilkins
  - .6 Emco

## **2.4 WATER HAMMER ARRESTORS**

- .1 Copper construction, bellows type: to PDI-WH 201.
- .2 Acceptable Manufacturers:
  - .1 Zurn Z-1700
  - .2 Mifab MWH-100
  - .3 Ancon No. 15

## **2.5 BACK FLOW PREVENTORS**

- .1 The backflow preventor shall prevent backflow by either backpressure or backsiphonage from a cross-connection between potable water lines and substances that are objectionable.
- .2 To CAN/CSA-B64.
- .3 Application: as indicated.



- .4 Double check valve assembly (DCVA):
  - .1 The double check type backflow preventer shall be ASSE 1015 approved, and supplied with full port ball valves. The main body and access covers shall be bronze (ASTM B584), the seat rings and all internal polymers shall be NSF® Listed Noryl™ and the seat disc elastomers shall be silicone. The first and second checks shall be accessible for maintenance without removing the device from the line.
  - .2 Acceptable Manufacturers:
    - .1 Watts 007 ½" - 2"
    - .2 Wilkins 950XL ¾" - 2"
    - .3 Conbraco 40-100 Series

## 2.6 VACUUM BREAKERS

- .1 To CAN/CSA-B64 Series.
- .2 Atmospheric vacuum breaker (A-VB):
  - .1 Acceptable Manufacturers:
    - .1 Watts 288A
    - .2 Conbraco 38-103 Series
    - .3 Wilkins 35
- .3 Hose connection vacuum breaker (HCVB):
  - .1 Acceptable Manufacturers:
    - .1 Watts Series 8
    - .2 Conbraco 38-304-AS
    - .3 Wilkins BFP-8
- .4 Laboratory faucet intermediate vacuum breaker (LFVB):
  - .1 Acceptable Manufacturers:
    - .1 Watts N-LF9
    - .2 Conbraco 38-502-01

## 2.7 HOSE BIBBS AND SEDIMENT FAUCETS

- .1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.
  - .1 Acceptable Manufacturers:
    - .1 Watts BD series
    - .2 Emco
    - .3 Chicago
    - .4 Zurn

## 2.8 WATER METERS

- .1 Compound type to ANSI/AWWA C702.
- .2 Accessories: remote readout device.

- .3 Acceptable Manufacturers:

- .1 Neptune

## 2.9 STRAINERS

- .1 860 kPa (125 psi), Y type with 20 mm (3/4") mesh, bronze or stainless steel removable screen.

- .2 NPS 50 mm (2") and under, bronze body, screwed ends, with brass cap.

- .1 Acceptable Manufacturers:

- .1 Watts Series 777SI
- .2 Crane/Powers
- .3 Colton 125 YTB
- .4 Wilkins S Series

- .3 NPS 65 mm (2½") and over, cast iron body, flanged ends, with bolted cap.

- .1 Acceptable Manufacturers:

- .1 Watts 77F-D (77F-D-FDA for water service)
- .2 Crane/Powers
- .3 Colton 125 YTB
- .4 Wilkins FS Series

## 2.10 WATER FILTERS

- .1 Five (5) micron filter assembly for taste/odour and dirt/rust.
- .2 The unit shall be constructed of molded transparent plastic housing and a bottom pressure relief for cartridge change.
- .3 Install as per manufacturer's recommendations
- .4 Supply a spare set of cartridges.
- .5 Acceptable Manufacturers:
  - .1 Aqua Puro AP11B

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

### 3.2 NON FREEZE WALL HYDRANTS

- .1 Install 600 mm (24") above finished grade unless otherwise indicated.

### 3.3 NON-FREEZE GROUND HYDRANT

- .1 Install with top of box flush with ground and with drainage connection to discharge as indicated.

### **3.4 WATER HAMMER ARRESTORS**

- .1 Install on branch supplies to each fixture or group of fixtures and where indicated.

### **3.5 BACK FLOW PREVENTORS**

- .1 Install in accordance with CAN/CSA-B64 Series, where indicated and elsewhere as required by code.
- .2 Pipe discharge to terminate over nearest drain and or service sink.
- .3 Provide test results in manual and leave tag with test results on device.

### **3.6 HOSE BIBBS AND SEDIMENT FAUCETS**

- .1 Install at bottom of all risers, at low points to drain systems, and as indicated.

### **3.7 STRAINERS**

- .1 Install with sufficient room to remove basket.
- .2 Strainer size to match pipe size.

### **3.8 WATER METERS**

- .1 Install water meter provided by local water authority.
- .2 Install water meter as indicated.
- .3 Install remote readout to acceptance of local water authority and as indicated.

### **3.9 WATER MAKE-UP ASSEMBLY**

- .1 Install with valved bypass.
- .2 Pipe discharge from relief valve to nearest floor drain.

### **3.10 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: commission only after start-up deficiencies rectified.
- .3 Access doors: verify size and location relative to items to be services.
- .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
  - .1 Non-freeze wall, ground hydrants:
    - .1 Verify complete drainage.
    - .2 Verify operation of vacuum breaker.
  - .2 Water hammer arrestors:
    - .1 Verify accessibility.
  - .3 Backflow preventors, vacuum breakers:
    - .1 Verify installation of correct type to suit application.
    - .2 Adjust as necessary to ensure proper operation.
    - .3 Verify visibility of discharge.

- .4 Pressure regulators:
  - .1 Adjust settings to suit installed locations, required flow rates.
- .5 Hose bibbs, sediment faucets:
  - .1 Verify operation.
- .6 Water make-up assembly:
  - .1 Verify operation.
- .7 Water meters:
  - .1 Verify operation.
- .8 Pipeline strainers:
  - .1 Verify accessibility of basket.
  - .2 Clean out during commissioning until system clean.
- .5 Commissioning reports:
  - .1 Record all results on approved report forms.
  - .2 Include signature of tester and supervisor.
  - .3 To be countersigned by Consultant.
- .6 Verification:
  - .1 Notify Consultant 48 h before commencing tests.
  - .2 All tests and procedures to be witnessed by Consultant.
  - .3 All reported results subject to verification by consultant.
- .7 Training:
  - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .8 Demonstrations:
  - .1 Demonstrate full compliance with Design Criteria.
  - .2 Demonstrations also to show completeness of O&M personnel training.

### **3.11 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .3 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .4 CAN/CSA-B79, Commercial and Residential Drains and Cleanouts.

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year, and capacity.
  - .2 Details of operation, servicing, and maintenance.
  - .3 Recommended spare parts list.

**Part 2 Products**

**2.1 FLOOR DRAINS**

- .1 Floor drains and trench drains: to CAN/CSA-B79.
- .2 **Refer to schedule for types and acceptable manufacturer.**
- .3 Type FD-: General duty; cast iron body, adjustable head, nickel bronze strainer, integral seepage pan, and clamping collar. Use square strainer in tiled areas and round strainer elsewhere.
  - .1 Acceptable Manufacturers:
    - .1 Zurn ZN-415-B
    - .2 Mifab F1100C
    - .3 Watts Drainage FD-100-C-AS-1 or FD-100-C-LS-1
    - .4 Jay R. Smith 2005-AO5NB

- .4 Type FD-: Combination funnel floor drain; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel.

- .1 Acceptable Manufacturers:

- .1 Zurn ZN-415-F, ZN-415-BE, ZN-415-BF
- .2 Mifab F1100C-EG
- .3 Watts Drainage FD-100-C-EG-1
- .4 Jay R. Smith 2005-AO5NB-358ONE (3591NB)

- .5 Type HD-1: General duty hub drain; cast iron body, clamping collar, nickel-bronze adjustable head hub.

- .1 Acceptable Manufacturers:

- .1 Zurn ZN-211-S
- .2 Watts Drainage
- .3 Mifab
- .4 Contour C2000FNB

## 2.2 CLEANOUTS

- .1 Cleanout plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

- .2 Wall access: face or wall type, stainless steel round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

- .1 Acceptable Manufacturers:

- .1 Zurn ZSS-1469
- .2 Mifab C1400-RD
- .3 Watts CO-480-RD-3
- .4 Jay R. Smith 4710

- .3 Floor access: rectangular, round, as indicated, cast iron body and frame with adjustable secured 15 mm (½") thick flush mounted heavy duty nickel bronze top and: Plugs: bolted bronze with neoprene gasket.

- .1 Cover for unfinished concrete floors: nickel bronze round, gasket, vandal-proof screws.

- .1 Acceptable Manufacturers:

- .1 Zurn ZN-1400 – HD or Zurn ZNX-1612
- .2 Mifab C1100-XR-6
- .3 Watts CO-200-RX-1-6
- .4 Jay R. Smith SQ-4-1753-XNBCO-SP-U

- .2 Cover for terrazzo finish: round polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

- .1 Acceptable Manufacturers:

- .1 Zurn ZN-1400-Z
- .2 Mifab C1100-UR-6
- .3 Watts CO-200-U-1-6

- .4 Jay R. Smith SQ-4-1753-NBRT-SP-U
- .3 Cover for VCT tile and linoleum floors: square polished nickel bronze with 15 mm (1/2") thick flush mounted heavy duty nickel bronze cover, complete with vandal-proof locking screws.
  - .1 Acceptable Manufacturers:
    - .1 Zurn ZN-1400-T – HD
    - .2 Mifab C1100-TS-6
    - .3 Watts CO-200-TS-1-6
    - .4 Jay R. Smith 4200-U
- .4 Cover for ceramic tile floors: 15 mm (½") thick heavy duty nickel bronze square, cover complete with gasket, vandal-proof screws, for flush finish.
  - .1 Acceptable Manufacturers:
    - .1 Zurn ZN-1400 – T-HD or Zurn ZNX-1612
    - .2 Mifab C1100-S-6
    - .3 Watts CO-200-S-1-6
    - .4 Jay R. Smith SQ-4-1753-NBCO-SP-U-Y
- .5 Cover for carpeted floors: round polished nickel bronze with flush cover, complete with stainless steel carpet marker, vandal-proof locking screws.
  - .1 Acceptable Manufacturers:
    - .1 Zurn ZN-1400-HD-CM or ZN-1612-CM
    - .2 Mifab C1100C-S-1-6
    - .3 Ancon CO-200-RC-1-6
    - .4 Smith
    - .5 Contour C3000RMNB

## **2.3 TRAP SEAL PRIMER STATIONS**

- .1 Provide trap primer stations where indicated complete with solenoid valve, backflow preventor, vacuum breaker, NPS 15 mm (1/2") solder ends, NPS 15 mm (1/2") drip line connections.
- .2 Solenoid valve electric characteristics shall be suitable for controlling function.
- .3 Coordinate location and number of trap primer stations with Building Automation System (BAS) contractor.
- .4 Acceptable Manufacturers:
  - .1 Mifab
  - .2 Watts
  - .3 Zurn

## **2.4 SOLENOID VALVES (HEADER TRAP SEAL PRIMER)**

- .1 Two (2) way normal closed all bronze construction.
- .2 With integral adjustable cycle time clock control. Timer control to have two dial functions, time between cycles and time held in "open position".

- .3 Suitable for 120V.
- .4 Acceptable Manufacturers:
  - .1 Asco

## **2.5 INLINE FLOOR DRAIN TRAP SEAL**

- .1 Waterless inline floor drain trap seal, commercial grade UV and ozone resistant PVC (XFR) plastic housing with proprietary EPDM rubber diaphragm and soft rubber sealing gasket.
- .2 Acceptable Manufacturers:
  - .1 Sure Seal
  - .2 Trap Guard
  - .3 BMEC ProSet

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

### **3.2 CLEANOUTS**

- .1 In addition to those required by code, and as indicated, install at base of all soil and waste stacks.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 100 mm (4").

### **3.3 BACKWATER VALVES**

- .1 Install where indicated.
- .2 Flapper type installed at 2% slope as per installation instructions.

### **3.4 TRAP SEAL PRIMERS**

- .1 Install for all floor, hub and trench drains and elsewhere, as indicated.
- .2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Consultant.
- .3 Install soft copper tubing to floor drains above grade and polyethylene piping to floor drains below grade.

### **3.5 TRAP SEAL PRIMER STATIONS**

- .1 Provide primer stations where indicated.
- .2 Install for all floor drains and elsewhere, as indicated.



- .3 Install copper piping to floor drains above grade. Install polypropylene piping to floor drains on grade.

### **3.6 INLINE FLOOR DRAIN TRAP SEAL**

- .1 Only to be used with permission from local plumbing inspector. Obtain prior to backfill.
- .2 Provide inline trap seal where indicated. Permissible for use in residential suites and auxiliary storage rooms. Product not to be used for mechanical and electrical service rooms.

### **3.7 COMMISSIONING**

- .1 In context of this paragraph, "verify" to include "demonstrate" to Consultant.
- .2 Timing: Commission only after start-up deficiencies rectified.
- .3 Access doors: Verify size and location relative to items to be services.
- .4 Adjust to suit site conditions, including, but not necessarily limited to, following:
  - .1 Floor, hub and trench drains:
    - .1 Verify proper operation of trap primer, flushing features.
    - .2 Verify security and removability of strainers.
  - .2 Cleanouts:
    - .1 Verify covers are gastight, secure and easily removable.
    - .2 Verify that cleanout rods can probe as far as next cleanout.
  - .3 Backwater valves:
    - .1 Verify accessibility of cover, valve.
  - .4 Trap seal primers:
    - .1 Verify operation.
    - .2 Adjust flow rate to suit site conditions.
  - .5 Acid dilution devices:
    - .1 Verify operation.
- .5 Commissioning reports:
  - .1 Record all results on approved report forms.
  - .2 Include signature of tester and supervisor.
  - .3 To be countersigned by Consultant.
- .6 Verification:
  - .1 Notify Consultant 48 h before commencing tests.
  - .2 All tests and procedures to be witnessed by Consultant.
  - .3 All reported results subject to verification by consultant.
- .7 Training:
  - .1 Train O&M personnel in start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .8 Demonstrations:

- .1 Demonstrate full compliance with Design Criteria.
- .2 Demonstrations also to show completeness of O&M personnel training.

**3.8 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM B32, Specification for Solder Metal.
- .3 ASTM B306, Specification for Copper Drainage Tube (DWV).
- .4 ASTM C564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .5 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
- .6 CAN/CSA-B125.3, Plumbing Fittings.

**Part 2 Products****2.1 COPPER TUBE AND FITTINGS**

- .1 Above ground sanitary, and vent, maximum 65 mm (2½") Type DWV copper to: ASTM B306.
  - .1 Fittings.
    - .1 Cast brass: to CAN/CSA B125.3.
    - .2 Wrought copper: to CAN/CSA B125.3.
  - .2 Solder: tin-lead, 50:50, to ASTM B32, type 50A.

**2.2 CAST IRON PIPING AND FITTINGS**

- .1 Above and below ground sanitary, and vent, minimum NPS 80 mm (3"), cast iron to: CAN/CSA-B70.
  - .1 Mechanical joints (vents)
    - .1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.
    - .2 Stainless steel clamps (2 band).
  - .2 Mechanical joints (sanitary)
    - .1 Heavy duty neoprene or butyl rubber compression gaskets to: ASTM C1540.
    - .2 Stainless steel clamps (4 band min).

**2.3 VENT FLASHINGS**

- .1 Thaler or equal spun aluminum complete with insulation, cap, and rubber gasket.

**2.4 FORCED MAINS**

- .1 Above and below ground sewage pump discharge, size as indicated, type 'L' copper to ASTM B88M.
- .2 Cast copper, solder fitting to ANSI B16.18.

- .3 Cast bronze threaded fittings, class 125 to ANSI/ASME B16.15.

### **Part 3 Execution**

#### **3.1 APPLICATION**

- .1 Install copper or cast iron drainage on first 10'-0" (3.0m) of all fixtures discharging waste above 110°F.

#### **3.2 INSTALLATION**

- .1 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.
- .2 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.
- .3 Place Cleanouts
  - .1 Where shown on Drawings and near bottom of each stack and riser.
  - .2 At every 90 degree change of direction for horizontal lines.
  - .3 Every 15 m (50') of horizontal run.
  - .4 Extend clean out to accessible surface. Do not place cleanouts in carpeted floors. In such locations, use wall type cleanouts.
- .4 Each fixture and appliance discharging water into sanitary sewer or building sewer lines shall have a seal trap in connection with a complete venting system so gases pass freely to atmosphere with no pressure or syphon condition on water seal.
- .5 Vent entire waste system to atmosphere.
  - .1 Discharge 500 mm (20") above roof. Join lines together in fewest practicable number before projecting above roof.
  - .2 Set back vent lines so they will not pierce roof near an edge or valley.
  - .3 Venting shall be 7.5 m (25'-0") from any outdoor air intakes.
  - .4 Provide copper vent piping through roof as per detail.
- .6 Use torque wrench to obtain proper tension in cinch bands when using hubless cast iron pipe. Butt ends of pipe against centering flange of coupling.
- .7 Flash pipes passing through roof with 453 g (16 oz) sheet copper flashing fitted snugly around pipes and caulk between flashing and pipe with flexible waterproof compound.
  - .1 Flashing base shall be at least 600 mm (24") square.
  - .2 Flashing may be a 24 kg/m<sup>2</sup> (5 lb/ft<sup>2</sup>) lead flashing fitted around pipes and turned down into pipe 15 mm (½") with turned edge hammered against pipe wall.
- .8 Before piping is covered, conduct tests in presence of Consultant and correct leaks or defective work. Conduct test prior to placing floor slab but after backfill is placed.
  - .1 Do not caulk threaded work.
  - .2 Fill waste and vent system to roof level [a minimum of 3,100 mm - (10')] with water and show no leaks for 2 hours.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI Z21.10.1/CSA 4.1, Gas Water Heaters Volume I, Storage Water Heaters with Inputs Ratings of 75,000 Btuh, or less.
- .3 ANSI Z21.10.3/CSA 4.3, Gas Water Heaters Volume III; Storage Water Heaters with Input Ratings above 75,000 Btuh, circulating and Instantaneous.
- .4 CSA-B149.1, Natural Gas and Propane Installation Code.
- .5 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .6 CAN/CSA-B139, Installation Code for Oil Burning Equipment.
- .7 CAN/CSA-B140.0, Oil Burning Equipment: General Requirements.
- .8 CSA B140.12, Oil Burning Equipment: Service Water Heaters for Domestic Hot Water, Space Heating, and Swimming Pools.
- .9 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.
  - .5 ASME Certification (for all heaters over 600 mm (24") in diameter).

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and engineering data for incorporation into manual specified in general requirements.
- .2 Data to include:
  - .1 Manufacturer's name, type, model year, capacity, and serial number.
  - .2 Details of operation, servicing, and maintenance.
  - .3 Recommended spare parts list with names and addresses.

**Part 2 Products****2.1 GAS FIRED HIGH EFFICIENCY WATER HEATER**

- .1 To ANSI Z21.10.3/CSA 4.3. Efficiency of 94%.
- .2 Tank: glass, lined steel, fibreglass insulation, enameled steel jacket.
- .3 Gas burner: complete with high limit control, gas valve, gas pressure regulator, 100% safety shut-off, firepower gas burner with air distribution ring, 120V /1/60.
- .4 Vent kit complete with wall vent and vent pipe.
- .5 Provide 80 mm (3") ULC S636 approved CPVC piping and fittings for combustion and exhaust. Install as per manufacturers recommendations. Support piping at 1.5 m maximum.
- .6 Provide neutralizing cartridge for each hot water tank as supplied by equipment
- .7 Acceptable Manufacturers:
  - .1 A. O. Smith Cyclone
  - .2 Ruud
  - .3 Bradford White

**2.2 WATER HEATER TRIM AND INSTRUMENTATION**

- .1 Drain valve: NPS 25 mm (1") with hose end.
- .2 Thermometer: 100 mm (4") dial type with red pointer and thermowell filled with conductive paste.
- .3 Thermowell filled with conductive paste for control valve temperature sensor.
- .4 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.
- .5 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

**Part 3 Execution****3.1 WATER HEATER**

- .1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .2 Provide structural steel for horizontal (vertical) mounted tanks.
- .3 Provide insulation between tank and supports.
- .4 Provide neutralizing cartridge on each vent drain.
- .5 Install oil burning domestic water heaters in accordance with CAN/CSA B139.
- .6 Install natural gas or propane gas fired domestic water heaters in accordance with CSA-B149.1-00.

**3.2 FIELD QUALITY CONTROL**

- .1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.
- .2 Check power supply.
- .3 Check starter protective devices.
- .4 Start up, check for proper and safe operation.
- .5 Check settings and operation of all hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.
- .6 Demonstrate equipment operation as directed by consultant.

**3.3 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 Gas fired high efficiency water heater: three (3) year warranty certificate.
  - .2 Gas fired water heater (power vent): three (3) year warranty certificate.
  - .3 Gas fired water heater (atmospheric): three (3) year warranty certificate.
  - .4 Domestic hot water heater and storage tank: extended warranty: ten (10) years. Provide certificate.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and engineering data for incorporation into manual specified in general requirements
- .2 Data to include:
  - .1 Manufacturer's name, type, model year, capacity, and serial number.
  - .2 Details of operation, servicing, and maintenance.
- .3 Recommended spare parts list with names and addresses.

**Part 2 Products**

**2.1 DOMESTIC HOT WATER EXPANSION TANK**

- .1 Pre-charged 6.4 gal (3.2 gal accept volume) hydropneumatic steel expansion tank complete with internal butyl diaphragm.
- .2 Tank construction shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, with all welds conforming to ASME Section IX. The tank must be stamped with a maximum working pressure of 150 psi and a maximum working temperature of 250°F.
- .3 Tank shall be one of two styles:
  - .1 Complete with anti legionella liner (silver antimicrobial) and designed with water agitator to deter any legionella growth.
  - .2 Flow through style to ensure continuous water movement.
    - .1 This Contractor shall pipe flow through expansion tanks as per manufacturer's recommendations. Provide isolation valve on both sides of horizontal tank. Provide bypass valve around tank.



.4 Tank volume: 24 l (4.5 gallons) with 0.73 acceptance factor.

.5 Acceptable Manufacturers:

.1 Amtrol ST-12C

.2 Calefactio FTTE-12

## **2.2 DOMESTIC HOT WATER CIRCULATING PUMPS**

.1 Capacity: 0.6 l/s (9.5 gpm) against total differential head of 10 kPa (1.45 psi or 3.35 ft. wc.) as indicated.

.2 Construction: closed-coupled, in-line centrifugal, all bronze construction, stainless steel shaft, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearings. Design for 105°C (220°F) continuous service.

.3 Motor: 124 W (1/6 hp), drip-proof, with thermal overload protection.

.4 Supports: provide as recommended by manufacturer.

.5 Acceptable Manufacturers:

.1 Bell & Gossett

.2 Armstrong

.3 Taco

## **2.3 THERMOSTATIC WATER CONTROLLER (3 Port)**

.1 1½" inlets 2" outlets thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows mounted out of water. Volume control shut off valve, bimetal dial thermometer (3" face, range 20° – 240°F), brass pipe, fittings and unions. Standard valve and piping finish is rough bronze.

.2 Acceptable Manufacturers:

.1 Symmons 7-1000A-ASB-W

.2 Powers

## **Part 3 Execution**

### **3.1 RECIRCULATING PUMP**

.1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

.2 Ensure pump and motor assembly do not support piping.

### **3.2 DOMESTIC HOT WATER EXPANSION TANK**

.1 Adjust expansion tank pressure to suit system pressure.

.2 Provide an expansion tank on the cold water feed to each water heater complete with lockshield type shutoff valve at inlet to tank.

.3 Provide an expansion tank at the water entrance.

**3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.
- .2 Check power supply.
- .3 Check starter protective devices.
- .4 Start up, check for proper and safe operation.
- .5 Check settings and operation of all hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.
- .6 Adjust flow from water-cooled bearings.
- .7 Adjust impeller shaft stuffing boxes, packing glands.
- .8 Demonstrate equipment operation as directed by consultant.
- .9 Demonstrate water softener regeneration controls.

**3.4 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Conform to Sections of Division 1 and to General Mechanical Requirements Section.

**1.2 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Perform work in accordance with the recommendations of and the requirements of:
  - .1 Local and district bylaws and regulations.
  - .2 N.F.P.A.14 "Installation of Standpipe and Hose Systems".
  - .3 The Ontario Building Code.
  - .4 U.L.C. or Factory Mutual approval for hose, valve and extinguisher requirements.
  - .5 N.F.P.A.10 "Standard for Portable Fire Extinguishers".
  - .6 The Ontario Fire Code.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and maintenance data in accordance with general requirements.

**1.4 COORDINATION**

- .1 Confirm fire extinguisher cabinet locations and quantities from both architectural and mechanical drawings and report any discrepancies to consultant prior to bid close.
- .2 Coordinate location of cabinet with other trades and provide protection against damage during construction.

**Part 2 Products**

**2.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS (CLASS ABC)**

- .1 Stored pressure rechargeable type with hose and shut off nozzle, ULC labelled for A, B and C class protection as indicated. Size of extinguishers shall be as follows:

.1	Kitchen	Type 'K'	10 lb	20BC rating
.2	Servery Areas	Type 'K'	10 lb	20 BC rating
.3	Mechanical Rooms		10 lb	ABC rating
.4	Storage Rooms		10 lb	ABC rating
.5	Corridor/Gym/Finished Areas		5 lb	ABC rating complete with cabinet
- .2 Acceptable Manufacturers:
  - .1 Wilson & Cousins
  - .2 National

## **2.2 CABINETS**

- .1 Recessed mounted type of a size sufficient to contain all necessary components. Tub to be constructed of 1.5 mm (16 gauge) steel and finished with Wilco "Pro-Tech" Premier white painted finish. Adjustable frame comprising of 180° opening door and trim to be separate assembly adaptable to any type of finished wall. Trim to have 6 mm (1/4") return on outer edges with full length semi-concealed piano hinge, and Corbin style latching device.
- .2 Doors and trim to be 1.5 mm (16 gauge) white painted finish. Door glass to be 6 mm (1/4") Duo Lite Safety Glass.
- .3 Cabinet to maintain fire resistive rating of construction in which they occur.
- .4 Do not provide cabinets for mechanical room and service area fire extinguishers unless indicated.
- .5 Acceptable Manufacturers:
  - .1 Wilson & Cousins Model IE - 105R (5 and 10 lb. Class)
  - .2 National

## **2.3 IDENTIFICATION**

- .1 Identify extinguishers in accordance with recommendations of NFPA 10.
- .2 Attach tag or label to extinguishers indicating month and year of installation and provide space for the addition of recording service dates.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide portable fire extinguisher cabinets and mount in wall during construction. Cabinet to be surface or recessed mounted as indicated on the drawings. Install cabinets so that the door will not obstruct normal traffic when open.
- .2 Hang extinguishers in cabinets with wall mounting bracket.
- .3 Prior to installing the extinguisher cabinets, confirm the mounting height and exact location with the Consultant. Mount extinguisher so top of unit is not more than 1.5 m (5').
- .4 Install wall mounted fire extinguishers complete with wall mounting bracket where indicated and/or directed on site by consultant.
- .5 Caulk perimeter of fire extinguisher cabinets after acceptance.

### **3.2 TESTS**

- .1 Fire protection equipment shall be tested to the requirements of NFPA10, NFPA13, NFPA14 and comply with the requirements of the authorities having jurisdiction.

### **3.3 NFPA 96 HOOD**

- .1 10 BC rated fire extinguisher next to each NFPA 96 hood.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/CSA B45S1, Supplement #1 to CAN/CSA B-45 Series Plumbing Fixtures.
- .3 CAN/CSA-B45 Series, CSA Standards on Plumbing Fixtures.
- .4 CAN/CSA-B125.3, Plumbing Fittings.
- .5 CAN/CSA-B651, Accessible Design for the Built Environment.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Indicate, for all fixtures and trim:
  - .1 Dimensions, construction details, roughing-in dimensions.
  - .2 Factory-set water consumption per flush at recommended pressure.
  - .3 For water closets, urinals: minimum pressure required for flushing.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data including monitoring requirements for incorporation into manual specified in general requirements.
- .2 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

**1.4 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION**

- .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
- .2 Equipment installed by others.
  - .1 Connect with unions.
- .3 Equipment not installed.
  - .1 Capped with valves for future connection by others.

**Part 2 Products****2.1 MANUFACTURED UNITS**

- .1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

- .2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.
- .3 Exposed plumbing brass to be chrome plated.
- .4 Number, locations: Architectural drawings to govern.
- .5 Fixtures in any one location to be product of one manufacturer and of same type.
- .6 Trim in any one location to be product of one manufacturer and of same type.

## **2.2 FIXTURE CARRIERS**

- .1 Provide factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.
- .2 Acceptable Manufacturers:
  - .1 Zurn
  - .2 Smith
  - .3 Ancon

## **2.3 PLUMBING FIXTURES**

- .1 Refer to plumbing fixture schedule on the drawings for fixture type, manufacturer, trim, drainage supply, and accessories.

## **2.4 FIXTURE PIPING**

- .1 Hot and cold water supplies to each fixture/faucet:
  - .1 Chrome plated flexible supply pipes each with screwdriver stop, reducers, escutcheon and chrome plated nipple.
  - .2 Acceptable Manufacturers:
    - .1 Delta 47T900 Series
    - .2 McGuire
- .2 Waste:
  - .1 Open grid strainer, or pop up as indicated, offset open grid strainer on Barrier-Free fixtures, cast brass fittings with tubular piping, chrome plated, rubber gasket compression fitting, and overflow flange.
  - .2 Acceptable Manufacturers:
    - .1 Delta 33T200 Series
    - .2 McGuire
- .3 'P' Traps:
  - .1 Cast brass P trap with cleanout on each fixture not having integral trap.
  - .2 Chrome plated in all exposed places.
  - .3 Acceptable Manufacturers:
    - .1 Delta 33T300 Series
    - .2 McGuire

**Part 3 Execution****3.1 INSTALLATION**

- .1 Mounting heights:
  - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified. Confirm mounting height(s) with consultant prior to rough-in.
  - .2 Wall-hung fixtures: measured from finished floor.
  - .3 Physically Barrier-Free: to comply with most stringent of either NBCC or CAN/CSA B651.
- .2 Drinking fountains:
  - .1 In accordance with CAN/CSA B45S1.

**3.2 ADJUSTING**

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments.
  - .1 Adjust water flow rate to design flow rates.
  - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
  - .3 Adjust flush valves to suit actual site conditions.
  - .4 Adjust urinal flush timing mechanisms.
  - .5 Adjust water cooler, drinking fountain flow stream to ensure no spillage.
  - .6 Automatic flush valves for water closets and urinals: set controls to prevent unnecessary flush cycles during silent hours.
- .3 Checks.
  - .1 Water closets, urinals: flushing action.
  - .2 Aerators: operation, cleanliness.
  - .3 Vacuum breakers, backflow preventors: operation under all conditions.
  - .4 Wash fountains: operation of flow-actuating devices.
  - .5 Refrigerated water coolers: operation, temperature settings.
- .4 Thermostatic controls.
  - .1 Verify temperature settings, operation of control, limit and safety controls.
- .5 Floor and wall mounted fixtures: caulk to floor or wall using silicone caulking to make water tight, colour to match fixture.
- .6 Counter mounted fixtures: lay fixtures into bead of caulking to ensure excess moisture does not reach the cut edge of the countertop. Clean excess caulking off outside the sink.

**3.3            WARRANTY**

.1        Warranty Start Date:

- .1        Warranty period starts as of the date of Ready for Takeover.
- .2        Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.

**END OF SECTION**



**Part 1 General**

**1.1 GENERAL INSTRUCTIONS**

- .1 Comply with the General Conditions, Supplementary Conditions, and all of Division 1, General Requirements of Plumbing, HVAC, and Electrical Divisions.

**1.2 CASH ALLOWANCES (HST EXCLUDED)**

- .1 Refer to CCDC requirements and Division 1 for CASH ALLOWANCES.
- .2 The Contract Price includes the allowances stated below, which allowances shall be expended as the Owner directs through the Consultant. The Consultant may direct the Contractor to bid work for which payment is made from an allowance.
- .3 The value of the work performed under a cash allowance is eligible to be included in progress payments.
- .4 HST (Harmonized Sales Tax) is not included in cash allowance(s).

**1.3 CASH ALLOWANCES FOR SUBCONTRACTOR SERVICES**

- .1 Amount of each cash allowance includes:
  - .1 All costs related to the services, excluding *Value Added Taxes*.
- .2 Amount of each cash allowance does not include General and/or Plumbing/HVAC *Contractor's* overhead and profit, and other related costs, which shall be included in the *Contract Price* and not in the cash allowance.
- .3 Allow the stipulated sum of \$45,000.00 for subcontractor services:
  - .1 **Testing & Balancing Allowance (HST Excluded)**
- .4 Allow the stipulated sum of \$180,000.00 for subcontractor services:
  - .1 **Controls Allowance (HST Excluded)**

**1.4 EXPENDITURE OF CASH ALLOWANCES**

- .1 *Owner*, through *Consultant*, will provide *Contractor* with documentation required to permit pricing of a cash allowance item.
- .2 *Owner*, through *Consultant*, may request *Contractor* to identify potential *Suppliers* or *Subcontractors*, as applicable, and to obtain at least three competitive prices for each cash allowance item.
- .3 *Owner*, through *Consultant*, may request the *Contractor* to disclose originals of all bids, quotations, and other price related information received from potential *Suppliers* or *Subcontractors*.
- .4 *Owner*, through *Consultant*, will determine by whom and for what amount each cash allowance item will be performed. Obtain *Owner's* prior written approval in the form of a *Change Order* before entering into a subcontract, amending an existing subcontract, or performing own forces work included in a cash allowance. Upon issuance of the *Change Order*, the *Contractor's* responsibilities for a cash allowance item shall be the same as for other work of the *Contract*.

- .5 Refer to CCDC 2 – 2020, GC4.1.4. Where the actual cost of the Work under any cash allowance exceeds the amount of the allowance, and unexpended amounts from other cash allowance shall be reallocated, at the Consultant's direction, to cover the shortfall, and, in that case, there shall be no additional amount added to the Contract Price for overhead and profit.
- .6 Only where the actual cost of the Work under all cash allowances exceeds the total amount of all cash allowances shall the Contractor be compensated for the excess incurred and substantiated, plus an amount for overhead and profit on the excess only, as set out in the Contract Documents.
- .7 Where the actual cost of all the Work under the cash allowances are less than the amount of the allowances, the *Owner* shall be credited for the unexpended portion of the cash allowances, but not for the *Contractor's* overhead and profit on such amount.

**1.5 CASH ALLOWANCE CONTRACT REQUIREMENTS**

- .1 The contractor accepts to provide all the contract requirements for the products supplied in the allowances. This service includes providing supervision to include the product into the contract, shop drawing submission, co-ordinating installation, accepting warranty, accepting instruction to the owner, providing as-builts, including product literature in maintenance manuals, etc.
- .2 All this work must be included in the contractor's tender price.

**Part 2 Not Used**

**Part 3 Not Used**

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 This section covers items common to all sections of Heating, Ventilation, and Air Conditioning (HVAC) Division.
- .2 Conform to Division 1 General Conditions.
- .3 Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.
- .4 Unless specifically indicated, all materials and equipment provided under this contract shall be new and shall be manufactured in the project year.
- .5 The term "Mechanical Contractor" shall remain active and shall mean a "single contractor" performing plumbing, drainage, heating, cooling, ventilation, and control services.
- .6 When quoting as a subcontractor this building contractor shall explicitly state the services they are providing i.e. Mechanical (all services), Plumbing (water and drainage systems) or HVAC (including hydronic and air systems).
- .7 Contractors shall be explicit to identify whether Fire Protection is included or omitted from the mechanical scope.

**1.2 INTENT**

- .1 Mention herein or indication on Drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for HVAC work.
- .2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.
- .4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.
- .5 Where used, word "provide" shall mean supply and install as each is described above.

**1.3 REGULATIONS, PERMITS, AND FEES**

- .1 All materials and quality of work shall meet all current and latest Provincial, Municipal and Fire Marshall requirements, regulations, codes, and by-laws in force in the area of the project.
- .2 Each contractor shall give all necessary notices, obtain all necessary permits, and pay all fees in order that the work shown or specified may be carried out. Each contractor shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction.

- .3 In the event that changes, or alterations are required on completed work by authorized inspectors, these changes shall be made at the contractor's expense.
- .4 Special equipment which does not have a standard CSA label shall be inspected by the local electrical authority having jurisdiction and the Approval Certificate shall be submitted to the Consultant as soon as possible. All costs and fees for inspections shall be borne by this contractor.

#### **1.4 DRAWINGS**

- .1 The drawings and this specification have been assembled together as a responsibility of the consultant. The same is true for the other consultants, i.e. architect, structural engineer, civil engineer, fire protection engineer, electrical engineer, etc.
- .2 The drawings and specifications are not assembled together for responsibility/division between subcontractors. The division of work between subcontractors remains the responsibility of the buildings' contractor (also known as the prime contractor or general contractor).
- .3 All subcontractors are encouraged to perform work amicably utilizing all of the drawings and specifications published by all of the consultants.
- .4 Plumbing and HVAC Drawings do not show structural and related details. Take information involving accurate measurements of building from building drawings, or at building. Make, without additional charge, any necessary changes, or additions to runs of piping, conduits, and ducts to accommodate structural conditions. Location of pipes, ducts, conduits and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.
- .5 As work progresses and before installing piping, ductwork, heating units, registers, diffusers, fixtures and any other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings, or obtain directions for exact location of such equipment and fitments.
- .6 Plumbing and HVAC drawings indicate general location and route of pipes, ducts and conduits which are to be installed. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Follow building lines, conceal piping, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .7 Install piping and ductwork to clear structural members and any fireproofing. Locate HVAC work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .8 Before commencing work, check and verify all sizes, locations, grade and invert elevations, levels, and dimensions to ensure proper and correct installation. Verify existing/municipal services.
- .9 Locate all HVAC and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.

- .10 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .11 Relocate equipment and/or material installed but not co-ordinated with work of other Sections and/or installed incorrectly as directed, without extra charge.
- .12 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

## **1.5 INTERFERENCE AND COORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.
- .5 Due to the nature of the building and the complexity of the building systems provide the following:
  - .1 Interference drawings, showing coordination of architectural, structural, plumbing, HVAC, and electrical systems for the consultant's review prior to fabrication.
  - .2 Detailed layout drawings, clearly showing fasteners and hangers.
- .6 Provide CAD drawings (minimum file version AutoCAD 2013) in addition to hard copies.

## **1.6 QUALITY ASSURANCE**

- .1 Perform work in accordance with applicable provisions of local plumbing code, gas ordinances, and adoptions thereof for all HVAC systems. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
- .2 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

## **1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout HVAC Division are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment. Submitted Bids shall be based on the supply of named articles and or products as specified in the Bid Documents.

- .2 Each bidder may elect to use "Alternate Equipment" from lists of Alternates where listed. Include for any additional costs including all costs for revisions to electrical contract to suit Alternate used. Prices are not required in Tender for Alternates listed except where specifically noted as "Separate Price". Complete the Supplementary Tender Form.
- .3 When two or more suppliers/manufacturers are named in the Bid Documents, only one supplier/manufacturer of the products named will be acceptable; however, it is the responsibility of this Division to ensure "Alternate Equipment" fits space allocated and gives performance specified. If an "Alternate Equipment" nor "equal" specified product unit is proposed and does not fit space allotted in Consultant's opinion, supply of specified described equipment will be required without change in Contract amount. Should electrical characteristics for "alternate" or "equal" equipment differ from equipment specified it shall be the responsibility of the equipment manufacturer to pay all costs associated with the revisions to the electrical contract. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .4 If item of material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.
- .5 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

## 1.8 EXAMINATION

- .1 Site Reviews
  - .1 Examine premises to understand conditions which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Plumbing and HVAC Drawings show general arrangement of piping, ductwork, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Plumbing, HVAC, and Fire Protection Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

## 1.9 SEQUENCING SCHEDULING AND COORDINATION

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of HVAC items, make proper provision to avoid interferences in a manner approved by Consultant. Each Contractor shall refer to all sections of the specification for their responsibilities with other trades. Changes required in work specified in HVAC Division caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by HVAC Division unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by HVAC Division.
- .5 Be responsible for required excavation, backfilling, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
  - .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  - .2 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
  - .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .6 Adjust locations of pipes, ducts, equipment, fixtures, etc., to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and duct prior to fabrication.

- .1 Make offsets, transitions, and changes in direction of pipes, ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
- .2 Furnish and install traps, air vents, sanitary vents, pull boxes, etc., as required to effect these offsets, transitions, and changes in direction.
- .7 Slots and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

#### **1.10 REQUEST FOR INFORMATION (RFI) PROCEDURES**

- .1 RFIs shall be submitted to the consultant minimum two (2) weeks prior to answer being required. Failure to submit an RFI in a timely manner will forfeit delay claims and schedule extension requests by the contractor.
- .2 All RFIs will be submitted with the following information:
  - .1 RFI number
  - .2 Name of project
  - .3 Date of initiation
  - .4 Date response required by (minimum two (2) weeks)
  - .5 Subject
  - .6 Submitter's name
  - .7 Drawing/specification reference
  - .8 Photograph of the issue (if applicable)
  - .9 Description of the issue
  - .10 Contractor's proposed resolution

#### **1.11 CONTRACT BREAKDOWN**

- .1 Provide breakdown of contract exclusive of HST to acceptance of consultants prior to first draw submission.
- .2 Provide labour and material cost for each item.
- .3 Breakdown shall indicate total contract amount.
- .4 Contract breakdown shall be as follows as a minimum.
  - .1 Mobilization and shop drawings (max. \$20,000.00)
  - .2 Demolition
  - .3 Piping insulation
  - .4 Ductwork
  - .5 Duct insulation
  - .6 Grilles & diffusers
  - .7 Fire stopping
  - .8 Fans & equipment
  - .9 HVAC system commissioning



- .10 Refrigeration piping
- .11 HVAC contractor closeout requirements (min. of 3%).

- .5 Progress claims, when submitted are to be itemized against each item of the contract breakdown, this shall be done in table form showing contract amount, work complete to date, previous draw, amount this draw and balance.
- .6 Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

#### **1.12 COMMISSIONING CONTRACT BREAKDOWN**

- .1 This contractor shall work with the HVAC system commissioning contractor as specified elsewhere. The following commissioning breakdown shall be indicated on the contract breakdown draw.

#### **1.13 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 14 days after award of Contract.
- .2 Upon receipt of reviewed shop drawing, product is to be ordered immediately.
- .3 Provide a complete list of shop drawings to be submitted prior to first submission.
- .4 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
- .5 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
- .6 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
- .7 Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
- .8 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or their Engineer shall not supersede Contract Documents.
- .9 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .10 Check work described by catalog data with Contract Documents for deviations and errors.

- .11 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances. e.g., access door swing spaces.
- .12 Shop drawings and product data shall be 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 as to current model production.
  - .5 Certification of compliance to applicable codes.
- .13 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
- .14 Shop drawings shall be submitted electronically as per the following directions:
  - .1 Electronic Submissions:
    - .1 Electronically submitted shop drawings shall be prepared as follows:
      - .1 Use latest software to generate PDF files of submission sheets.
      - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.
      - .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
      - .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
      - .5 Submissions shall contain multiple files according to section names as they appear in Specification.
      - .6 File names shall include consultant project number and description of shop drawing section submitted.
      - .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
      - .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
      - .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
    - .2 Email submissions shall include subject line to clearly identify the consultants project number and the description of the shop drawings submitted.

- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating "1 of 2" and "2 of 2" in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the "reviewed" shop drawings in a binder as noted above.
- .6 Contractor to print copies of "reviewed" shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### **1.14 EQUIPMENT NAMEPLATE DATA**

- .1 Between the manufactures design published literature, the shop drawing submission literature, and the nameplate data on the equipment, they can all read differently.
- .2 Most of the confusion and differences are coming out of the electrical power installation.
- .3 The contractors installing and connecting the equipment are responsible for the coordination of this data through the construction period.
- .4 The contractors shall share and/or request this information through out the project and monitor/make adjustments, provide recommendations accordingly based on any discrepancies.
- .5 The contractors are responsible for any cost associated with the changing data.
- .6 The final installation must meet the "Nameplate Data" on the equipment on site.

#### **1.15 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as in submittals' requirements.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
- .3 Submit 1 copy of Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by Consultant. Submission can be done electronically in pdf format or as a hardcopy.
  - .1 Electronic submission/pdf file is required to be bookmarked. Any submission received without bookmarking will be immediately returned as unacceptable.
  - .2 Hardcopy submission shall be in a three-ring binder (minimum 50 mm (2") ring) and labelled as 'Operation and Maintenance Manual' with project name and location. Dividers are to be used for binder organization.
- .4 Make changes as required and re-submit as directed by Consultant.
- .5 Operation data to include:
  - .1 Control schematics for each system including environmental controls.

- .2 Description of each system and its controls.
- .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
- .4 Operation instruction for each system and each component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .8 Spare parts equipment list.
- .9 Manufacturers standard or extended warranty information.
- .6 Maintenance data shall 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.
- .7 Performance data to include:
  - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified elsewhere.
  - .4 Testing, adjusting and balancing reports as specified in Testing, Adjusting and Balancing Section.
  - .5 Copy of all substantial performance final certificates.
- .8 Miscellaneous data to include:
  - .1 Letter of contractor's warranty and guarantee.
  - .2 Index sheet.
  - .3 Tabbed format for each section.
  - .4 Manufacturers approved shop drawings.
  - .5 Spare parts list and source.
  - .6 List of Manufacturers and suppliers address for each piece of equipment.
- .9 Final Submittals:
  - .1 Upon acceptance of Operation and Maintenance Manual by the Consultant provide the following:
    - .1 Provide two (2) copies of final operation maintenance manuals, as well as a PDF file of the entire approved manual on a USB stick. Only one USB stick is to be provided containing both the approved manual and as-built drawings.

**1.16 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible HVAC drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing HVAC systems, control systems and low voltage control wiring.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.
- .2 As-Built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW HVAC SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 TAB to be performed using as-built drawings.
    - .1 Submit hard copy to Consultant for approval. When returned, make corrections as directed.
    - .2 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals.

**1.17 WARRANTIES**

- .1 In addition to guarantee specified in General Conditions, guarantee heating, cooling, and plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
- .2 Provide certificates of warranty for each piece of equipment made out in favor of Owner. Clearly record "start-up" date of each piece of equipment on certificate. Include certificates as part of Operation & Maintenance Manual.
- .3 Contractor shall rectify any installation deficiencies in the boiler or pressurized other systems identified by a TSSA Inspector for a period of three (3) years from ready for takeover.
- .4 Warranty period shall start from date of ready for takeover. Warranty period shall start from date of ready for takeover. Warranty start date based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .5 Warranty Duration:
  - .1 One (1) year warranty period applies unless otherwise noted.
- .6 Warranty Coverage:
  - .1 Applies to parts and labour.

**1.18 READY FOR TAKEOVER**

- .1 Complete the following to the satisfaction of the consultant prior to request for ready for takeover.
  - .1 As-Built Drawings.
  - .2 Maintenance Manuals
  - .3 System Start up
  - .4 TAB Reports
  - .5 HVAC System Commissioning
  - .6 Instructions to Owners

**1.19 REVISION TO CONTRACT**

- .1 Provide the following:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/supplier's invoice if requested.

**1.20 DELIVERY, STORAGE, AND HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials. Contractor to include all costs associated with delivery storage and handling in tender price.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or environmental damaging conditions but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.
- .3 Remove any damaged materials from the site.

**1.21 DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS**

- .1 **If designated substances and/or hazardous materials are suspected or identified cease all work in the immediate area in accordance with OHSA and notify consultant.**
- .2 **Each contractor and on site employee of the contractor shall have "asbestos awareness training".**
- .3 The Contractor shall ensure that employees who may come into contact with designated substances and/or hazardous materials due to the nature of the work that they perform, have received training that enables them to recognize designated substances and/or hazardous materials and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with designated substances and/or hazardous materials occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the designated substances and/or hazardous materials book in the building prior to starting any work.**

- .5 Existing occupied buildings (depending upon their age) may contain designated substances and/or hazardous materials in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain designated substances and/or hazardous materials and shall not be disturbed.
- .6 A survey of each building documenting the location and condition of designated substances and/or hazardous materials -containing materials is available for your mandatory review prior to commencing any work on premises.

#### **1.22 PHASING OF WORK**

- .1 This work for this project shall be constructed in phases. Refer to the architectural drawings for phasing information and details. Misinterpretation of the drawings with respect to the extent of the phasing of the work shall not relieve the contractor of the work required to complete the entire contract.
- .2 Provide all necessary services or temporary services to suit phasing of construction with respect to all HVAC services and fire protection.
- .3 Life safety systems in the building are to remain fully operational in occupied areas for building staff and occupants during renovations.
- .4 Provide all necessary tests and certificates at completion of each phase to suit requirements of local authorities and consultants for occupancy of completed areas.

#### **1.23 TSSA INSPECTION**

- .1 Prior to final completion of the project, this contractor shall make application, arrange, and pay for a TSSA inspection of all piping systems and equipment installations, including, but not limited to medical gasses, refrigeration, fuel piping, compressed air, heating plant, cooling plant, and associated equipment installed under the contract.
- .2 Provide a copy of the TSSA report in the maintenance manuals for each system.

#### **1.24 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

#### **1.25 ENERGY EFFICIENCY**

- .1 The HVAC systems of this building must achieve the energy efficiency levels by conforming to ANSI/ASHRAE/IESNA 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Chapter 2 of Division 3 of SB-10 prescriptive method from the Ontario Building Code.
- .2 All equipment, products, and installations must conform to the Codes and Standards.

**END OF SECTION**

**Part 1            General**

**1.1            OCCUPANCY REQUIREMENTS**

- .1        The contractor shall provide the following documentation to the consultant's satisfaction prior to receiving occupancy. Failure to provide the proper documentation will result in the occupancy not being granted. List of required documentation:
  - .1        Final Certificates (required prior to consultant's release of conformance letter).
    - .1        Mandatory TSSA Gas Pressure Test (CSA B149.1)
    - .2        Contractor letter verifying all refrigeration leak detection systems and their interlocks to downstream devices have been installed and tested.

**Part 2            Not Used**

**Part 3            Not Used**

**END OF SECTION**



**Part 1 General**

**1.1 TESTS**

- .1 Give 48 hours' written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant.
- .4 Bear costs including retesting and making good.
- .5 Piping:
  - .1 General: Maintain test pressure without loss for 4 h unless otherwise specified.
  - .2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure or minimum 860 kPa, whichever is greater.
  - .3 Test natural gas systems to CSA-B149.1-00, TSSA requirements and requirements of authorities having jurisdiction.
- .6 Equipment: Test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

**1.2 SYSTEM START UP**

- .1 **Provide adjusting testing and start up of all equipment prior to testing and balancing (TAB) specified elsewhere.**
- .2 **Provide Consultant with written notice verifying all equipment operation and installation is complete.**
- .3 **Start up shall be in presence of the following: Owner or Representative, Contractor, Building Automation Systems (BAS) Contractor, and Manufacturer's Representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by Consultant.**
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 Arrange with all parties and provide 72 hours' notice for start up procedure.
- .6 Arrange with building automation systems contractor to sequence all components and ensure system operation.

**1.3 COMMISSIONING**

- .1 **Co-ordinate and direct each step of the commissioning process and recommend acceptance or non-acceptance to the Owner/Owner's Representative.**
- .2 **Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to Consultant and Owner/Owner's Representative.**
- .3 **The Commissioning Process is detailed in *ASHRAE Guideline 1-1996 HVAC Commissioning Process*. The commissioning plan may be modified to reflect the actual construction schedule and design.**

- .4 Provide a pre-functional test of all HVAC system and sub-system elements, including control devices, shall be checked for the following:**
  - .1 Verify that each element has been properly installed, properly identified, and that all connections (including electrical) have been made correctly.**
  - .2 Verify that each element has been checked for proper lubrication, drive rotation, belt tension, control sequence, flow direction, or other conditions which may cause damage or reduce system performance.**
  - .3 Verify that tests, meter readings, and specific HVAC/electrical performance characteristics agree with those required by equipment or system manufacturer.**
  - .4 Controls calibration to be completed in accordance with the specification.**
  - .5 The TAB shall be done in accordance with the specifications.**
- .5 A functional performance testing shall be done during two separate periods – one during the cooling season and one during the heating season. The first (cooling) testing period shall occur as soon after completion of installation as practical. The heating testing period shall occur as soon as weather conditions make it practical to test warm-up, zone heating and economizer functions. These tests ensure that all equipment and systems operate in accordance with design intent. The tests are dynamic tests and test the systems through all possible modes of operation.**
- .6 Reports:**
  - .1 The Contractor shall be responsible for recording, documenting, and maintaining detailed inspection and testing data on the test documentation reports. The data record shall be comprehensive and concise.**
  - .2 All data must be recorded as soon as possible during the course of the inspection and testing.**
  - .3 All documentation shall have the date, time, and names of persons participating in the inspection and testing.**
  - .4 All test instruments shall be documented for valid calibration.**
  - .5 The recording work sheets, inspection check lists, and Performance Testing plans must all be approved by the Engineer and the Owner's Representative prior to the start of the testing.**
  - .6 Include all commissioning documentation in the maintenance manuals.**
- .7 HVAC System Execution:**
  - .1 Operate equipment and systems shall be tested in the presence of the Owner's Representative and the Consultant to demonstrate compliance with specified requirements. To minimize the time of Commissioning Team members, testing shall be done in four seasonal single blocks of time insofar as possible.**
  - .2 Notify the consultant, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.**
  - .3 Testing shall be conducted under specified design operating conditions as recommended or approved by the Consultant.**

- .4 All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.
- .5 All special testing materials and equipment shall be provided by the appropriate contractor.
- .6 Provide three copies of all test reports and records to the Consultant.
- .8 The verification testing procedures shall address all operating characteristics of all HVAC equipment and systems, including:

**Equipment Checklist**

Rooftop Heating/Cooling Unit(s)

Exhaust Fans

Heat Recovery Unit(s)

Controllers/Dampers

Relays/Sensors/Transducers

**System Checklist**

Air Handling Units

Heat Recovery Unit(s)

**1.4 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTION**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 HVAC Contractor to schedule and coordinate the demonstration all on the same day, starting at a pre-approved time and continuing consequently until complete.
- .3 Where specified elsewhere in HVAC Division, qualified manufacturers' representatives who are knowledgeable about the project to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Where deemed necessary, Consultants may record these demonstrations on video tape for future reference.

**1.5 TRIAL USAGE**

- .1 Consultant or Owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
  - .1 HVAC
  - .2 Exhaust air
  - .3 Control systems

**1.6 DEFICIENCIES**

- .1 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions, and instruction to correct work.
- .2 Instruction to correct work shall be done within the work period before the next review.

- .3 The Contractor shall not conceal any work until inspected.
- .4 The Contractor shall expedite 100% complete rough-in work and have inspected prior to concealing services and equipment especially above ceiling.
- .5 Upon completion of the project, the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicating the deficiencies are completed. A re-inspection will only be done once Consultant receives this in writing.

#### **1.7 EQUIPMENT INSTALLATIONS**

- .1 Unions or flanges: Provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: Provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: Pipe to floor drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

#### **1.8 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply anchor bolts and templates for installation by other divisions.

#### **1.9 PROTECTION OF OPENINGS**

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

#### **1.10 ELECTRICAL**

- .1 Electrical work to conform to Electrical Division including the following:
  - .1 Supplier and installer responsibility and related HVAC responsibility is indicated in Equipment Schedule on HVAC and/or electrical drawings,
  - .2 Power wiring and conduit is specified in Electrical Division except for conduit, wiring and connections below 50 V which are related to control systems specified in HVAC Division. Follow Electrical Division for quality of materials and workmanship.
  - .3 Electrically operated equipment shall be C.S.A. approved label. Special Inspection Label of Provincial Authority having jurisdiction will be accepted in lieu of C.S.A. approval. Each motor shall have an approved starter. Starter will be supplied and installed by Electrical Division unless otherwise indicated.

#### **1.11 CONTROL WIRING**

- .1 Furnish and install all components, devices, and control wiring for all HVAC equipment, HVAC systems, lighting, and other electrical loads to make all equipment operable to satisfaction of Owner and Consultant and to manufacturer's requirements and recommendations.
- .2 All electrical wiring, HVAC wiring and installations shall comply with local and national electrical and HVAC codes.

- .3 Supply and install wiring as required for all devices and systems. Install wiring in EMT conduit and otherwise comply with all requirements of the Electrical Division. Approved plenum wire may be used for sensor and network communication wiring where it complies with appropriate building codes and regulatory authorities.
- .4 All wiring concealed in walls and chases, and all exposed wiring shall be run in conduit.
- .5 Provide recessed conduit and backer boxes where controls are wall mounted. Surface mounted boxes and conduit are acceptable in service rooms.
- .6 Free-run plenum rated cable shall be run in cable hangers where provided by electrical division or tied neatly to pipe and duct hangers in the ceiling. Avoid wiring that droops. Follow building lines and do not run wiring "as the crow flies".

#### **1.12 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install equipment at following heights unless indicated otherwise.
  - .1 Thermostats (Operable, Barrier Free) 1200 mm (47.2")
  - .2 Thermostats (Non Barrier Free) 1500 mm (59")
- .4 Also follow direction of architectural drawings and where discrepancies occur clarify prior to rough-in.

#### **1.13 MOTORS**

- .1 Provide high efficiency motors for HVAC equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W, (1/2 hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, voltage as indicated.
- .4 Motors 373 W, (1/2 hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated.

#### **1.14 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW 10 hp: Standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW 10 hp and over: Sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centre line adjustment.
- .7 Provide sheave changes as required for final air balancing.

#### **1.15 GUARDS**

- .1 Provide guards for unprotected devices.
- .2 Guards for belt drives:
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm (18 gauge) thick sheet metal tops and bottoms.
  - .3 40 mm (1 1/2") diameter holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm (16 gauge) thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 20 mm (3/4") mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.
- .7 Duct Openings
  - .1 Provide reinforced expanded mesh grating, style 3 (3 lbs/sq.ft.) cover on accessible unprotected duct openings over 300 mm (12") wide and as indicated. This includes all ductwork terminating in air handling units and plenums.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.

#### **1.16 PIPING AND EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: Specified elsewhere in HVAC Division.
- .2 Piping and equipment supports not supplied by equipment manufacturer: Fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings.
- .3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. Concrete specified elsewhere.

- .4 Where housekeeping pads incorporate existing pads provide 10 mm dowels into existing pads. New pad height shall match existing.

#### **1.17 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated. Grout sleeves in place.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
  - .3 Through fire rated walls and floors.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  - .4 Fill future-use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.
- .7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at wall as indicated.

#### **1.18 FIRE STOPPING**

- .1 This contractor shall work with all other contractors on the project in providing one common method of fire stopping all penetrations made in fire rated assemblies.
- .2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.
- .3 Do not use cementitious or rigid seals around penetrations for pipe or ductwork where penetrating through walls, floors, ceilings, etc.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.
- .5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

- .6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.
- .8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.
- .9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.
- .11 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .12 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .13 Submit product literature and installation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and consultant.
- .14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.
- .15 Acceptable Alternate Manufacturers to approval of local authority:
  - .1 Minnesota Mining and Manufacturing
  - .2 Fryesleeve Industries Inc.
  - .3 General Electric Pensil Firestop Systems
  - .4 International Protective Coatings Corp.
  - .5 Rectorseal Corporation (Metacaulk)
  - .6 Proset Systems
  - .7 3M
  - .8 AD Systems
  - .9 Hilti
- .16 Ensure firestop manufacturer representative performs onsite inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

#### **1.19 ESCUTCHEONS**

- .1 On pipes and ductwork passing through walls, partitions, floors and ceilings in exposed finished areas and on water and drain pipes inside millwork and cabinets.
- .2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.



## **1.20 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Apply two coats of paint to exposed piping service in service room, base colour as specified in HVAC Identification Section.
- .4 Prime and touch up marred finished paintwork to match original.
- .5 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

## **1.21 SPARE PARTS**

- .1 Furnish spare parts in accordance with general requirements and as follows:
  - .1 One set of packing seals for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One head gasket set for each heat exchanger.
  - .4 One set of belts for each type or each size of machinery.
  - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide list of equipment in maintenance manuals indicating corresponding spare parts required. List of spare parts to be signed off by receiving personnel.

## **1.22 SPECIAL TOOLS**

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Maintenance Materials Special Tools and Spare Parts.

## **1.23 ACCESS DOORS**

- .1 Provide access doors to concealed HVAC equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: Use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: Use prime coated steel.
  - .3 Fire rated areas: Provide ULC listed access doors.
  - .4 Washrooms or high moisture area ceilings: Aluminum with mill finish suitable for painting.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.

- .2 Locate so that hand or body entry (as applicable) is achieved.
- .5 Acceptable Manufacturers:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

**1.24 DIELECTRIC COUPLINGS**

- .1 General:
  - .1 To be compatible with and to suit pressure rating of piping system.
  - .2 Where pipes of dissimilar metals are joined.
- .2 Pipes NPS 50 mm (2") and under: Isolating unions.
- .3 Pipes NPS 65 mm (2 1/2") and over: Isolating flanges.

**1.25 DRAIN VALVES**

- .1 Locate at low points and at section isolating valves unless otherwise specified.
- .2 Minimum NPS 20 mm (3/4") unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.
- .3 Drain valves on potable water systems shall be complete with vacuum breaker.

**1.26 REPAIRS, CUTTING, AND RESTORATION**

- .1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

**1.27 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

**1.28 CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to owner.

- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

**1.29 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment, piping, ductwork, etc. as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

**1.30 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.

**1.31 DEMOLITION**

- .1 **The general requirements are indicated on the drawings and on the outline specification in Division 1.**
- .2 **The general execution of the demolition is to be carried out in a clean and efficient manner.**
- .3 **Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.**
- .4 All openings or holes created by removal of existing HVAC systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate HVAC systems are to be patched to match surrounding surfaces.
- .6 Protect all existing furnishings, materials, and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitate changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.

**1.32 EXCAVATING AND BACKFILLING**

- .1 Provide all excavating and backfilling inside and outside the building for any buried services. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150 mm (6") layer to the satisfaction of the Consultant.
- .2 Provide excavating and backfilling outside the building with granular A brought in specifically for backfilling to a minimum of 450 mm (18") over the pipe or ductwork. Backfilling outside building over and above the 450 mm (18") backfill as previously specified herein shall be by the HVAC Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2 the HVAC Contractor shall provide new clean granular 'A' fill to grade level.
- .3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150 mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.
- .4 Should water be encountered during excavation, the HVAC Contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300 mm (12") base of compacted 50 mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.
- .5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.
- .6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450 mm (18") bedding material.

**1.33 CONFINED SPACES**

- .1 Certain areas of the building may be defined as a "Confined Space". Any personnel working in these areas must have confined space training, appropriate equipment and undertake all work in conformance with appropriate codes and standards.
- .2 Refer to building documentation for any spaces deemed "Confined Space".

**1.34 TSSA INSPECTION**

- .1 Prior to final completion of the project, this contractor shall make application, arrange, and pay for a TSSA inspection of all piping systems and equipment installations, including, but not limited to medical gasses, refrigeration, fuel piping, compressed air, heating plant, cooling plant, and associated equipment installed under the contract.
- .2 Provide a copy of the TSSA report in the maintenance manuals for each system.

**1.35 REFRIGERANT CONTAINING EQUIPMENT**

- .1 A2L refrigerants are classified as mildly flammable. CSA B52-2023 has specific safety clauses related to the use of refrigerants with this classification within buildings.
- .2 This Contractor shall be responsible to ensure that the installation requirements of CSA B52-2023 are met.

- .3 Throughout this specification various pieces of equipment have been specified with refrigerant leak detection systems. Field wiring of the alarm status of this system to various downstream system components is required under Annex P of the standard and is the responsibility of this Contractor. These devices include the following:
  - .1 Open all zone dampers connected to the affected system.
  - .2 Disable electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves on the affected refrigeration systems.
  - .4 De energize any potential sources of ignition with the ductwork system of the affected system.
  - .5 Energize fans within the ductwork system.
  - .6 Activate any designated refrigeration leak ventilation systems.

#### **1.36 FREEZE PROTECTION**

- .1 Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

#### **1.37 SCAFFOLDING, RIGGING, AND HOISTING**

- .1 Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

#### **1.38 COOPERATION WITH OTHER TRADES**

- .1 Give full cooperation to other trades and furnish in writing to other trades, with copies to the engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- .2 Where plumbing work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. Prepare composite working drawings and sections at a suitable scale, not less than ¼ inches = 1-foot – 0-inches, clearly showing how the HVAC work is to be installed in relation to the work of other trades. If work is installed before coordinating with other trades, or if it causes any interference with work of other trades, make the necessary changes in the work to correct the conditions and bear all costs.
- .3 Furnish to other trades necessary templates, patterns, setting drawings, and shop details for the proper installation of work and for coordinating adjacent work.

#### **1.39 WATERPROOFING SEAL MATERIALS**

- .1 Modular, compressed seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.

- .2 Standard of quality assurance manufacturers are:
  - .1 Thunderline Corp. (Power Plant Supply Co.) "Link Seal" Model S-316
  - .2 The Metraflex Co. "MetraSeal" type ES
  - .3 Or approved equivalent.

**1.40 SLEEVE, CUT, AND FORMED OPENING LOCATION DRAWINGS**

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses, and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

**1.41 SUSTAINABLE CONSTRUCTION**

- .1 Construction Waste Management:
  - .1 Recycle all waste materials to avoid land fill sites where possible.
  - .2 All metal contents shall be recycled.
  - .3 All cardboard and paper shall be recycled.
  - .4 All plastic packaging shall be recycled.
  - .5 All wood shall be directed to the appropriate recycled wood section at the landfill site.
- .2 This Contractor is responsible for their own waste management system and cost associated with the disposal. This can be their own on site system, daily removal, back to shop, or a communal system shared with other contractors on site.
- .3 In all cases the cost to remove materials on site are the cost of this Contractor.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL PROVISIONS**

- .1 Conform to the General Provisions of General Requirements Section.
- .2 This project is one of a retrofit nature in part, and which will require some demolition.
- .3 Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

**1.2 RELATED WORK SPECIFIED ELSEWHERE**

- .1 Electrical Division.

**1.3 SCOPE OF WORK**

- .1 The scope of work is essentially the selected disconnection and/or removal of services and/or equipment, piping, ductwork, etc. as indicated or required to complete the work.

**Part 2 Products**

**2.1 GENERAL**

- .1 This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the Owner.
- .2 This Division is to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

**Part 3 Execution**

**3.1 GENERAL**

- .1 The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2 All rooftop units, ductwork, and other accessories to be demolished completely. Contractor to visit site ahead of pricing.
- .3 The general execution of the demolition is to be carried out in a clean and efficient manner.
- .4 Demolition of existing ceilings, walls, etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.
- .5 All openings or holes created by removal of existing HVAC systems which are not being reused are to be patched with the same material surrounding surfaces.
- .6 All new holes and openings to facilitate HVAC systems are to be patched to match surrounding surfaces.

- .7 Protect all existing furnishings, materials, and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .8 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .9 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .10 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, invert elevations, etc., immediately after moving on site. Should for any reason the information obtained necessitate changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .11 Disconnect and/or remove equipment, piping, ductwork, etc. as indicated.
- .12 Cap and conceal all redundant and obsolete connections.
- .13 Provide a list of equipment to be removed to the Owner, for his acceptance of same. Remove all equipment from site which the Owner does not retain.
- .14 Maintain equipment to be retained by Owner on site where directed by Consultant.
- .15 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.
- .16 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.
- .17 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.
- .18 Co-ordinate making safe electrical devices, capping plumbing and removal of fixtures prior to commencement of demolition.
- .19 All piping and equipment to be removed and/or abandoned shall be drained prior to capping and/or abandoning. Disposal of all liquids shall be to the approval of authority of having jurisdiction and/or provincial regulations.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture Selection, Application, and Installation.

**1.2 DESIGN REQUIREMENTS**

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

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 All bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

**1.4 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products****2.1 GENERAL**

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

**2.2 CONSTANT SUPPORT SPRING HANGERS**

- .1 Springs: alloy steel to ASTM A 125, shot peened, magnetic particle inspected, with +/- 5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with 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 (1") minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

**2.3 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of miscellaneous metals, specified herein. Submit calculations with shop drawings.

**2.4 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

**2.5 HOUSE-KEEPING PADS**

- .1 For base-mounted equipment: Reinforced concrete, at least 100 mm (4") high, 150 mm (6") larger all around than equipment, and with chamfered edges as indicated.
- .2 Size of housekeeping pads shall be determined from approved shop drawings.
- .3 Concrete: 30 Mpa concrete with reinforced wire mesh.
- .4 Install all housekeeping pads not indicated on architectural drawings.

**2.6 OTHER EQUIPMENT SUPPORTS**

- .1 From structural grade steel meeting requirements of structural steel section specified herein.
- .2 Submit structural calculations with shop drawings.

**2.7 MANUFACTURER**

- .1 Acceptable Manufacturers:
  - .1 Grinnell
  - .2 Anvil
  - .3 Myatt
  - .4 Taylor

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere 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 be 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 at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

**3.2 HANGER SPACING**

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 15 mm (1/2"): every 1.8 m (6').
- .4 Copper piping: up to NPS 15 mm (1/2"): every 1.5 m (5').

- .5 Within 300 mm (12") of each elbow and:

Maximum Pipe Size: NPS	Spacing Steel	Maximum Spacing Copper
up to 32 mm (1 1/4")	2.1 m (7')	1.8 m (6')
40 mm (1 1/2")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2 1/2")	3.6 m (12')	3.0 m (10')
80 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3 1/2")	3.9 m (13')	3.3 m (11')
100 mm (4")	4.2 m (14')	3.6 m (12')
125 mm (5")	4.8 m (16')	
150 mm (6")	5.1 m (17')	
200 mm (8")	5.7 m (19')	
250 mm (10")	6.6 m (22')	
300 mm (12")	6.9 m (23')	

- .6 Pipework greater than NPS 300 mm (12"): to MSS SP-69.

### 3.3 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Do "NOT" support piping, ductwork and equipment from roof deck, on bottom chord of floor and/or roof joist and/or from OWSJ bridging. Provide structural member between joist.

### 3.4 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4mm (5/32") from vertical.
- .2 Where horizontal pipe movement is less than 15 mm (1/2"), offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.5 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.

- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

**END OF SECTION**

**Part 1            General**

**1.1            SHOP DRAWINGS**

- .1      Submit shop drawings in accordance with general requirements.
- .2      Provide separate shop drawings for each isolated system complete with performance and product data.

**Part 2            Products**

**2.1            GENERAL**

- .1      Size and shape of bases type and performance of vibration isolation to be as indicated.
- .2      To be of the same manufacturer for all isolation.
- .3      Acceptable Manufacturers:
  - .1          Korfund
  - .2          Vibro-Acoustics
  - .3          Vibron

**2.2            HANGERS**

- .1      Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2      Type H1 - neoprene - in-shear, molded with rod isolation bushing, which passes through hanger box.
- .3      Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.
- .4      Type H3 - stable spring, elastomeric element with pre-compression washer and nut [with deflection indicator].
- .5      Performance as indicated.
- .6      Acceptable Manufacturers:
  - .1          Vibron
  - .2          IAC Acoustics
  - .3          Korfund
  - .4          Vibro-Acoustics

**2.3            ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES**

- .1      Acoustic barriers: between pipe and support, consisting of 25 mm (1") minimum thick heavy-duty duct and neoprene isolation material.
- .2      Acceptable Manufacturers:
  - .1          Vibron

- .2 IAC Acoustics
- .3 Vibro-Acoustics

## **2.4 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 10 mm (3/8").
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.
- .3 Acceptable Manufacturers:
  - .1 Korfund
  - .2 IAC Acoustics
  - .3 Vibron
  - .4 Vibro-Acoustics

## **2.5 ROOF CURB ISOLATION RAIL**

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

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 All roof top units to have curb isolation rail.
- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 Provide roof curb acoustic lining on all HVAC equipment above 4,000 cfm/10 tonnes capacity.
- .4 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.

- .5 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm (1") minimum static deflection as follows:
  - .1 Up to NPS 100 mm (4"): first 3 points of support. NPS 125 mm (5") to NPS 200 mm (8"): first 4 points of support. NPS 250 mm (10") and Over: first 6 points of support.
  - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm (2").
- .6 Where isolation is bolted to floor use vibration isolation rubber washers.
- .7 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

### **3.2 SITE VISIT**

- .1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Consultant.
- .2 Provide Consultant with notice 24 h in advance of visit.
- .3 Make adjustments and corrections in accordance with written report.

### **3.3 TESTING**

- .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 Testing Adjusting and Balancing Section.
- .2 Vibration measurements shall be taken for equipment-listed below:
- .3 Provide Consultant with notice 48 h in advance of commencement of tests.
- .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations including sound curves.
- .5 Submit complete report of test results including sound curves.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Canadian Standards Association (CSA).
  - .1 Natural Gas and Propane Installation Code CSA B149.1.
- .4 National Fire Protection Association
  - .1 NFPA 13, Installation of Sprinkler Systems.
  - .2 NFPA 14, Standpipe and Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with General Requirements.
- .2 Product data to include paint colour chips, all other products specified in this section.

**1.3 PRODUCT LITERATURE**

- .1 Submit product literature in accordance with General Requirements.
- .2 Product literature to include nameplates, labels, tags, lists of proposed legends.

**Part 2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

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

**2.2 SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

**.2 Construction:**

- .1 3 mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned, and machine engraved into core.

**.3 Sizes:****.1 Conform to following table:**

Size	No. of Sizes mm (")	Height of Line mm (")	Letters mm (")
1	10 x 50 (3/8" x 2")	1 (3/64")	3 (1/8")
2	15 x 75 (1/2" x 3")	1 (3/64")	6 (1/4")
3	15 x 75 (1/2" x 3")	2 (5/64")	3 (1/8")
4	20 x 100 (3/4" x 4")	1 (3/64")	10 (3/8")
5	20 x 100 (3/4" x 4")	2 (6/64")	6 (1/4")
6	20 x 200 (3/4" x 8")	1 (3/64")	10 (3/8")
7	25 x 125 (1" x 5")	1 (3/64")	15 (1/2")
8	25 x 125 (1" x 5")	2 (5/64")	10 (3/8")
9	32 x 200 (1¼" x 8")	1 (3/64")	20 (3/4")

- .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.  
 .3 Roof top equipment: use size #9.  
 .4 Equipment above ceiling: use size #1 riveted to ceiling suspension system.

**2.3 FIRE DAMPER/FIRE STOP FLAP NAMEPLATES/FIRE SMOKE DAMPER****.1 Colours:**

- .1 Black letters, yellow background.

**.2 Construction:**

- .1 Self adhesive 50 mm x 25 mm, matte finish, with round corners.

**.3 Locations:**

- .1 Install on adjacent ceiling grid. Where fire stop flap is installed in gypsum ceiling install on diffuser/grille frame. Where fire damper is installed above gypsum ceiling install on adjacent wall.

**2.4 PIPING SYSTEMS GOVERNED BY CODE****.1 Identification:**

- .1 Natural and propane gas: To CSA B149.1-00 and authority having jurisdiction and as indicated elsewhere.  
 .2 Sprinklers: To NFPA 13.

## 2.5 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 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .3 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm (3"): 100 mm (4") long x 50 mm (2") high.
  - .2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150 mm (6") long x 50 mm (2") high.
  - .3 Use double-headed arrows where flow is reversible.
- .4 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .5 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm (3/4") and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395°F).
- .6 Colours and Legends:
  - .1 Where not listed, obtain direction from Consultant.
  - .2 Colours for legends, arrows: To following table:

Background colour:	Legend:	Arrows:
Yellow	White	Black
Green	White	Black
Red	White	Black
- .7 Pictograms:
  - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

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

CONTENTS	BACKGROUND COLOUR MARKING		LEGEND
Condensate	Green		CONDENSATE
Refrigeration suction	Yellow		REF. SUCTION
Refrigeration liquid	Yellow		REF. LIQUID
Refrigeration hot gas	Yellow		REF. HOT GAS
Natural gas	Yellow		NATURAL GAS
Gas regulator vents			to Codes
Conduit for low voltage			
Control wiring	White		CONTROL WIRING____VOLTS

## 2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm (2") high stencilled letters and directional arrows 150 mm (6") long x 50 mm (2") high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.

## 2.7 VALVES, CONTROLLERS

- .1 Brass tags with 15 mm (1/2") 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.
- .3 Provide adhesive coloured tab (max. size 15 mm) indication on ceiling to locate valves/equipment above. Same applies to grid. Colour to be approved by consultant.

## 2.8 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.
- .3 Provide equipment identification and/or indication on ceiling to locate devices/equipment above ceiling. Install identification on grid. Colours to be approved by consultant.

## 2.9 LANGUAGE

- .1 Identification to be in English.

**Part 3 Execution**

**3.1 TIMING**

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

**3.2 INSTALLATION**

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

**3.3 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 in any way.

**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 not more than 1.7 m (5'-8") 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, other confined spaces, at entry and exit points, and at each access opening.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

**3.5 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 Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively. Where existing numbering system is installed start new numbering system at 100.

**END OF SECTION**

**Part 1 General**

**1.1 CONTRACT REQUIREMENTS**

- .1 TAB contractor will work for the owner from the cash allowance in the Mechanical Allowances section.**
- .2 This contractor must co-ordinate their work with that of the TAB contractor.**
- .3 Prequalified TAB contractors are to submit quotes to the engineers on or before the tender closing time specified in Division 1.**
- .4 Should the Engineer's Office not receive the quotes it will be the successful mechanical contractor's responsibility to obtain the quotations.**
- .5 If required, the successful mechanical contractor shall:**
  - .1 Provide copies of specified drawings and addendums to the NEBB certified Testing and Balancing contractors listed below.**
  - .2 Obtain quotations for Testing and Balancing services.**
  - .3 Submit quotations to the engineer's office for review.**
- .6 The Engineer's Office will issue required instruction for the initiation of Testing and Balancing agency's work.**

**1.2 GENERAL**

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section including all air handling systems and equipment, all plumbing systems and equipment and all temperature controls system, building automation systems and equipment.**
- .2 This contractor must co-ordinate their work with that of the TAB contractor.**

**1.3 QUALIFICATIONS OF TAB AGENCIES**

- .1 Names of all personnel it is proposed to perform TAB to be submitted to and approved by Consultant within 30 days of start of work.**
- .2 Provide documentation confirming qualifications, successful experience.**
- .3 Only the following NEBB (National Environmental Balancing Bureau) TAB contractors may quote:**
  - .1 Air Audit Inc.**  
110 Turnbull Court, Unit 11  
Cambridge, ON N1T 1K6  
(519) 740-0871
  - .2 Flowset Balancing Ltd.**  
431 Willis Drive  
Oakville, ON L6L 4V6  
(416) 410-9793

- .3      Air Adjustments & Balancing Inc.  
P.O. Box 176  
Schomberg, ON L0G 1T0  
(416) 254-3004
- .4      Clark Balancing Ltd.  
8094 Esquesing Line  
Milton, ON L9T 2X9  
(905) 693-1518
- .5      Red Leaf Technical Inc.  
5249 Ament Line  
Linwood, ON N0B 2A0  
(519) 504-1617
- .6      VPG Associates  
2062 King Road  
King City, ON L7B 1K9  
(905) 833-4334
- .7      Airwaso Canada Inc. (WRDSB)  
3365 Paulpeel Avenue  
London, ON N6L 0A4  
(519) 652-4040

#### **1.4            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 (95% design) and low (75% of design) loads using actual or simulated loads. TAB contractor to perform equipment evaluation upon start up and once during each season in the first year of operation.
- .2      Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions. Confirm all equipment interlocks and functions of associated systems.
- .3      Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges and temperatures. Refer to BAS for system operating functions.

#### **1.5            EXCEPTIONS**

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

#### **1.6            CO-ORDINATION**

- .1      Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.



- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems. Co-ordinate with other trades to ensure all systems are interlocked as indicated elsewhere prior to TAB.

### **1.7 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.
- .4 During construction indicate all tolerances of piping, ductwork etc. conforms to specifications.

### **1.8 START-UP**

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

### **1.9 OPERATION OF SYSTEMS DURING TAB**

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

### **1.10 START OF TAB**

- .1 Notify Consultant in writing 3 days prior to start of TAB.
- .2 Start TAB only when building is essentially completed, including:
  - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
  - .2 Application of weather-stripping, sealing, caulking.
  - .3 All pressure, leakage, other tests specified elsewhere in the Mechanical Division.
  - .4 All provisions for TAB installed and operational.
  - .5 Start-up, verification for proper, normal and safe operation of all mechanical and associated electrical and control systems affecting TAB including but not limited to:
    - .1 Proper thermal overload protection in place for electrical equipment.
    - .2 Air systems:
      - .1 Filters in place, clean.
      - .2 Duct systems clean.
      - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
      - .4 Correct fan rotation.
      - .5 Fire, smoke, volume control dampers installed and open.

- .6 Coil fins combed, clean.
- .7 Access doors, installed, closed.
- .8 All outlets installed, volume control dampers open.

**1.11 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 10%, minus 5%.

**1.12 ACCURACY TOLERANCES**

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

**1.13 INSTRUMENTS**

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

**1.14 SUBMITTALS**

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

**1.15 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Consultant, 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.

**1.16 TAB REPORT**

- .1 Format to be in accordance with NEBB, AABC, or SMACNA.
- .2 The following additional information shall be provided for all air systems:
  - .1 Minimum damper position (MAD/Economizer) and the corresponding BAS signal and the voltage to the actuator to meet the full ASHRAE occupied ventilation requirements.
  - .2 Minimum damper position (MAD/Economizer) and the corresponding BAS signal and the voltage to the actuator to meet the full ASHRAE unoccupied ventilation requirements.

- .3 Static pressure reading for each HVAC/AHU unit with VAV/VVT boxes open to 80% of design airflow and bypass damper closed to 0%. Provide reading at normal MAD/economizer damper position, dampers fully closed and dampers fully open.

- .3 TAB report to show all results in SI or imperial units as indicated on plans and to include:
  - .1 Project as-built drawings.
  - .2 System schematics.

#### **1.17 VERIFICATION**

- .1 All reported results subject to verification by Consultant.
- .2 Provide manpower and instrumentation to verify up to 30% of all reported results.
- .3 Number and location of verified results to be at discretion of Consultant.
- .4 Bear costs to repeat TAB as required to satisfaction of Consultant.

#### **1.18 SETTINGS**

- .1 After TAB is completed to satisfaction of Consultant, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings. Replace all ceiling tile etc.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

#### **1.19 COMPLETION OF TAB**

- .1 TAB to be considered complete only when final TAB Report received and approved by Consultant.

#### **1.20 AIR SYSTEMS**

- .1 Standard: TAB to be to most stringent of TAB standards of NEBB, AABC, SMACNA, ASHRAE.
- .2 Do TAB of all systems, equipment, components, controls specified in the Mechanical Division including but not limited to following:
  - .1 Air handling systems and equipment
  - .2 Duct testing to SMACNA standards.
- .3 Qualifications: personnel performing TAB to be current member in good standing of NEBB.
- .4 Quality assurance: Perform TAB under direction of qualified supervisor.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:

- .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, and other equipment causing changes in conditions.
- .2 At each controller, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, grille, register or diffuser.

#### **1.21 DUCT LEAKAGE TESTING**

- .1 Co-ordinate leakage testing with the sheet metal contractor. TAB contractor will be responsible for all duct testing.
- .2 Duct to be tested in accordance with SMACNA HVAC Duct Leakage Test Manual and as indicated.

#### **1.22 DOMESTIC HWC SYSTEMS**

- .1 Meet all requirements as specified for hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

#### **1.23 OTHER PLUMBING SYSTEMS**

- .1 This contractor shall test, adjust, and record the domestic water (in 1.24 change read "plumbing") system after the plumbing contractor has completed their work.
  - .1 Recirculating Systems: pump flows and pressures
  - .2 Pumped sanitary and storm water systems: test for proper operation at all possible flow rates.

#### **1.24 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to all 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.
- .3 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
  - .2 TAB procedures:

<u>Positive</u>	<u>Negative</u>
Corridors	Washrooms
- .4 Zone pressure differences:
  - .1 Adjust HVAC systems, equipment, controls to establish air pressure differentials, with all systems in all possible combinations of normal operating modes.
- .5 Provide duct testing as specified.

- .6 Provide AHU testing as specified.
- .7 Provide plenum testing as specified.
- .8 Changing of air handling equipment sheave and belts as required for specified air flow sheaves and belts supplied by unit manufacturer. Retest equipment after sheave change.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL**

- .1 The Mechanical Contractor shall provide the labour and material to conduct the closeout process as outlined in this specification section.
- .2 The mechanical contractor shall perform the closeout requirements specified in conjunction with the independent commissioning consultant (CC) retained by the owner.

**Part 2 Products**

**2.1 GENERAL**

- .1 The mechanical contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Mechanical Contractor shall advise the Mechanical Consultant of instrumentation to be used and the dates the instruments were calibrated.

**Part 3 Execution**

**3.1 THE CONTRACT CLOSE OUT PROCESS**

- .1 The mechanical contractor close out process shall consist of:
  - Shop Drawings and As-built Drawings
  - Installation inspection and equipment verification
  - Plumbing and drainage system testing
  - Testing of air systems
  - Independent contractor balancing of air systems
  - Testing of equipment and systems
  - BAS Commissioning
  - Verification of refrigeration leak detection systems
  - Commissioning Consultant performance testing
  - Commissioning meetings
  - Operating and maintenance manuals
  - Training
  - Systems Demonstration and turnover
  - Testing forms
  - Warranties
  - Contractor to provide list of equipment maintenance including schedule of maintenance parts, quantities, and model fixtures, etc.

**3.2 SHOP DRAWINGS AND AS-BUILT DRAWINGS**

- .1 Conform to General Requirements Section for shop drawings and as-built drawings requirements.

**3.3 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION**

- .1 The Mechanical Contractor shall co-ordinate with the Consultant who will inspect the mechanical installation.
- .2 The Mechanical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - Manufacturers name, address and telephone number
  - Distributors name, address and telephone number
  - Make, model number and serial number
  - Fans - belt type and size, shive type and size
  - Electrical - volts, amps, fuse size, overload size
  - Any other special characteristics.

**3.4 THE CONTRACTORS TESTING OF AIR SYSTEMS**

- .1 Conform with the specification section, Testing, Adjusting and Balancing.
- .2 All tests shall be performed in the presence of the Mechanical Consultant or the Commissioning Consultant. Complete the testing forms and forward to the Consultant.

**3.5 THE INDEPENDENT CONTRACTORS TESTING AND BALANCING OF AIR SYSTEMS**

- .1 Conform with specification section, Testing, Adjusting and Balancing.
- .2 The Independent Contractor shall be hired by The Mechanical Contractor and shall report to the Commissioning Consultant.

**3.6 TESTING OF EQUIPMENT AND SYSTEMS**

- .1 General:
  - .1 The Mechanical Contractor shall hire the services of the manufacturers technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Consultant or Owners representative. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the operating and maintenance manual.
  - .2 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed.
  - .3 Tests which have not been witnessed shall not be accepted and shall be repeated.
  - .4 The equipment and systems to be tested shall include:
    - Condensing Units
    - Air Handling Units
    - Life Safety and Fire Protection Systems
    - Building Automation Systems (BAS)
- .2 BAS Testing:
  - .1 The BAS Contractor shall test the system as described in General Requirements and/or Controls Sections.

- .2 Co-ordinate with the Consultant and submit completed test forms monthly.
- .3 Demonstrate to the Owner and Consultant the operation of the BAS when all tests have been completed.
- .3 Verification of Refrigeration Leak Detection System Operation:
  - .1 The commissioning process shall include the verification of the refrigeration leak detection system.
  - .2 All interlocks between leak detection systems installed and system components, as well as interlocks between field installed detection systems and associated safety system components shall be tested and verified to operate as per the requirements of CSA B52. Specifically, the following shall occur for each independent system on registration of a refrigerant leak:
    - .1 Open all zone dampers in the affected system.
    - .2 Disable all electric reheat coils within the affected system.
    - .3 Activate field installed safety shut off valves within the affected refrigeration system.
    - .4 Energize all fans within the affected ductwork system.
    - .5 Activate all refrigerant leak system specific ventilation systems.
    - .6 De-energize any other potential sources of ignition within the affected system.

### **3.7 CLOSEOUT SCHEDULE**

- .1 The Mechanical Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 All testing forms and reports associated with the mechanical systems shall be directed to the Consultant with copies to the Owner and Consultant.
- .3 The forms and reports to be issued shall include:
  - Shop drawings, issued and accepted
  - Equipment verification forms
  - Testing forms
  - Reports resulting from tests
  - Testing schedule
  - Equipment Start-up Forms

### **3.8 OPERATION AND MAINTENANCE MANUAL**

- .1 Conform to General Requirements section for the Operating and Maintenance Manual requirements.

### **3.9 OPERATOR TRAINING**

- .1 Conform to General Requirements section for requirements for Instruction to Operating Staff.
- .2 The training shall be conducted in a classroom and at the equipment or system.
- .3 Training will begin when the operating and maintenance manuals have been delivered to The Owner and approved by the Consultant.



- .4 Each training session shall be structured to cover:
- The operating and maintenance manual
- Operating procedures
  - Maintenance procedures
  - Trouble-shooting procedures
  - Spare parts required
  - Submit a course outline to the Mechanical Consultant before training commences.
- Provide course documentation for up to eight people.
- .5 The training sessions shall be scheduled and co-ordinated by the Mechanical Contractor.
- .6 Training shall be provided for the following systems:
- | <u>System</u>                         | <u>Minimum Training Times</u> |
|---------------------------------------|-------------------------------|
| Condensing Units                      | 2 hours                       |
| Air Handling Units                    | 2 hours                       |
| Life Safety & Fire Protection Systems | 2 hours                       |
| The Mechanical System                 | 8 hours                       |
- .7 The minimum training for the BAS shall be 16 hours. The training shall include:
- A walk through of the installation for the Building Owner to review the installation and equipment
  - Operation of the central computer
  - Operation of portable terminals
  - Control sequences
  - Report set-up and generation
  - Managing the system
  - Maintenance requirements
- Refer to Controls specification section for further information.
- .8 The training requirement for the mechanical system shall include a walk-through of the building by the Mechanical Contractor. During the walk through the Mechanical Contractor shall:
- Identify equipment
  - Identify starters associated with equipment
  - Identify valves and balancing dampers
  - Identify access doors
  - Review general maintenance of equipment
  - Review drain points in pipework systems
  - Identify maintenance items
- .9 When each training session has been completed The Owner shall sign the associated form to verify completion.

### **3.10 COMMISSIONING CONSULTANT**

- .1 A Commissioning Consultant (CC) reports to the Owner.
- .2 The CC responsibilities shall include:
- preparing the commissioning plan
  - co-ordinating with the contractor to schedule tests
  - preparing a test form manual

- witnessing selected tests
- receiving all test forms
- conducting performance test
- co-ordinating the contractors training
- chair commissioning meetings

- .3 The Mechanical Contractor shall co-operate with the CC.
- .4 The Mechanical Contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each mechanical system shall be tested in the operational mode.
- .5 Performance testing shall begin when all systems have been completed, tested by the Mechanical Contractor and the Consultant has completed their final review.

### **3.11 MECHANICAL SYSTEM DEMONSTRATION AND TURNOVER**

- .1 Refer to General Requirements section, Mechanical Project Completion.
- .2 The system demonstration and turnover to The Owner shall occur when:
  - The installation is complete
  - The acceptance test conducted by the Mechanical Consultant has been completed successfully
  - The Commissioning Consultant system performance testing has been completed successfully
  - Training has been completed
  - Operating and Maintenance Manuals have been accepted
  - Shop-drawings have been updated
  - As-built drawings have been completed
- .3 The systems demonstration shall be conducted by the Mechanical Contractor and the manufacturers. The demonstration shall cover a demonstration of equipment installation and operation.

### **3.12 TESTING FORMS**

- .1 The Mechanical Contractor and manufacturers shall provide forms for testing. The forms must be approved by the Consultant and The Owner before they are used.

### **3.13 WARRANTIES**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Owner.
- .2 The Mechanical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to the general conditions specification section for the requirements during the warranty period.

### **3.14 CLOSEOUT PROCESS ALLOCATION**

- .1 The mechanical contractor closeout process shall be as follows:
  - .1 3% for the contract value.

- .2 The Mechanical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The monies shall not be paid out until the performance testing, O & M manuals, systems demonstration, and training including all required paperwork have been completed to the satisfaction of the consultant. Refer to General Requirements section for contract breakdown.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-[89], Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Underwriters Laboratories of Canada (ULC).
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .4 American Society for Testing and Materials (ASTM).
  - .1 ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Mean of the Guarded Hot-Plate Apparatus.
  - .2 ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .3 ASTM C 449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C1729 Standard Specification for Aluminum Jacketing for Insulation.
  - .5 ASTM C1290 Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  - .6 ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes And Tanks.
  - .7 ASTM C553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .8 ASTM C612, Mineral Fiber Block and Board Thermal Insulation.
  - .9 **ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.**
  - .10 **ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.**
  - .11 **ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.**
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - .1 ASHRAE Standard 90.1.
- .6 Manufacturer's Trade Associations.
  - .1 Thermal Insulation Association of Canada (TIAC)
  - .2 North American Commercial and Industrial Insulation Standards.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.
- .3 Submit completed detail plates from the North American Commercial and Industrial Insulation Standards manual, applicable to installation types required by this specification section.

**1.3 INSTALLATION INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with general requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

**1.4 QUALIFICATIONS**

- .1 Installer to have successfully completed apprenticeship program.
- .2 Installer to be 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.

**1.5 DELIVERY, STORAGE, AND HANDLING**

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

**1.6 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 "ASJ+" – All Service Jacket – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper, with outer poly film leaving no paper exposed.
  - .4 "ASJ" – All Service Jacket (no outer film) – vapor retarder laminate of aluminium foil inner layer, reinforced with fiberglass scrim, bonded to a bleached kraft paper outer layer.
  - .5 "FSK" – Foil Scrim Kraft – vapor retarder laminate of aluminium foil outer layer, reinforced with fiberglass scrim, bonded to a natural kraft paper inner layer.
- .2 Insulation systems - insulation material, fasteners, jackets, and other accessories.

## 1.7 QUALITY ASSURANCE

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.
- .2 **Products shall be Certified UL GREENGUARD Gold or Indoor Advantage Gold and formaldehyde free.**
- .3 **Recycled content: Mineral fiber products will contain a minimum of 50% recycled glass content certified and UL validated and are to be constructed using bio-based thermosetting binder.**

## Part 2 Products

### 2.1 LIMITATION ON MATERIALS

- .1 Products shall not contain formaldehyde, asbestos, lead, mercury or mercury compounds or PBDE fire retardants.
- .2 Materials shall be: **"Certified Asthma and allergy friendly" and "verified Healthy Air."**

### 2.2 FIRE AND SMOKE RATING

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

### 2.3 INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C177 or ASTM C518.
- .3 Type C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket meeting the requirement of ASTM C1136 Type II and IV (FSK):
  - .1 Jacket: to ASTM C1136 Type II and IV (FSK)
  - .2 Maximum "k" value: .033 W/M•°C (.23 BTU•IN/HR•FT<sup>2</sup>•°F)
- .4 Type C-2: Mineral fibre blanket to ASTM C553 Type I, II, and III, ASTM C1136 Type II and IV, and ASTM C1290 Type III:
  - .1 Jacket: to ASTM C1136, Type II and IV.
  - .2 Maximum "k" value: 0.042 W/M•°C (.29 BTU•IN/HR•FT<sup>2</sup>•°F)
- .5 Type C-3: High temperature fire rated duct wrap, ULC classified soluble amorphous wool blanket with factory applied flame resistant aluminum foil fiberglass reinforced facing. Suitable for up to 1200°F service temperature.
  - .1 Acceptable Manufacturers:
    - .1 3M
    - .2 Morgan Firemaster Fastwrap XL
    - .3 CL4 Fire

- .6 Type C-6: Pipe and tank insulation: Fibreglass segmented board bonded to laminated vapor retarder:
  - .1 Mineral fibre: to ASTM C1393 type II or type IIIA, Category 2.
  - .2 Jacket: ASJ or FSK type
  - .3 Maximum "k" factor: 0.26 BTU • IN/HR • FT<sup>2</sup> • °F (0.037 W/M • °C) or less
- .7 Manufacturers:
  - .1 All materials must be supplied by the same manufacturer.
  - .2 Acceptable Manufacturers:
    - .1 Johns Manville **(with proof of Asthma and allergy friendly certification)**
    - .2 Knauf
    - .3 Manson

## 2.4 JACKETS

- .1 Canvas:
  - .1 220 g/m<sup>2</sup> (6 oz/sq.yd.) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
  - .2 Lagging adhesive: Compatible with insulation.

## 2.5 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 g/m<sup>2</sup> (6oz/yd<sup>2</sup>) cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
- .5 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.
- .6 Contact adhesive: quick-setting Childers CP-82 or equal.
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm (16 gauge) stainless steel.
- .9 Facing: 25 mm (1") stainless steel hexagonal wire mesh stitched on one face of insulation
- .10 Fasteners: weld pins, length to suit insulation, with 40 mm (1½") diameter clips.

**Part 3 Execution**

**3.1 PRE-INSTALLATION REQUIREMENTS**

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

**3.2 INSTALLATION**

- .1 Install in accordance with North American Commercial and Industrial Insulation Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Supports, Hangers in accordance with general requirements.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .5 Fasteners: At 300 mm (12") oc. in horizontal and vertical directions, minimum two rows each side.
- .6 Provide rigid insulation for exposed ductwork.

**3.3 DUCTWORK INSULATION SCHEDULE**

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

Application	Type	Thickness
Rectangular supply air ducts	C-1	25 mm (1")
Round supply air ducts	C-2	25 mm (1")
Round supply/exhaust air ducts	C-6	25 mm (1")
requiring additional finish/jacket		
Supply, return, and fan exhaust ducts	None	
exposed (visible) in space being served		
Energy/heat recovery ventilator	C-1	25 mm (1")
Exhaust ducts		
Outdoor air intake ductwork and plenums	C-1	50 mm (2")
Exhaust plenums dampers and louvres	C-1	25 mm (1")
Interior acoustically lined ducts	None	
Last 1.5m of exhaust duct	C-1	25 mm (1")
Fire wrapped duct as indicated	C-3	To meet fire separation

- .2 Exposed round ducts 600 mm (24") and larger, smaller sizes where subject to abuse:
  - .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
  - .2 **C-6 insulation is also acceptable. Same thickness, schedule, and facing to be used as C-1 material.**



- .3 Finishes: Conform to following table:

Application	Rectangular	Round
Indoor, concealed	None	None
Indoor, exposed	Canvas	Canvas

### 3.4 FIRE BARRIER UTILITY SERVICE WRAP INSTALLATION

- .1 The Fire Barrier Utility Service Wrap and Fire Barrier Silicone Sealants must be stored in a dry warehouse environment. Pallets should not be stacked.
- .2 In order to install the utility service firestop system, the surfaces of all the openings and penetrating items need to be clean, dry, frost free and free of dust.
- .3 The Fire Barrier Utility Service Wrap blanket shall be wrapped around the perimeter of the duct and is cut to a length to overlap itself not less than 76 mm (3"). The overlap made by adjacent blankets shall form the "longitudinal" overlap. Aluminum foil tape is used to seal all cut edges of the blanket and any tears in the foil scrim.
- .4 Filament tape can be used to temporarily hold the blanket in place until the banding is applied. The steel banding is applied around the duct 38 mm (1 1/2") from each edge of the blanket, and maximum 26,7 cm (10-1/2") centers. The banding is placed around the material and tightened so as to sufficiently hold the Fire Barrier Utility Service Wrap in place against the duct, compressing the foil but not cutting the foil.
- .5 Additional pinning to prevent sagging of the wrap: For Ducts 60 cm (24") and larger in width, additional pins are needed to support the blanket on the bottom horizontal surface and on the outside face of a vertical duct run. Space pins a maximum of 26,7 cm (10-1/2") apart in the direction of the blanket width, and a maximum of 30 cm (12") apart in the direction of the blanket length.
- .6 Support hanger systems shall be external of the duct wrap.
- .7 Provide four galvanized steel threaded rods, ¼ " diameter 6,35 mm by (4-1/2"). to 5 in. long (114 mm to 127 mm) are welded to the duct at the corners of the door opening. Four steel tubes, each 3 in. (76 mm) long, are placed over the rods to act as protection for the Fire Barrier Utility Service Wrap when fastening the door. Four installation pins are welded to the door panel for installation of the blanket. One layer of Fire Barrier Utility Service Wrap shall be cut approximately the same size as the access panel and impaled over the insulation pins on the panel. It is essential that this layer fit tightly against the wrap surrounding the access door opening with no through openings. A second layer of Fire Barrier Utility Service Wrap shall be cut so as to overlap the first layer by a minimum of 1 in. (25,4 mm). The second layer is impaled over the pins and both layers are locked in place with galvanized speed clips. Pins that extend beyond the outer layer of Fire Barrier Utility Service Wrap shall be turned down to avoid sharp points on the door.
- .8 When the duct penetrates a fire rated wall, ceiling or floor, an approved firestop system must be constructed to manufactures recommendation.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch.
- .3 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .5 ANSI B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
- .6 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings.
- .7 ASTM A53/A53M, and A106, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded ERW and Seamless.
- .8 ASTM B32, Specification for Solder Metal.
- .9 ASTM B75M, Specification for Seamless Copper Tube [Metric].
- .10 CSA B149.1, Natural Gas and Propane Installation Code.
- .11 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings product data in accordance with general requirements.
- .2 Indicate on manufacturers catalogue literature.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 GAS SERVICE**

- .1 Arrange with the local utility to have the gas service provided from the street to the gas meter where indicated.
- .2 Fees and charges requested by the local utility to provide the gas service and meter.
- .3 Submit all plans as requested by the local utility.
- .4 Utility supplied gas meter shall be complete with pulse signal for connection to BAS system (co-ordinate pulse representation in m<sup>3</sup> of gas used on meter specifications.
- .5 Provide approved pulse gas meter in all locations where indicated on the drawings.

**2.2 PIPE**

- .1 Steel pipe: to ASTM A106, Schedule 40, seamless as follows:
  - .1 NPS 15 mm to 50 mm (1/2" to 2"), screwed.
  - .2 NPS 65 mm (2 1/2") and over, plain end.
- .2 Buried pipe: CGA approved polypropylene complete with tracer wire and marker.
- .3 Copper tube: to ASTM B75M.

**2.3 JOINTING MATERIAL**

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Soldered: to ASTM B32, tin antimony 95/5.
- .5 Screwed brass fittings: Teflon Tape.

**2.4 FITTINGS**

- .1 Steel pipe fittings, screwed, flanged or welded:
  - .1 Malleable iron: screwed, banded, Class 150.
  - .2 Steel pipe flanges and flanged fittings: to ANSI/ASME B16.5.
  - .3 Welding: butt-welding fittings.
  - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
  - .5 Bolts and nuts: to ANSI B18.2.1.
  - .6 Nipples: schedule 40, to ASTM A53/A53M/A106.
- .2 Copper pipe fittings, screwed, flanged or soldered:
  - .1 Cast copper fittings: to ANSI B16.18.
- .3 Brass fittings: To ASTM B16.

**2.5 BALL VALVES**

- .1 NPS 50 mm (2") and under:
  - .1 Body and cap: cast high tensile bronze to ASTM B62.
  - .2 Pressure rating: Class 125, 860 kPa (125 psi) steam, WP = 1.4 MPa (203 psi) WOG.
  - .3 Connections: Screwed ends to ANSI B1.20.1 and with hex. 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.

**2.6 LUBRICATED PLUG VALVES**

- .1 All sizes
  - .1 Provincial Code approved, lubricated plug type.
  - .2 Body: cast iron to ASTM A 126 Class B semi-steel.
    - .1 Rating: Class 125 psig.
  - .3 Plug: tapered, with regular pattern port – 90 from full open to fully closed.
  - .4 Ends: 50 mm (2") and smaller with hexagon shoulders, ends screwed to ANSI B1.20.1. Flanged to ANSI B16.1.
  - .5 Lubrication system, nickel-plated.
  - .6 Lubricant: to suit type, temperature and pressure of contained fluid.
  - .7 Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leakproof operation, and corrosion preventing film.
  - .8 Lubricant screw for lubrication.
  - .9 O-rings between body and plug.
  - .10 Operator: removable manual lever handle.
  - .11 Acceptable Manufacturers:
    - .1 Newman Hattersley
    - .2 Crane
    - .3 Jenkins
    - .4 Milwaukee
    - .5 Toya

**2.7 GAS REGULATOR**

- .1 Reduce pressure from 34.5 kPa (5 psi) to 1.74 kPa (7" WC) capacity as indicated.
  - .1 Acceptable Manufacturers:
    - .1 Singer
    - .2 Schlumberger
- .2 Vent interior relief valve to outdoors with gooseneck and stainless steel insect screen. Vent piping shall be sized as per manufacturers' requirements and recommendations.
- .3 Isolate with lubricated plug valve and union connection.

**2.8 MANUFACTURED ROOF SUPPORTS**

- .1 Single piece injection moulded polypropylene support.
- .2 Type 3-20 psi extruded polystyrene UV protected base glued to the support.
- .3 Minimum base dimension of 300 x 225 (12" x 9") and be 140 mm (5.5") high.
- .4 Pull test of 1.4 kN (315 lbs) using two #14-10 screws on pipe strap.
- .5 Acceptable Manufacturers:
  - .1 Quick Block
  - .2 Erico

**2.9 PIPING THROUGH ROOF**

- .1 Provide Thaler MEF-9 or equal gas piping flashing where pipe and/or relief vent penetrates roof.

**Part 3 Execution****3.1 PIPING**

- .1 Install in accordance with applicable Provincial/Territorial Codes.
- .2 Install in accordance with CAN/CSA B149.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .5 Slope piping down in direction of flow to low points.
- .6 Install drip points:
  - .1 At low points in piping system.
  - .2 At each connection to equipment.
- .7 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .8 Provide clearance for access and for maintenance.
- .9 Ream pipes, clean scale and dirt, inside and out.
- .10 Install piping to minimize pipe dismantling for equipment removal.
- .11 Install regulator vents to code. Terminate in open air with Gooseneck fitting complete with stainless steel screen.
- .12 Paint gas piping with two (2) coats yellow paint. Banding of gas will not be accepted.

**3.2 PIPING ON ROOF**

- .1 Support piping as follows or as per seismic requirements (1.8 m (6' - 0") O.C.) whichever is more stringent:
  - ≤ 40 mm (1½") 2.4 M (8' - 0") O.C.
  - ≥ 50 mm (2") 3.0 M (10' - 0") O.C.
- .2 Provide support at each elbow and fitting.
- .3 Provide support at each regular and/or isolating valve.
- .4 Provide support within 600 mm (24") of each piece of equipment.

**3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.
- .2 Install valves at branch take-offs to isolate each piece of equipment, and as indicated.
- .3 Provide lubricated plug type when gas line is exterior of building or 65 mm (2½") and larger.

- .4 Provide ball valve when gas line is interior of building and 50 mm (2") or smaller.

**3.4 FIELD QUALITY CONTROL**

- .1 Test system in accordance with CAN/CSA B149. Requirements of authorities having jurisdiction.
- .2 Provide copy of TSSA tag to the consultant.

**3.5 PURGING**

- .1 Purge after pressure test in accordance with CAN/CSA B149.

**3.6 GAS SERVICE**

- .1 Arrange with local gas distributor to install gas service and gas meter. Pay all fees and charges to provide the gas service and gas meter.
- .2 Install all the gas meters where indicated.

**3.7 GAS FIRED EQUIPMENT START-UP**

- .1 Start-up of all new and existing gas fired equipment shall be by this contractor to the requirements of the equipment manufacturer.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1      All codes, standards, etc. as referenced shall be the latest edition.
- .2      SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3      SMACNA HVAC Duct Leakage Test Manual.
- .4      ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .5      ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process. (Metric).
- .6      ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7      ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1      Submit shop drawings and product data in accordance with Section general requirements.
- .2      Indicate following:
  - .1      Sealants
  - .2      Tape
  - .3      Proprietary Joints
  - .4      Fittings

**1.3            CERTIFICATION OF RATINGS**

- .1      Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2           Products**

**2.1            DUCTWORK**

- .1      Galvanized Steel:
  - .1      Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.

## .2 Thickness:

Size Type	Class A Gauge	Class B Gauge	Class C Gauge
<b>Square and Rectangular</b>			
Up to 600 mm (24")	22	24	24
625 mm to 1000 mm (25" to 40")	20	22	24
1025 mm to 1800 mm (41" to 72")	18	20	22
1825 mm to 2400 mm (73" to 96")	16	18	20
2450 mm and over (97")	16	16	16
<b>Round and Oval</b>			
Up to 300 mm (12")	24	24	24
325 mm to 600 mm (13" to 24")	22	24	24
625 mm to 900 mm (25" to 36")	20	22	24
925 mm to 1200 mm (37" to 48")	18	20	22
1225 mm (49") and over	18	18	20
<b>Residential Suite Ductwork:</b>			
<b>Square and Rectangular</b>			
Up to 300 mm (12") *	26	26	26
<b>Round and Oval Snap Lock *</b>			
Up to 200mm (8") *	30	30	30

\*Following SMACNA for low pressure ductwork.

- .3 All ductwork between HVAC unit connections and 3.0 m (10'-0") downstream or to silencers shall be 1.4 mm (18 gauge).

## .2 Aluminum

- .1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.
- .2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA or as indicated.
- .3 Joints: to ASHRAE and SMACNA.
- .1 Acceptable Manufacturers:
- .1 Ductmate Canada Ltd.
- .4 Foil tape all transverse and longitudinal joints.

**2.2 DUCT CONSTRUCTION**

## .1 Round and oval:

- .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
- .2 Transverse joints up to 900 mm (36"): slip type with tape and sealants.
- .3 Transverse joints over 900 mm (36"): Ductmate or Exanno Nexus Duct System.



- .2 Square and rectangular:
  - .1 Ducts: to SMACNA.
  - .2 Transverse joints, longest side:  
up to and including 750 mm (30"): SMACNA proprietary duct joints.
- .3 Ducts with sides over 750 mm (30") to 1200 mm (48"), transverse duct joint system by Ductmate/25, Nexus, or WDCI (Lite) (SMACNA "E" or "G" Type connection). Weld all corners.
  - .1 Acceptable Manufacturers:
    - .1 Ductmate Canada Ltd.
    - .2 Nexus, Exanno Corp.
    - .3 WDCI
- .4 Ducts 1200 mm (48") and larger, Ductmate/35, Nexus, or WDCI (heavy) (SMACNA "J" Type connection). Weld all corners.
  - .1 Acceptable Manufacturers:
    - .1 Ductmate Canada Ltd.
    - .2 Nexus, Exanno Corp.
    - .3 WDCII.

## **2.3 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: standard radius and or short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
  - .2 Round:
    - .1 In exposed areas one-piece smooth radius, 1.5 times diameter.
    - .2 In concealed areas 3-piece adjustable, 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm (16"): with double thickness turning vanes.
  - .2 Over 400 mm (16"): with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with 45° entry on branch.
  - .2 Round main and branch: enter main duct at 45° with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Diffuser connection to main:
  - .1 90° round spin in collars with balancing damper and locking quadrant.
- .6 Transitions:
  - .1 Diverging: 20° maximum included angle.
  - .2 Converging: 30° maximum included angle.

- .7 Offsets:
  - .1 Full short radiused elbows.
- .8 Obstruction deflectors: maintain full cross-sectional area.

## 2.4 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa (" w.c.)	SMACNA Seal Class	Acceptable Leakage Classification (Rectangular)	Acceptable Leakage Classification (Round)
2500 (10")	A	4	2
1500 (6")	A	4	2
1000 (4")	A	4	2
750 (3")	A	8	4
500 (2")	B	16	8
250 (1")	B	16	8
125 (0.5")	C	16	8

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

## 2.5 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of -30°C (-22°F) to plus 93°C (199°F).
- .2 Flame-spread rating not more than 25.
- .3 Smoke developed classification not more than 50.
- .4 Acceptable Manufacturers:
  - .1 Duro Dyne S-2
  - .2 Foster

## 2.6 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm (2") wide.
  - .1 Acceptable Manufacturers:
    - .1 Duro Dyne FT-2

## 2.7 DUCT LEAKAGE

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

**2.8 FIRESTOPPING**

- .1 40 mm x 40 mm x 3 mm (1½" x 1½" x 16ga) retaining angles all around duct, on both sides of fire separation.
- .2 Firestopping material and installation must not distort duct.
- .3 All ductwork passing through partition walls shall be firestopped.

**2.9 HANGERS AND SUPPORTS**

- .1 Band hangers: use on round and oval ducts only up to 500 mm (20") diameter, of same material as duct but next sheet metal thickness heavier than duct.
- .2 DUCTMATE "Clutcher" cable hanging system may be utilized on round ductwork up to 450mm (18 inch) diameter in areas of exposed ceilings where lateral movement/loads on ductwork is not present (such as those caused by attached linear diffusers).
- .3 Trapeze hangers: ducts over 500 mm (20") diameter or longest side, to ASHRAE and SMACNA.
- .4 Hangers: galvanized steel angle with black steel rods to ASHRAE and SMACNA following table:

Duct Size mm (")	Angle Size mm (")	Rod Size mm (")
up to 750 (30)	25 x 25 x 3 (1 x 1 x 1/8)	6 (1/4)
>750 to 1050 (>30 to 42)	40 x 40 x 3 (1½ x 1½ x 1/8)	6 (1/4)
>1050 to 1500 (>42 to 60)	40 x 40 x 3 (1½ x 1½ x 1/8)	10 (3/8)
>1500 to 2100 (>60 x 84)	50 x 50 x 3 (2 x 2 x 1/8)	10 (3/8)
>2100 to 2400 (>84 x 96)	50 x 50 x 5 (2 x 2 x 1/8)	10 (3/8)
>2400 (96) and over	50 x 50 x 6 (2 x 2 x ¼)	10 (3/8)

- .5 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
    - .1 Acceptable Manufacturers:
      - .1 Myatt fig. 485
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
    - .1 Acceptable Manufacturers:
      - .1 Grinnell fig. 61 or 60
  - .3 For steel beams: manufactured beam clamps:
    - .1 Acceptable Manufacturers:
      - .1 Grinnell Fig. 60

**Part 3 Execution****3.1 GENERAL**

- .1 The following systems shall conform to these requirements:

System	Pressure	Class	Material
VAV Supply	+/-	A	Galvanized steel
General Exhaust	+	A	Galvanized Steel/Aluminum
Individual Exhaust	+	A	Galvanized Steel/Aluminum
Dryer Exhaust	+	A	Aluminum
Exhaust Plenum	+/-	A	Galvanized steel
HVAC Supply and Return	+/-	B	Galvanized steel
General Exhaust	-	B	Galvanized steel

- .2 Do work in accordance with ASHRAE and SMACNA.
- .3 Do not break continuity of insulation vapour barrier with hangers or rods.
- .4 Support risers in accordance with ASHRAE and SMACNA.
- .5 Install breakaway joints in ductwork on each side of fire separation.
- .6 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .7 Manufacture duct in lengths to accommodate installation of acoustic duct lining.

**3.2 HANGERS**

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

Duct Size	Spacing
mm (")	mm (")
to 1500 (60")	3000 (120")
over 1500 (60")	2500 (100")

- .4 Do not support ductwork over 250 mm x 250 mm (10" x 10") from roof deck.

**3.3 SEALING**

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

**3.4 LEAKAGE TESTS**

- .1 Co-ordinate leakage testing with TAB contractor **and commissioning agent**. TAB contractor will be responsible for all duct testing.
- .2 Duct to be tested in accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Leakage tests to be done in sections.
- .4 Trial leakage tests to be performed as instructed to demonstrate workmanship.

- .5 Install no additional ductwork until trial test has been passed.
- .6 Test section to be minimum of 15 m (50'-0") long with not less than 3 branch takeoffs and two 90° elbows. Maximum test length and area to be determined by BAS testing equipment. Allow for twelve (12) tests.
- .7 Complete test before insulation or concealment.
- .8 Provide all necessary end caps and fittings as required for the TAB contractor. Remove same after successful completion of duct test.
- .9 Pressure test ductwork to 1½ times operating pressure (minimum pressure 500 Pa (2" wc) all systems).

### **3.5 CLEANING**

- .1 Keep ducts clear from dust and debris
- .2 Keep duct liner clean from dust, debris, and moisture.
- .3 At completion of project vacuum ducts if dirt or dust is present.
- .4 Where new systems connect into existing systems the existing systems shall be cleaned and vacuumed prior to reconnection. **The extent of the cleaning shall be limited to the area immediately surrounding the new connection point.**
- .5 Ensure all systems are clean prior to start up.

### **3.6 INSTALLATION REQUIREMENTS**

- .1 All ductwork is to be protected from the weather and precipitation. The top and sides of all ductwork are to be completely covered with 6mil poly to the satisfaction of the consultant. Maintain protection of the ductwork until the building is made watertight and hollow cores drained. Tape all joints.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .4 ANSI/NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 CSA B228.1, Pipes, Ducts and Fittings for Residential Type Air Conditioning.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Flexible connections.
  - .2 Duct access doors.
  - .3 Turning vanes.
  - .4 Instrument test ports.

**1.3 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture in accordance with CSA B228.1.

**2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at -40°C (-40°F) to plus 90°C (194°F), density of 1.3 kg/m.

**2.3 ACCESS DOORS IN DUCTS**

- .1 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (24 gauge) thick complete with sheet metal angle frame and 25 mm (1") thick rigid glass fibre insulation.

- .2 Gaskets: neoprene
- .3 Hardware:
  - .1 Up to 300 mm (12"): 2 sash locks
  - .2 301 mm to 450 mm (13" to 18"): 4 sash locks Complete with safety chain.
  - .3 451 mm to 1000 mm (19" to 40"): piano hinge and minimum 2 sash locks.
  - .4 Doors over 1000 mm (40"): piano hinge and 2 handles operable from both sides.
  - .5 Hold open devices.
- .4 Acceptable Manufacturers:
  - .1 Nailor
  - .2 E. H. Price
  - .3 Titus

**2.4 TURNING VANES**

- .1 Factory or shop fabricated double thickness, to recommendations of SMACNA and as indicated.
- .2 Acceptable Manufacturers:
  - .1 Duro Dyne
  - .2 Ductmate

**2.5 INSTRUMENT TEST PORTS**

- .1 1.6 mm (16 gauge) thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm (1 1/8") minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.
- .5 Acceptable Manufacturers:
  - .1 Duro Dyne IP1 or IP2
  - .2 Duct mate

**2.6 PREFABRICATED ROOF CURB**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: 1.3 mm (18 gauge) galvanized steel with raised cant and wood nailer.
- .3 25 mm (1") insulation 3 lb density.
- .4 Acceptable Manufacturers:
  - .1 Greenheck GPR – 600 mm (24") high
  - .2 Penn

**2.7 SPIN-IN COLLAR**

- .1 Construction: galvanized straight or conical spin-in collar complete with spin-in bead and crimped collar connection.
- .2 Provide balancing damper where indicated.
- .3 Acceptable Manufacturers:
  - .1 Ecco Manufacturing
  - .2 Flex Master

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Flexible connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans. (Unless internally isolated)
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm (4").
  - .3 Minimum distance between metal parts when system in operation: 75 mm (3").
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on each side of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access doors:
  - .1 Size:
    - .1 600 mm x 600 mm (24" x 24") for person size entry.
    - .2 600 mm x 1000 mm (24" x 40") for servicing entry.
    - .3 300 mm x 300 mm (12" x 12") for viewing.
    - .4 As indicated.
  - .2 Location:
    - .1 At fire and smoke dampers.
    - .2 At control dampers.
    - .3 At devices requiring maintenance.
    - .4 At locations required by code.
    - .5 At inlet and outlet of reheat coils.
    - .6 Elsewhere as indicated.
    - .7 Inlet and outlet of duct mounted coils.



- .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 At ducted inlets to roof and wall exhausters.
      - .2 At inlets and outlets of other fan systems.
      - .3 At 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 Consultant.
      - .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.
  - .2 Install on supply ducts only.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements
- .2 Indicate the following: performance data.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SINGLE BLADE DAMPERS**

- .1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened, minimum 1.6 mm (16 gauge).
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm (4").
- .3 Shaft extension to accommodate insulation thickness and locking quadrant.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**2.3 MULTI-BLADED DAMPERS**

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height:
  - .1 50 mm (2") up to 375 mm (15") high duct.
  - .2 100 mm (4") max 400 mm (16") high duct and over.
- .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 **Shaft extension to accommodate insulation thickness and locking quadrants.**

.8 Acceptable Manufacturers:

- .1 Duro Dyne
- .2 E.H. Price
- .3 Nailor
- .4 T.A. Morrison
- .5 Tamco
- .6 Ruskin
- .7 Ventex/Alumavent
- .8 United Enertech

**2.4 LOCKING QUADRANTS**

- .1 6 mm (1/4") dial regulator with square bearing shaft.
  - .1 18 gauge oval frame, cadmium plated, clearly shows damper position.
  - .2 18 gauge formed handle for easy adjustment.
  - .3 Bolt and wing nut lock damper securely.
  - .4 Offset mounting holes avoid interference with damper movement and mechanical fastening to duct.
- .2 9 mm (3/8") and larger: clamp quadrant with square bearing shaft.
  - .1 Accommodates and securely locks square rod, bearing fitting and adaptor pins.
  - .2 Heavily ribbed 16 gauge steel frame, 3 mm (1/8") thick formed steel handle, cadmium-plated.
  - .3 By tightening nut, bearing is securely locked in handle, preventing slippage and rattle.
  - .4 Neoprene and steel washer assembly seals bearing opening to eliminate air-leakage.
  - .5 Screw holes for mechanically fastening to ductwork.
- .3 High pressure system locking quadrant:
  - .1 Airtight, rattle-proof regulator, designed for ZERO leakage at high pressure. Use for applications up to 500°F constant temperature.
  - .2 Handle design for easy recognition of damper position.
  - .3 Heavy-gauge, zinc-plated steel, 2 high temperature rubber seals and washers, end bearing support, and 2 end bearings. Pressure loss and damper rattle in ductwork has been a constant annoyance for as long as HVAC ductwork has been installed. Now, a truly air-tight, rattle-proof regulator is available. The SPEC-SEAL regulator utilizes a special high-temperature rubber seal to eliminate leakage and rattle even at many times the pressure found in high pressure.
  - .4 Soft, comfortable grip handle with a highly-visible, plastic cover which indicates the damper position.
  - .5 Handle to accommodate 9 mm (3/8") or 12 mm (1/2") to match damper shaft size, square and round bearing shafts.

- .4 Acceptable Manufacturers:
  - .1 Duro Dyne
  - .2 Ductmate
  - .3 Pottorff

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
  - .1 Single blade dampers up to 200 mm (8").
  - .2 Multi-blade dampers over 200 mm (8").
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Leave all dampers in open position for T.A.B.
- .7 Fasten locking quadrants to ductwork and shaft.
- .8 Place locking quadrants on standoffs where ductwork insulated.
- .9 Lock down quadrant arm in the open position.

**3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .3 CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies.
- .4 CAN/ULC-S112.1, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .5 ULC-S505, Fusible Links for Fire Protection Service.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Operators.
  - .3 Firestop flaps.
  - .4 Fusible links.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4 MAINTENANCE MATERIALS**

- .1 Provide the following:
  - .1 Six (6) fusible links of each type.

**1.5 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 FIRE DAMPERS (DYNAMIC)**

- .1 Multi blade or roll type, fire damper suitable for HVAC system velocities up to 2000 fpm (610 m/mm), dual direction air flow, max 4" wg pressure.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; guillotine type; sized to maintain full duct cross section.

- .4 Stainless closure spring to positively close damper upon fusible link release, for horizontal or vertical orientations.
- .5 Linkage concealed in frame.
- .6 40 mm x 40 mm x 3 mm (1½" x 1½" x 16ga) retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .7 Fire damper assemblies and type to meet requirements of provincial fire authority and authority having jurisdiction.
- .8 Acceptable Manufacturers:
  - .1 Ruskin
  - .2 Nailor
  - .3 E.H. Price
  - .4 T.A. Morrison
  - .5 Tamco
  - .6 Greenheck
  - .7 Ventex/Alumavent
  - .8 Pottorff

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Provide where indicated and at all fire rated partitions indicated, on architectural drawing.
- .2 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .3 Maintain integrity of fire separation.
- .4 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .5 Install access door adjacent to each damper.
- .6 Coordinate with installer of firestopping.
- .7 Static fire dampers: Only on transfer air ducts where ductwork is not connected to a fan/blower.
- .8 Dynamic fire dampers: In all duct work where air is moved by a fan/blower.

**3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.

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**FIRE DAMPERS**

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- .2      Warranty Duration:
  - .1      One (1) year warranty period applies.
- .3      Warranty Coverage:
  - .1      Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 CODES AND STANDARDS**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .3 CAN/ULC-S112, Standard Method of Fire Test of Fire Damper Assemblies.
- .4 CAN/ULC-S112.1, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .5 ULC-S505, Fusible Links for Fire Protection Service.
- .6 CAN/ULC-S524, Installation of Fire Alarm Systems
- .7 CAN/ULC-S1001.11, Integrated Systems Testing of Fire Protection and Life Safety Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements indicating the following:
  - .1 Damper type
  - .2 Operators
  - .3 Fusible links
  - .4 Smoke detectors
  - .5 Power requirements
  - .6 Size, orientation, construction

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4 MAINTENANCE MATERIALS**

- .1 Provide the following:
  - .1 Six (6) fusible links of each type.

**1.5 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.



**Part 2 Products****2.1 COMBINATION FIRE AND SMOKE DAMPERS**

- .1 Provide a complete system, consisting of the damper, damper actuator, smoke detector with duct sampling tube, sleeve and all other components necessary for a complete and operable system. **The assembly shall be factory assembled as a single unit.** Field assembly shall be permitted at contractor discretion provided all listings are maintained and the installation follows all manufacturer installation guidelines.
- .2 Damper
  - .1 Damper shall be ULC listed and labelled
  - .2 Both damper and damper actuator to be ULC listed and labelled.
  - .3 Normally closed smoke/seal: folding blade type. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units.
  - .4 Damper shall have Class I leakage rating.
  - .5 Suitable for horizontal or vertical installations.
  - .6 Damper Material: Damper material shall match ductwork it is installed in (i.e., stainless steel in laboratory). Refer to specification section 23 31 13 Metal Ducts.
- .3 Actuator/Link
  - .1 Actuator shall be ULC listed and labelled
  - .2 Motorized actuator: 2-position, spring return, normally open with power on. When power is interrupted damper shall close automatically. Upon return of power, damper shall automatically reset open. Actuators are to be located outside of airstream, unless otherwise specified or shown on drawings.
  - .3 Exterior visualization of damper position.
  - .4 Damper actuator end switches for monitoring damper position by the BAS.
  - .5 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.
  - .6 Fusible link, or electric re-settable link (ERL).
  - .7 Electric fire sensor capable of remote openable control is to be provided in place of fusible link where specifically indicated in project documents.
  - .8 Where ERL or electric fire sensor is used in place of fusible link, this device shall fail closed upon power failure.
  - .9 Actuator may be mounted in duct in areas of renovation work when ductwork is over 450mm (18") wide.
  - .10 Where the FSD is mounted immediately behind a sidewall grille the actuator shall be mounted inside the ductwork to avoid an additional access door beside the grille.
- .4 Factory sleeve.
  - .1 Type and style: matching application.
- .5 Operating Temperature: 0° Celsius to 99° Celsius ambient temperature rating for 300 fpm to 4000 fpm air velocity.

- .6 Smoke Detector:
  - .1 ULC approved photoelectric duct smoke detector;
  - .2 Operates from 300 to 3000 ft/min air velocity (fan systems), -4 to 158°F temperature, and 0 to 95% non-condensing humidity;
  - .3 Operates from 100 to 4000 ft/min air velocity, -4 to 158°F temperature and 0 – 95% non-condensing humidity (transfer ducts)
  - .4 Test/reset button with LED display;
  - .5 The detector housing shall be ULC listed specifically for use in air handling systems; capable of local testing via magnetic switch and test button; duct mounted smoke detector with sampling tube, housing
  - .6 The detector shall incorporate separate 2.0A 30VDC Alarm and Supervisory contacts. Alarm contacts shall be normally open (N.O.) in which closed contacts will indicate an alarm condition to the fire alarm panel. Supervisory contacts shall be normally closed (N.C.) in which open contacts will indicate a trouble condition to the fire alarm panel.
  - .7 Sensor may be mounted in duct in areas of renovation work when ductwork is over 450mm (18") wide.
  - .8 Where the FSD is mounted immediately behind a sidewall grille the smoke detector shall be mounted inside the ductwork to avoid an additional access door beside the grille.
- .7 Damper assembly to operate at 120V with single point power connection.
- .8 Large damper sizes can be provided in multiple sections. Field assembly is acceptable following manufacturer's installation guidelines.
- .9 Fire rating to match wall assembly i.e. 1 hour/1 ½ hour/2 hour/ 3 hour.
- .10 Size: as indicated on drawings.
- .11 Detectors and electrical components within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code).
- .12 Acceptable Manufacturers:
  - .1 E H Price
  - .2 NCA Ltd.
  - .3 Nailor Industries Inc.
  - .4 Ruskin
  - .5 Alumavent
  - .6 United Enertech
  - .7 Pottorff
  - .8 Safeair-Dowco (stainless steel)
  - .9 Pottorff

## 2.2 LOCATION OF SMOKE DETECTORS

- .1 Ontario Building Code Section 3.1.8.11 requires the smoke detector to be installed downstream of the damper.
- .2 Ship units to site to suit supply or return/exhaust configuration.

- .3 The contractor shall be responsible to cover all costs of a qualified Electrician/Fire Alarm Technician should field relocation of the damper components be required.

## **2.3 TRANSFER DUCTS**

- .1 In accordance with OBC 3.1.8.11, provide secondary smoke detector at all transfer ductwork. Smoke detector shall be installed on both sides of rated separation.
- .2 This contractor shall be responsible to cover all costs of a qualified Electrician/Fire alarm Technician to field supply, install, and wire the secondary detectors.
- .3 This contractor shall extend transfer ductwork and acoustic lining to facilitate proper installation and clearance requirements.

## **2.4 NUMBER OF AIR TYPE SMOKE DETECTORS**

- .1 Where air velocities are greater than 1.5 m/s (300 feet per second), one air duct type detector shall be installed for every 1.5 meters square (16 square feet) of cross-sectional duct area.
- .2 Where air velocities are less than 1.5 m/s (300 feet per second), one duct type smoke detector shall be installed for every 0.5 meters square (5.3 square feet) or cross-sectional duct area.

## **2.5 PRESSURE RELIEF DOORS**

- .1 Frames shall be Z-shape, 12 gage (2.8) galvanized steel.
- .2 Door shall be 12 gage (2.8) galvanized steel, hinged on one side.
- .3 Seal shall be around the door perimeter allowing no more than 7 cfm/ft<sup>2</sup> at 1.0 inch w.g..
- .4 Door shall include stainless steel springs to close door upon pressure relief and system shutdown.
- .5 All release mechanisms, springs and parts shall be completely out of airstream.
- .6 Pressure relief settings available from 2" (0.5 kPa) to 10" (2.49 kPa) increments of 1" w.g. (0.25 kPa). Supplier shall examine plans to provide appropriate pressure relief based on associated air handling system.
- .7 Pressure relief mechanism shall be factory calibrated in an AMCA Registered Laboratory.
- .8 Pressure Relief Doors shall be provided as indicated in the execution section.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide smoke dampers where indicated and at all duct penetrations through smoke barrier partitions indicated on architectural drawings.
- .2 Provide combination fire and smoke dampers where indicated and at all duct penetrations through fire rated smoke barrier partitions indicated on architectural drawings. To provide separated fire dampers and smoke dampers, obtain approval from the consultant for the alternate arrangement.

- .3 Provide pressure relief doors (both positive and negative as applicable) as follows:
  - .1 For all systems with a combination fire smoke or smoke damper in the duct main of the system when:
    - .1 The system operates at static pressure of 1.0 inches w.g. or higher; and
    - .2 More than 50% of the system airflow passes through the combination fire/smoke or smoke damper.
  - .2 Where/as indicated on the plans.
- .4 Install in accordance with ANSI/NFPA 90A, in accordance with conditions of ULC listing and manufacturer's recommendation.
- .5 Maintain integrity of smoke separation and fire rating.
- .6 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .7 Install access door adjacent to each damper and smoke detector.
- .8 Front grille access for through wall dampers that terminate in a grille is acceptable.
- .9 Provide proper firestopping and duct seal to fire barrier wall.
- .10 Confirm proper operation and test sheets.
- .11 Should contractor provide separated devices mount smoke detector downstream of damper and within 1.5 m (5 ft) of damper.
- .12 Ensure access doors/panels, fusible links, damper actuators and sensors are easily observed and accessible.

### **3.2 LOCATION OF SMOKE DETECTORS**

- .1 Ontario Building Code Section 3.1.8.11 requires the smoke detector to be installed downstream of the damper.
- .2 Ship units to site to suit supply or return/exhaust configuration.
- .3 The contractor shall be responsible to cover all costs of a qualified Electrician/Fire Alarm Technician should field relocation of the damper components be required.

### **3.3 TRANSFER DUCTS**

- .1 In accordance with OBC 3.1.8.11, provide secondary smoke detector at all transfer ductwork. Smoke detector shall be installed on both sides of rated separation.
- .2 This contractor shall be responsible to cover all costs of a qualified Electrician/Fire alarm Technician to field supply, install, and wire the secondary detectors.
- .3 This contractor shall extend transfer ductwork and acoustic lining to facilitate proper installation and clearance requirements.

**3.4 PROTECTION**

- .1 Contractor is to ensure all fire smoke dampers detectors are protected from dust, dirt, humidity, and water at all times during construction. This applies to detectors installed, stored on site or stored in storage containers. Contractor shall seal all open-ended ductwork on site at all times. Failure to properly protect dampers, ductwork and detectors will result in the Contractor cleaning all dampers and ductwork. Any detectors that are damaged or dirty shall be replaced at the contractor's expense.

**3.5 WIRING**

- .1 All fire alarm wiring shall be 1 hour rated and in conduit or as per electrical fire alarm wiring requirement.
- .2 When the building has a BAS contractor, the BAS contractor can be used to provide the 120V power wiring.

**3.6 CLEANING**

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

**3.7 INTEGRATED LIFE SAFETY SYSTEMS TESTING**

- .1 Prior to the building Integrated Life Safety Systems Testing the mechanical contractor shall commission/verify the operation of all installed smoke dampers.
- .2 Participate in the Integrated Life Safety Systems Testing to confirm proper operation of all operating smoke dampers and associated Life Safety Systems (i.e. fire alarm).
- .3 This contractor shall work with the Integrated Life Safety Contractor and reset all systems back into proper operation.
- .4 Include all costs associated with participation Integrated Life Safety System Testing in the tender value.

**3.8 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL**

- .1 This section applies to operating dampers not specified in Controls Section.

**1.2 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

**1.3 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Performance data.

**1.4 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.5 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

**Part 2 Products**

**2.1 MOTORIZED DAMPERS**

- .1 Opposed blade type.
- .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 Operator: Refer to BAS Section.
- .6 Performance:
  - .1 Leakage: in closed position to be less than 2% of rated air flow at 250 Pa (1" w.c.) differential across damper.
  - .2 Pressure drop: at full open position to be less than 10 Pa (0.04" w.c.) differential across damper.

- .7 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with R factor of 5.0.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0.
  - .3 Use on services to the exterior.
  - .4 Acceptable Manufacturers:
    - .1 Honeywell
    - .2 Johnson
    - .3 T. A. Morrison
    - .4 E.H. Price
    - .5 Tamco
    - .6 Ruskin
    - .7 Nailor
    - .8 Henderson Industrial
    - .9 Ventex/Alumavent
    - .10 Pottorff

**2.2 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted or counterweighted, as indicated.
- .2 Acceptable Manufacturers:
  - .1 T.A. Morrison
  - .2 Tamco Series 7000
  - .3 Ruskin
  - .4 Nailor
  - .5 E.H. Price
  - .6 Henderson Industrial
  - .7 Ventex/Alumavent
  - .8 Pottorff

**2.3 RELIEF DAMPERS**

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counterweights set to open at 100 Pa (0.4" w.c.) static pressure, (adjustable).
- .2 Acceptable Manufacturers:
  - .1 T. A. Morrison
  - .2 Henderson Industrial
  - .3 Ventex/Alumavent
  - .4 Pottorff

**Part 3 Execution**

**3.1 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 Duct Accessories Section.
- .5 Insulated dampers on all outside air intake and exhaust damper.
- .6 Non-insulated dampers on all interior motorized dampers not exposed to outside air.

**3.2 ELECTRICAL ROOM DAMPER OPERATION**

- .1 Outdoor air damper modulates open on increase of room temperature above 80°F.
- .2 When damper is fully open end switch start exhaust fan.
- .3 When temperature reaches below setpoint damper is closed and exhaust fan off.

**3.3 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
  - .2 Disk type dampers gasket: Ten (10) years warranty.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**



**Part 1            General**

**1.1            REFERENCES**

- .1    All codes, standards, etc. as referenced shall be the latest edition.
- .2    CAN/ULC-S110, Standard Methods of Test for Air Ducts.
- .3    UL 181, Factory Made Air Ducts and Air Connectors.
- .4    ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .5    ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .6    SMACNA HVAC Duct Construction Standards - Metal and Flexible.

**1.2            PRODUCT DATA**

- .1    Submit product data in accordance with general requirements.
- .2    Indicate the following:
  - .1    Thermal properties.
  - .2    Friction loss.
  - .3    Acoustical loss.
  - .4    Leakage.
  - .5    Fire rating.

**1.3            CERTIFICATION OF RATINGS**

- .1    Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2           Products**

**2.1           GENERAL**

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

**2.2           METALLIC – UNINSULATED**

- .1    Spiral wound flexible aluminum, Class 1 duct material.
- .2    Performance:
  - .1    Factory tested to 2.5 kPa (10" w.c.) without leakage.
  - .2    Maximum relative pressure drop coefficient: 3.
  - .3    Operating pressure: 300 mm (12").

.3 Acceptable Manufacturers:

- .1 Flexmaster T/L
- .2 Ductmate

**2.3 METALLIC –INSULATED**

- .1 Spiral wound flexible aluminum with factory applied, 25 mm (1") thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, Class 1 duct material.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa (10" w.c.) without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Operating pressure: 300 mm (12").
- .3 Acceptable Manufacturers:
  - .1 Flexmaster T/L – VT
  - .2 Ductmate

**Part 3 Execution**

**3.1 DUCT INSTALLATION**

- .1 Install in accordance with: SMACNA.
- .2 Maximum length of flexible duct: 1.8 m (6' 0").
- .3 Minimum length of acoustical ductwork; 1.5 m (5' 0") with minimum of 1 bend.
- .4 Provide support at centre of flexible duct with 25 mm (1") wide galvanized hanger.
- .5 **Insulated flexible ductwork in areas where ceilings are not utilized as return air plenums.**
- .6 **Uninsulated flexible ductwork in areas where ceilings are utilized as return air plenums.**

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .3 ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .4 ASTM C916 Standard Specification for Adhesive for Duct Thermal Insulation.
- .5 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .6 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .7 **ASTM C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.**
- .8 **CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.**

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.

**Part 2 Products**

**2.1 RECTANGULAR/SQUARE DUCT LINER**

- .1 General:
  - .1 Acoustical duct liner to be fibreglass duct liner meeting or exceeding requirements of ASTM C1071, Type I, Flexible or Type II, Rigid, and NFPA 90A/90B.
  - .2 Bonded with formaldehyde free bio-based binder
  - .3 Mat faced airstream surface
  - .4 Factory applied edge coating
  - .5 Shall not contain formaldehyde, PBDE's, asbestos, mercury, mercury compounds, lead, contain 50% or greater recycled glass content.
  - .6 Thermal conductivity, ASTM C177/C518/C1114 .24BTU (sf•hr•°F) @ 75°F mean temp).
  - .7 Noise Reduction Coefficient (NRC) 1.5 PCF 1" = .70, 1 ½ " = .80, 2" =.95  
ASTM C423, Type A mounting.
  - .8 Noise Reduction Coefficient (NRC) 2.0 PCF 1/2" = .50, 1" = .70, 1 ½ " = .85  
ASTM C423, Type A mounting
  - .9 Corrosiveness/corrosion, ASTM C665/C1617. Does not accelerate/pass.
  - .10 Mold and mildew growth/fungi resistance, ASTM C1338, ASTM G21/G22, UL2824. Pass/resistant to mold.
  - .11 Maximum service temperature, ASTM C411, 250°F (121°C).

- .12 Maximum rate air velocity, ASTM C1071, 6,000 ft./min. (30.5 m/sec.)
- .13 Water vapor sorption, ASTM C1104, less than 3%.
- .14 Surface burning characteristics, ASTM E84, UL 273, CAN/ULC S102, 20/50 flame spread/smoke development.
- .15 Acceptable Manufacturers:
  - .1 Knauf Atmosphere Duct Liner
  - .2 Manson
  - .3 Johns Manville
  - .4 Owen Corning
- .2 Rigid:
  - .1 Use on flat surfaces.
  - .2 25 mm (1") thick, to CGSB 51-GP-10M, fibrous glass rigid board duct liner.
  - .3 Density: 96 kg/m<sup>3</sup> (6 lb/ft<sup>3</sup>).

## **2.2 FLEXIBLE/ROUND ACOUSTIC DUCT LINER**

- .1 General:
  - .1 Acoustical duct liner to be fibreglass duct liner meeting or exceeding requirements of ASTM C1071, Type I, Flexible, and NFPA 90A/90B.
  - .2 Liner to have factor made, evenly spaced kerfs to allow material to conform to interior of round duct.
  - .3 Bonded with formaldehyde free bio-based binder
  - .4 Airstream Surface protected by acrylic coating.
  - .5 Factory applied edge coating
  - .6 Shall not contain formaldehyde, PBDE's, asbestos, mercury, mercury compounds, lead, contain 50% or greater recycled glass content.
  - .7 Thermal conductivity, ASTM C177/C518/C1114 0.23 BTU (sf•hr•°F) @ 75°F mean temp).
  - .8 Noise Reduction Coefficient (NRC) 1" = 0.75, 1 ½ " = 0.85, 2" = 0.95  
ASTM C423, Type A mounting.
  - .9 Mold and mildew growth/fungi resistance, ASTM C1338, ASTM G21/G22, UL2824. Pass/resistant to mold.
  - .10 Maximum service temperature, ASTM C411, 250°F (121°C).
  - .11 Maximum rate air velocity, ASTM C1071, 6,000 ft./min. (30.5 m/sec.)
  - .12 Water vapor sorption, ASTM C1104, less than 3%.
  - .13 Surface burning characteristics, ASTM E84, UL 273, CAN/ULC S102, 20/50 flame spread/smoke development.
  - .14 Acceptable Manufacturers:
    - .1 Johns Manville Spiracoustic
    - .2 Knauf
    - .3 Manson
    - .4 Owen Corning

- .2 Flexible:
  - .1 Use on round or oval surfaces only.
  - .2 25 mm (1") thick, to ASTM C1071, fibrous glass blanket duct liner.
  - .3 Density: 64 kg/m<sup>3</sup> (4.0 lb/ft<sup>3</sup>).

**2.3 ADHESIVE**

- .1 Meet requirements of ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -29°C (-20°F) to 93°C (200°F).
- .3 Acceptable Manufacturers:
  - .1 Duro Dyne 1A-22
  - .2 Ductmate

**2.4 FASTENERS**

- .1 Weld pins 2.0 mm (14 gauge) diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm (1¼") square.
- .2 Acceptable Manufacturers:
  - .1 Duro Dyne
  - .2 Ductmate

**2.5 JOINT TAPE**

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.
- .2 Acceptable Manufacturers:
  - .1 Duro Dyne FT2
  - .2 Ductmate

**2.6 SEALER**

- .1 Meet requirements of ANSI/NFPA 90A and ANSI/NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -68°C (-90°F) to 93°C (200°F).
- .3 Acceptable Manufacturers:
  - .1 Duro Dyne 1A-94
  - .2 Ductmate

**Part 3 Execution**

**3.1 GENERAL**

- .1 Do work in accordance with recommendations of MAIMA Fibrous Glass Duct Liner Standards (FGDLS) or SMACNA duct liner standards.
- .2 Line inside of ducts where indicated.

- .3 Duct dimensions, as indicated, are clear inside duct lining.
- .4 Provide an interior of ductwork from fans from minimum distance of 3 m (10'-0").

### **3.2 DUCT LINER**

- .1 Install in accordance with manufacturer's recommendations, and as follows:
  - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
  - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 300 mm (12") on centres.
- .2 Weld pins are to have cupped or beveled heads to prevent damage to lining surface.
- .3 Store foam liners away from sunlight.

### **3.3 JOINTS**

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

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 AMCA 99, Standards Handbook.
- .3 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamics Performance Rating.
- .4 AMCA 300, Revised 1987, Reverberant Room Method for Sound Testing of Fans.
- .5 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .6 ANSI/ASHRAE 51, Laboratory Methods of Testing Fans for Certified Aerodynamics Performance Rating.
- .7 ANSI/NFPA 96 – Ventilation Control and Fire Protection of Commercial Cooking Operations.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Product data to include fan curves and sound rating data.

**1.3            OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in general requirements.

**1.4            CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

**Part 2            Products**

**2.1            FANS GENERAL**

- .1 Capacity: Flow rate, total static pressure Pa, r/min, W (" w.c., r/min, bhp) model and size and sound ratings as indicated on schedule.
- .2 Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .3 Sound ratings: Comply with AMCA 301, tested to AMCA 300.
- .4 Performance ratings: Based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51.

- .5 Bearings: Sealed lifetime of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 80,000 100,000 h in accordance with AFBMA L10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.
- .6 Provide vibration isolation hangers/pads for all fans.
- .7 Electrical components and motors within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code) when connected to ductwork systems served by refrigerant containing air handling systems.
- .8 Provide factory mounted speed control for all direct drive motors.
- .9 Acceptable Manufacturers:
  - .1 Greenheck
  - .2 Penn-Barry
  - .3 Cook
  - .4 Jenco (S & P)/Jenn
  - .5 Carnes
  - .6 Acme
  - .7 Zonex
  - .8 Nutone (Range hood)
  - .9 Broan (Range hood)
  - .10 Twin-City
  - .11 Reversomatic
  - .12 Fantech
  - .13 Aerovent

## **2.2 WALL EXHAUSTERS**

- .1 Centrifugal backward inclined or Axial fan units, V belt or direct driven as indicated.
  - .1 Spun aluminum housings, complete with resilient mounted motor and fan.
  - .2 15 mm (1/2") mesh 2.0 mm (79 mil) diameter aluminum birdscreen.
  - .3 Automatic gasketted aluminum backdraft dampers.
  - .4 Disconnect switch within fan housing.
  - .5 Cadmium plated securing bolts and screws.
- .2 Eisenheiss coated wheel for fume service with motor out of air stream.
- .3 Housings:
  - .1 Provide with rubber or neoprene grommets for wiring passages, integral attachment collar, or angle ring mounted to mating flanged wall sleeve with full gasketting.
  - .2 Discharge pattern: Away from building.
- .4 Size, type, and capacity: As indicated.



**2.3 ROOF EXHAUSTERS**

- .1 Centrifugal V belt or direct driven as indicated.
  - .1 Housing: Spun aluminum complete with resilient mounted motor and fan.
  - .2 Impeller: Aluminum non-overloading.
  - .3 Adjustable motor sheave.
  - .4 15 mm (1/2") mesh 2.0 mm (79 mil) diameter aluminum birdscreen.
  - .5 Automatic gasketed aluminum backdraft dampers.
  - .6 Disconnect switch within fan housing.
  - .7 Continuous curb gaskets, cadmium plated securing bolts and screw, and sound insulating.
- .2 Roof curbs: of same manufacturer as fan and built to suit model specified. Roof curbs to be minimum 500 mm (20") high except where indicated otherwise. Roof curbs for NFPA 96 fans are to be vented.
- .3 Size, type, and capacity: As indicated.
- .4 Power feed shall be through roof curb.
- .5 To NFPA 96 requirements where indicated.

**2.4 CEILING DISCHARGE FANS**

- .1 Centrifugal direct drive, with plug in type electric motor suitable for ceiling installation, zinc coated rectangular metal housing.
- .2 Sizes and capacity: As indicated.
- .3 Toggle switch operated complete with integral electrical outlet box with plug-in type receptacle.
- .4 Side duct outlet with integral backdraft damper, size as indicated.
- .5 Wall cap complete with spring loaded backdraft damper with neoprene gasket.
- .6 Silver anodized aluminum grille paint finish.

**2.5 PROPELLER FANS**

- .1 Fabricate multibladed propellers of aluminum of airfoil shape within bell mouth entrance on integral mounts, with grease lubricated ball bearings, with extended lubrication fittings, suited for operating in any position, direct or [belt] driven, complete with motor as indicated.
- .2 Provide blade guards, bird screen and automatic back draft dampers on discharge or intake, with gasketed edges.
- .3 Provide insulated motorized dampers on fan greater than 140 l/s (300 cfm). Damper motors suitable for 120/1/60 with end switch to star/stop fans. Wired into fan motor.

.4 Acceptable Manufacturers:

- .1 Buffalo
- .2 Greenheck
- .3 Penn
- .4 Bailey
- .5 Carnes
- .6 Jenn
- .7 Penn Barry

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide flexible duct connection for all fans.
- .3 Provide backdraft damper at building exterior penetration.
- .4 Provide and install vibration isolation.
- .5 Provide and install roof curb for all roof mounted fans.
- .6 Provide and install sleepers for utility set style roof mounted fans; provide roof curb for duct penetration.

**3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Performance data.
  - .2 Noise data.
  - .3 Physical dimensions.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**1.4 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by an independent testing agency.

**Part 2 Products**

**2.1 VARIABLE AIR VOLUME BOXES**

- .1 Single duct, variable volume air distribution assemblies of the sizes and capacities as shown on the plans.
- .2 The assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume.
- .3 At an inlet velocity of 610 m/min (2,000 fpm), the differential static pressure for any unit with attenuator section, sizes 4 through 16, shall not exceed 25 Pa (0.10" w.c.).
- .4 Sound ratings of air distribution assemblies, shall not exceed 30 NC at 25 Pa (0.10" w.c.) static pressure.
- .5 Pressure shall be ARI Certified.
- .6 The air flow sensor shall be of a cross configuration located at the inlet of the assembly and shall have multiple pickup points, designed to average the flow across the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.
- .7 Provide a discharge air temperature sensor on discharge of VAV box. Temperature sensor shall be capable of display on BAS.

- .8 The assembly casing shall be constructed of 0.7 mm (22 gauge) zinc coated steel, internally lined with 20 mm (¾") thick, dual density fiberglass insulation, which complies with UL-181 and NFPA-90A. Any cut edges of fiberglass exposed to the air stream shall be coated with NFPA-90A approved sealant.
- .9 The primary air valve damper shall be heavy gauge metal, with peripheral gasket, pivoted in self-lubricating bearings. In the full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalogue rating at 750 Pa (3" w.c.) inlet static pressure, as rated by ARI Standard 880.
- .10 Provide 900 mm (36") long discharge sound attenuator for each unit.
- .11 Provide hot water reheat coil mounted in 0.7 mm (22 gauge) galvanized steel housing. Reheat coil to have copper tubes, aluminum fins with O.D. sweat connections, and quick opening cam lock access door. Refer to schedule for reheat coil requirements. Provide minimum 2 row coil.
- .12 **Electric reheat coils, if provided, shall accept a low voltage, digital, input signal from the associated HVAC unit's refrigeration detection system. On receipt of the signal the electric reheat coil will be de-energized. The shut off shall automatically reset upon stop of the signal.**
- .13 DDC controls including controller, flow transducer, electric actuator and protective shroud if required to be provided by controls manufacturer.
- .14 Electrical components and motors within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code) when connected to ductwork systems served by refrigerant containing air handling systems.
- .15 Terminal unit manufacturer shall factory mount controller and actuator including tubing from cross flow sensor to controls, wiring controller to motor and calibration.
- .16 Size and capacity: as indicated.
- .17 Acceptable Manufacturers:
  - .1 E.H. Price
  - .2 Nailor
  - .3 Titus
  - .4 Krueger
  - .5 Carnes
  - .6 Metalaire

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Install quick opening access door (with sash locks) adjacent to each damper.
- .4 Install controls as per manufacturer's requirements.

- .5 Install with at least 100 mm (4") of flexible inlet ducting.
- .6 Wire associated HVAC unit's refrigeration detection system alarm to all damper actuators and electric reheat coil input signal connection locations.

### **3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .1 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

**1.2 MAINTENANCE MATERIALS**

- .1 Include:
  - .1 Keys for volume control adjustment.
  - .2 Keys for air flow pattern adjustment.

**1.3 MANUFACTURED ITEMS**

- .1 Grilles, registers, and diffusers of same generic type to be product of one manufacturer.

**1.4 CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by them from independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
  - .1 Full perimeter gaskets.
  - .2 Plaster frames where set into plaster or gypsum board and as specified.
  - .3 Concealed fasteners.
- .3 Concealed operators.
- .4 Colour and Finish: standard as directed by Consultant.

.5 Acceptable Manufacturers:

- .1 E.H. Price
- .2 Nailor
- .3 Krueger
- .4 Titus
- .5 Carnes
- .6 Seiho
- .7 Metalaire
- .8 Tuttle and Bailey

**2.2 SUPPLY GRILLES AND REGISTERS**

- .1 General: with opposed blade dampers as indicated, concealed manual operator and gaskets.
- .2 Type, size, and capacity: as indicated.

**2.3 RETURN AND EXHAUST GRILLES**

- .1 General: with opposed blade dampers as indicated, concealed manual operator and gaskets.
- .2 Type, size, and capacity: as indicated.

**2.4 DIFFUSERS**

- .1 General: volume control dampers with flow straightening devices and blank-off quadrants, as indicated and gaskets.
- .2 Type, size, and capacity: as indicated.

**2.5 LINEAR BAR, WALL GRILLES**

- .1 Fixed 15° pattern, 15 mm (½") spacing, side wall mounted, narrow border, alignment pins concealed fastening.
- .2 Plaster frame, sealing strip and accessories.
- .3 Grilles to be continuous around entire bulkhead as indicated.
- .4 Model: E.H. Price LBMH-500F-26B.
- .5 Provide grilles for blank space for continuous wall installation.
- .6 Finish to approval of consultant.
- .7 Type, size, and capacity: as indicated.

**2.6 SPOT DIFFUSER**

- .1 The diffuser shall consist of a ball and socket arrangement and shall provide means for directional control of the supply air in both the horizontal and vertical planes up to a 75 degree total angle.

**Part 3                    Execution**

**3.1                        INSTALLATION**

- .1            Install in accordance with manufacturer's instructions.
- .2            Install with flat head screws in countersunk holes where fastenings are visible.
- .3            Bolt grilles, registers and diffusers, in place
- .4            Provide concealed safety chain on each grille, register and diffuser in gymnasium, similar game rooms, and on exposed diffusers, and elsewhere as indicated.
- .5            Clean grilles upon completion.
- .6            Paint ductwork beyond grilles, matte black where visible.
- .7            Ensure all grilles, diffusers, etc. match opening sizes as indicated on the drawings and as fabricated on site by the contractor.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM E90, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions, and Elements.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with general requirements.
- .2 Indicate the following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.
  - .4 Colour and finish.

**1.3 CERTIFICATION OF RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**1.4 TEST REPORTS**

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**Part 2 Products**

**2.1 FIXED LOUVRES – ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm (60").
- .4 Frame, head, sill and jamb: 100 mm (4") deep one piece extruded aluminum, minimum 3 mm (1/8") thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm (60") maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 15 mm (1/2") exhaust 20 mm (3/4") intake mesh, 2 mm (5/64") diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

- .8 Finish:
  - .1 Powder coated
  - .2 Colour: to Consultant's approval.
- .9 Acceptable Manufacturers:
  - .1 Greenheck
  - .2 Construction Specialties
  - .3 E.H. Price
  - .4 Krueger
  - .5 Ruskin
  - .6 Ventmaster
  - .7 Ventex
  - .8 Nailor

## **2.2 WALL BOXES**

- .1 0.3 mm (16 gauge) aluminum wall sleeve sized as noted on plans.
- .2 Extruded aluminum grille, 25 mm (1") perimeter flange with 4-hole screw fasten.
- .3 Bottom outlet with removable 15 mm x 15 mm (1/2") x (1/2") aluminum screen.
- .4 Neoprene backdraft damper with aluminum crimp on bottom edge.
- .5 Acceptable Manufacturers:
  - .1 Reversomatic
  - .2 Broan
  - .3 Ventex
  - .4 AirVent
  - .5 Shop fabricated (submit sample for approval).

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 In accordance with manufacturers and SMACNA recommendations.
- .2 Reinforce and brace air vents, intakes and goosenecks as indicated.
- .3 Anchor securely into opening.
- .4 Seal with caulking all around to ensure weather tightness.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 CAN/CSA B149.1 Natural Gas Installation Code.
- .3 ANSI Z83.8/CSA 2.6, Standard for Gas Unit Heaters, Gas Package Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, capacity and piping connections.
  - .2 Dimensions, internal and external construction details, recommended method of installation with proposed support, sizes and location of mounting bolt holes.

**1.3 MAINTENANCE**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.

**Part 2 Products**

**2.1 HORIZONTAL GAS FIRED UNIT HEATERS (PROPELLER FAN)**

- .1 Casing: 1.6 mm (16 gauge) thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .2 Heat Exchanger: Aluminized steel tubing, silver brazed to steel headers, evenly spaced.
- .3 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .5 Air outlet: two-way adjustable louvers, matching cabinet finish.
- .6 Aluminized steel burner complete with gas valve and limit controls.
- .7 Induced draft blower suitable for 120/1/60.
- .8 Factory installed vibration isolated power vent fan and motor, to draw combustion air through unit.
- .9 Capacity: as indicated, minimum 82% efficiency. Gravity vent models will not be accepted.
- .10 Control room thermostat: by building automation system.

- .11 Acceptable Manufacturers:
  - .1 Reznor UDAP Series
  - .2 Lennox
  - .3 Trane

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide flexible connection to gas valve.
- .3 Provide supplementary suspension steel as required.
- .4 Before acceptance, set discharge patterns and fan speeds to suit requirements.

**3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers.
- .3 AMCA Standard 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
- .4 ANSI/UL 1995, Heating and Cooling Equipment
- .5 CAN/CSA C22.2 No 236, Heating and Cooling Equipment
- .6 CAN/CSA 439 Laboratory methods of test for rating the performance of heat/energy-recovery ventilators

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general requirements.
- .2 Indicate following: performance.

**1.3 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in general requirements.

**1.4 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with general requirements.
- .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.

**1.5 MANUFACTURED ITEMS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

**Part 2 Products**

**2.1 GENERAL**

- .1 Comply with ASHRAE.
- .2 The energy recovery ventilator shall comply with OBC 6.2.1.6 minimum ERV efficiency and performance. This manufacturer shall provide testing details as part of shop drawing review. ERV to be certified to CSA-C439, including performance with a Station 1 test temperature of -25°C.

**2.2 AIR TO AIR FIXED PLATE, HEAT RECOVERY VENTILATORS (COMMERCIAL)**

- .1 General
  - .1 Packaged, energy recovery ventilator (s) (outdoor or indoor as shown in equipment schedule) consisting of a fixed plate air to air heat/energy recovery core, ventilation air fan, exhaust air fan, filters and necessary dampers, temperature sensors and microprocessor controls.
  - .2 The equipment must transfer both sensible and latent energy.
  - .3 The unit must be able to operate as a stand alone component, or as part of a larger HVAC system.
- .2 Quality Assurance
  - .1 The fixed plate heat/energy recovery core must be AHRI certified for the 1060 standard.
  - .2 The unit must be tested to ANSI/UL 1995 and CAN/CSA C22.2 No 236, Fourth Edition, October 14, 2011.
  - .3 The unit must be ETL certified.
  - .4 The unit must be fully tested before delivery.
- .3 Cabinet
  - .1 Double wall construction with 25 mm (1 inch) thick fibreglass insulation.
  - .2 Floor of the unit must be insulated with 25mm (1 inch) fiberglass and protected with 0.8mm (22 ga) galvanized steel sheet metal.
  - .3 Interior wall must be made of minimum 0.8 mm (22 gauge) thick galvanized steel with baked on enamel finish.
  - .4 Exterior wall must be made of minimum 0.8mm (22 gauge) prepainted steel. Paint must withstand minimum 150 rubs (back and forth) with methyl ethyl ketone when tested to ASTM D5402.
  - .5 Structural base to be 1.99 mm (14 ga) galvanized steel minimum.
  - .6 The cabinet must allow for access to all inside components from a single side.
  - .7 The cabinet shall be fully sealed and water tight.

- .4 Heat transfer surfaces:
  - .1 Fixed plate air to air type
  - .2 Acceptable materials as follows
    - .1 Polymeric Core
  - .3 The core must be removeable and easily cleaned. Core must be cleanable with water by hose down. **(Note to writer – only Polymeric cores are water washable, cellulose does not stand up to moisture)**
  - .4 Core must meet efficiencies required by AHRI 1060 and be certified by AHRI.
  - .5 Cross contamination: not permitted.
- .5 Blowers
  - .1 Fan ratings are based on tests made in accordance with AMCA Standard 210.
  - .2 Supply and exhaust blowers to be either double inlet forward curved or plenum type with direct drive to meet specified flow and external static conditions.
  - .3 Blowers must be selected to operate on a stable efficient part of the fan curve when delivering air quantities scheduled against the static of the system.
  - .4 Fan blades shall be statically and dynamically balanced and tested prior to shipment.
  - .5 Bearings shall be sealed and permanently lubricated.
  - .6 Fans shall be either belt drive or direct drive with a means of balancing to meet the specified flows.
  - .7 Fan shall be provided with internal vibration isolation mounts.
  - .8 Fan discharge shall be as noted on plans.
- .6 Motors
  - .1 Electrically Commutated
    - .1 The motor shall be a high efficiency EC motor with integrated electronics.
    - .2 The motor shall have an IP54 protection class and a 155 thermal class.
    - .3 The motor shall have an overtemperature protection through an active temperature management.
    - .4 The motor shall be capable of operating in a temperature range from -25C / -13F to 60C/140F.
    - .5 Motor shall have a means of speed control for system balancing.
- .7 Filters
  - .1 Each air circuit to have 2 inch thick, pleated and replaceable filters.
  - .2 Filters shall be installed in both the supply and exhaust air stream before the core.
  - .3 Filters to be MERV 8.

- .8 Electrical
  - .1 Single point power connection.
  - .2 Unit voltage as per schedule.
  - .3 Unit must be equipped with a non-fused disconnect.
  - .4 All controls shall be factory mounted and wired, requiring only field installation of remote sensing devices and wiring to unit mounted terminal strips.
  - .5 Unit shall have 24 VAC (30VA) for field installed sensing devices, etc.
- .9 Intake/Exhaust Dampers
  - .1 Extruded aluminium insulated and activated with an actuator. Dampers must be low leakage type. Controlled by unit.
- .10 Face and Bypass Damper, Free Cooling Enthalpy Control
  - .1 Provide face and bypass damper for air side economizer operation.
  - .2 Unit shall control free cooling operation based on internal enthalpy sensors.
- .11 Condensate drain: NPS 20 mm (3/4").
- .12 Controls
  - .1 Unit shall be provided with a factory mounted and factory wired microprocessor control for internal operation.
  - .2 All service connectors shall be quick disconnect type.
  - .3 Provide programmable wall controller.
    - .1 7 day, 24 hour programmable timer to control the start/stop of the unit.
    - .2 Programmable timer shall allow for:
      - .1 forced exhaust mode
      - .2 Fan low or high speed control
- .13 Accessories:
  - .1 Frost Protection
    - .1 Exhaust Only Defrost
      - .1 If outdoor air ambient drops below 5°F (-15°C) (adjustable at unit) the outdoor air damper closes, supply fan shuts off, and the exhaust air fan continues to run. Set point based on 40% relative humidity.
  - .2 Disconnect Switch
    - .1 Unit shall include fused or non-fused disconnect switch.
  - .3 Access Panels
    - .1 Unit shall have deluxe door access for filters and blower doors consisting of ¼ turn fasteners and polymide handles.
    - .2 Doors to have 180 degree opening range



.14 Performance characteristics: as indicated.

.15 Acceptable Manufacturers:

- .1 Aldes
- .2 Greenheck
- .3 Ruskin
- .4 Daikin
- .5 PennBarry

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Sections for access to coils and dampers.

**3.2 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 Five (5) year warranty on Polymeric core.
  - .2 One (1) year warranty on Cellulose with Polymeric coating core.
  - .3 One (1) year warranty on other components.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ANSI/ARI 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .3 ARI 270, Standard for Sound Rating of Outdoor Unitary Equipment.
- .4 CSA B52, Mechanical Refrigeration Code.
- .5 CSA C22.1, Canadian Electrical Code, Part 1.
- .6 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7 ANSI/UL 1995, Central Cooling Air Conditioning.
- .8 C.1 CSA B52-2023, Mechanical Refrigeration Code
- .9 C.2 CAN/CSA-C22.2 No 60335 Safety of Household and similar electrical appliances – Heat Pumps, Air-conditioners and dehumidifiers

**1.2            SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with general requirements.
- .2 Indicate:
  - .1 Equipment, and connections, together with control assemblies, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
  - .2 Piping, valves, fitting shipped loose showing final location in assembly.
  - .3 Control equipment shipped loose, showing final location in assembly.
  - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
  - .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
  - .6 Details of vibration isolation.
  - .7 Estimate of sound levels to be expected across each individual octave band in dB referred to A rating.
  - .8 Type of refrigerant used (A1 or A2L classification only).

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in general requirements.
- .2 Indicate:
  - .1 Brief description of unit, indexed, with details of function, operation, control, and service for each component.
- .3 Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance and service of items. Include names and addresses of spare part suppliers.
- .4 Include following:
  - .1 Provide for each unit, manufacturer's name, type, year, number of units, and capacity.

**Part 2 Products**

**2.1 STANDARD EFFICIENCY HVAC EQUIPMENT (15 TONS AND LESS)**

- .1 General:
  - .1 Roof mounted, self-contained single zone unit with gas burner and DX refrigeration and bear label of CSA, CGA, and ULC.
  - .2 Units to consist of cabinet and frame, supply fan, heat exchanger, burner control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized opposed blade outside air damper, return damper, gravity exhaust damper or power exhaust as indicated.
  - .3 Prefabricated roof curb complete with isolation rails (where indicated) to conform to requirements of National Roofing Contractors Association (NRCA), minimum height as indicated.
  - .4 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW (136 MBH) nominal.
  - .5 All units shall be of the same manufacture.
- .2 Cabinet:
  - .1 Cabinets: weatherproofing tested and certified to AGA and soundproofing tested to ARI 270.
  - .2 Framing and supports: 2 mm (14 gauge) thick welded steel, galvanized after manufacture, with lifting lugs.
  - .3 Outer casing: weathertight galvanized steel, bonderized with baked enamel finish, complete with flashing.
  - .4 Access: removable gasketted panels with screwdriver operated flush cam type fasteners.
  - .5 Insulation: neoprene coated glass fiber on all surfaces where conditioned air is handled, 1.6 mm (16 gauge) thick, 2.2 kg/m (1.5 lb/ft) density.

- .3 Fans:
  - .1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, isolated hinge mounted motor. Vibration isolators: 95% efficiency.
- .4 Air Filters:
  - .1 50 mm (2") thick, 30% efficiency, permanent metal framed, replaceable media standard to unit manufacturer.
  - .2 To meet ANSI/NFPA 90A, air filter requirements.
- .5 Heat Exchangers and Burners:
  - .1 Gas fired, multiple flue passes, with primary heating surface of stainless steel; secondary heating surface, stainless steel tubes.
  - .2 Gas burner: factory mounted, wired and fire tested complete with operating and safety controls.
    - .1 Forced type.
    - .2 Spark ignited pilot with pilot flame safety shut-off.
- .6 Refrigeration:
  - .1 Conform to CSA B52 and ANSI/UL 1995 requirements.
  - .2 Compressor/condenser section:
    - .1 Compressors:
      - .1 Unit shall use one fully hermetic, scroll compressor for each independent refrigerant circuit.
      - .2 Provide two (2) stages on units 7.5 tons and larger.
      - .3 Resiliently mount compressors on rubber mounts for vibration isolation.
      - .4 Compressor motors to be cooled by refrigerant gas passing through motor windings.
      - .5 Compressors shall be internally protected from high discharge temperature conditions.
      - .6 Compressors shall have internal current and temperature protection.
      - .7 Compressors shall be isolated from condenser and evaporator air streams.
      - .8 Crank case heaters shall be used on all models to protect compressors with specific refrigerant charges.
    - .2 Fans: propeller type with single piece spun venturi outlets and zinc plated guards. Motors shall be sequenced for head pressure control.
    - .3 Electrical system shall have operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.
    - .4 Include refrigerant piping with sight glass, filter, and valves.
    - .5 Condenser: staggered copper tube aluminum fin coil assembly with sub-cooling rows.

- .6 Capacity reduction: staged scroll compressor.
- .7 Refrigerant: A1 or A2L classified.
- .3 Evaporator:
  - .1 Rated to ANSI/ARI 210/240.
  - .2 Thermostatic expansion valve, with adjustable super heat and external equalizer.
  - .3 Coil: staggered seamless copper tubes expanded into aluminum fins, and insulated condensation pan.
  - .4 Cooling coil condensate drain pans: designed to avoid any standing water, to be easily cleaned or removable for cleaning. Drain connection to have deep seal trap and be complete with trap seal primer.
- .7 Unit Controls:
  - .1 In addition to combustion safety controls, provide low limit on supply.
  - .2 Zone cooling control:
    - .1 Room thermostat to activate cooling relay in control circuit cycling compressor. Provide safeties and pressure controls. Condenser fans to operate in sequence.
    - .2 When call for cooling is satisfied, relay is de-energized. On two compressor units provide separate circuits to evaporator and condenser and manual double pole double throw switch for lead-lag unit choice.
  - .3 Zone heating control:
    - .1 Room thermostat controls burner operation, to maintain room temperature setting.
  - .4 Mixed air control:
    - .1 Motorized outside, return and gravity relief dampers with spring return damper operator and control package to automatically vary outside air quantity. Outside air and exhaust air dampers, normally closed.
    - .2 Tight fitting opposed blade dampers with neoprene or suitable gaskets, synthetic bushings and 1% maximum leakage.
    - .3 Damper operation: 24 V, spring return motor with gear train sealed in oil.
    - .4 Mixed air controls: maintain 14°F (57°F) mixed air temperature, lock out compressor below 10°C (50°F) ambient, restart 15°C (59°F), revert dampers to provide 25% fresh air above 21°C (70°F) adjustable.
  - .5 **All control components shall utilize industry standard input/outputs. (i.e 0-10vDC). Proprietary voltages, communication languages etc. between components is not acceptable.**

**2.2 REFRIGERATION DETECTION SYSTEM**

- .1 The Refrigerant detection system shall meet the requirements of CSA B52 and have the following functionality:
  - .1 Utilize a set point, nonadjustable in the field, to generate a digital output signal to initiate mitigation actions to both internal safeties and external components in the ductwork (dampers, electric coils etc.). Signal shall be generated in not more than 30 seconds from sensor exposure to refrigerant concentration of 25% LFL (+0%, -1%)
  - .2 Sensor within the equipment, near potential source of leaks.
  - .3 Field calibration of the system is not allowed.
  - .4 Be capable of detecting the refrigerant used in the system.
  - .5 Have self diagnostics
  - .6 Energize fans upon failure of a self-diagnostic check
  - .7 Activate refrigerant safety shut off valves in the event of a leak being detected.

**2.3 CAPACITY**

- .1 As indicated.

**2.4 ACCESSORIES**

- .1 600 mm (24") high roof curb.
- .2 Leveling curb on sloped roof.
- .3 Vibration rail.
- .4 Opposed blade economizer dampers.
- .5 Condenser coil hail guard.
- .6 Power exhaust on units nominal 7.5 tons and larger (with field installed wiring).
- .7 Stainless steel vertical extension on flue gas discharge.
- .8 Stainless steel heat exchanger.
- .9 **Commission low speed fan setting to 57 Hz on two speed VFD systems.**

**2.5 ELECTRICAL REQUIREMENTS**

- .1 As indicated.
- .2 Field installed devices.
  - .1 Provide all field installed wiring required for all units that are equipped with power exhaust. Provide transformers as required.
- .3 Mount all accessories shipped loose onto the units.

**2.6 ACCEPTABLE MANUFACTURERS**

- .1 Carrier
- .2 Trane
- .3 Lennox
- .4 York

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer as indicated. Provide all necessary continuous wolmanized wood blocking to install roof curb level complete with 20 gauge liner to ensure combustible wood blocking is not exposed in the building.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.

**3.2 START-UP/COMMISSIONING**

- .1 Unit manufacturer shall perform start-up and commissioning.

**3.3 REFRIGERANT LEAK DETECTION SYSTEM**

- .1 This contractor shall provide all wiring between leak detection systems installed within the provided equipment and system components in the spaces served and ductwork system.
- .2 Specifically, the following shall occur for each independent system on registration of a refrigerant leak:
  - .1 Open all zone dampers in the affected system.
  - .2 Disable all electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves within the affected refrigeration system.
  - .4 Energize all fans within the affected ductwork system.
  - .5 Activate and refrigerant leak system specific ventilation systems.
  - .6 De-energize any other potential sources of ignition within the affected system.
- .3 All interlocks between field installed detection systems and associated safety system components shall be tested and verified to operate as per the requirements of CSA B52.

**3.4 TRAINING**

- .1 Provide 2 hours training to owner's staff on the care, maintenance, and operation of the equipment. Dedicated visit to site is required as it will not be paired with equipment startup.

**3.5 SPARE PARTS**

- .1 Two (2) complete sets of filters.
- .2 One (1) set of spare belts.

**3.6 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .1 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year on parts and labour on all components.
  - .2 Five (5) years on compressor.
  - .3 Ten (10) years on stainless steel heat exchanger.
  - .4 Manufacturer hereby warrants refrigeration compressors in accordance with GC 24, but for five (5) years.
  - .5 Manufacturer hereby warrants the gas heat sections for a minimum of ten (10) years.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 ASTM C553, Mineral Fiber Blanket, Thermal Insulation for Commercial and Industrial Applications.
- .3 EPS 1/RA/2, Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .4 C.1 CSA B52-2023, Mechanical Refrigeration Code.
- .5 C.2 CAN/CSA-C22.2 No 60335 Safety of Household and similar electrical appliances – Heat Pumps, Air-conditioners and dehumidifiers.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with general conditions.
- .2 Indicate major components and accessories including sound power levels of units.
- .3 Type of refrigerant used.

**1.3 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in general conditions.

**Part 2 Products**

**2.1 GENERAL**

- .1 System type:
  - .1 Air flow arrangement: horizontal
  - .2 Cooling: direct expansion
  - .3 Condensing: air cooled

**2.2 OUTDOOR CONDENSING UNITS**

- .1 General: Factory-assembled, single piece, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, refrigerant holding charge, and special features required prior to field start-up. Unit shall be rated in accordance with ARI Standard and be CSA approved.
- .2 Unit Cabinet:
  - .1 Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a prepainted baked enamel finish.
  - .2 A heavy gage roll-formed perimeter base rail with forklift slots and lifting holes shall be provided to facilitate rigging.

- .3 Fans:
  - .1 Condenser fans shall be direct driven, propeller-type, discharging air horizontally.
  - .2 Fan blades shall be balanced.
  - .3 Condenser fan discharge openings shall be equipped with PVC coated steel wire safety guards.
  - .4 Condenser fan and motor shaft shall be corrosion resistant.
- .4 Compressor:
  - .1 Compressor shall be mounted on vibration isolators.
  - .2 Compressors shall include overload protection.
- .5 Condenser Coil:
  - .1 Condenser coil shall be air-cooled and circuited for integral subcooler.
  - .2 Coil shall be constructed of aluminum fins (copper fins optional) mechanically bonded to internally grooved seamless copper tubes which are then cleaned, dehydrated, and sealed.
- .6 Controls and Safeties:
  - .1 Minimum control functions shall include:
    - .1 Control wire terminal blocks.
    - .2 Five-minute recycle protection to prevent compressor short-cycling.
    - .3 Compressor lockout on auto-reset safety until reset from thermostat.
  - .2 Minimum Safety devices which are equipped with automatic reset (after resetting first at thermostat), shall include:
    - .1 High discharge pressure cutout.
    - .2 Loss-of-charge cutout.
- .7 Electrical Requirements:
  - .1 Refer to schedule for voltage.
  - .2 Unit electrical power shall be single-point connection.
  - .3 Unit control circuit shall contain a 24-v transformer for unit control.
- .8 Capacity: Refer to schedule.
- .9 Provide the following:
  - .1 Hail Guard Package.
  - .2 Winter Start Package.
- .10 Acceptable Manufacturers:
  - .1 Carrier 38AK007
  - .2 Trane
  - .3 Lennox.

**2.3 WALL HUNG FAN COIL UNIT**

- .1 Indoor, direct-expansion, wall mounted fan coil, complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware.
- .2 Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- .3 Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided.
- .4 Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
- .5 Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
- .6 Controls shall consist of a microprocessor based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 18°C to 29°C (64°F to 84°F). The unit shall have the following functions:
  - .1 An automatic restart after power failure at the same operating conditions as at failure.
  - .2 A timer function to provide a minimum 24-hour timer cycle for system Auto. Start/Stop.
  - .3 Temperature-sensing controls shall sense return-air temperature. Indoor-air high discharge temperature shutdown shall be provided.
  - .4 Indoor coil freeze protection.
  - .5 Wall mounted thermostat to enter set points and operating conditions.
  - .6 Auto Stop features shall have integral setback control.
  - .7 Automatic airsweep control to provide on or off activation of airsweep louvers.
  - .8 Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
  - .9 Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during all operating modes.
  - .10 A time delay shall prevent compressor restart in less than three minutes.
- .7 Filter track with factory-supplied cleanable filters.

- .8 Capacity:
  - .1 Refer to schedule.
- .9 Acceptable Manufacturers:
  - .1 Carrier
  - .2 Trane
  - .3 Lennox

## **2.4 REFRIGERANT**

- .1 Refrigerant shall be A1.
- .2 Refrigerant holding charge shall be applied at factory.
- .3 Refrigeration circuit components shall include liquid line service valve, suction line service valve, liquid filter drier, a full charge of compressor oil, a holding charge of refrigerant and leak mitigation solenoid valves.
- .4 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. (split face coils are not acceptable). Provision for use of thermal expansion valves must be included for variable air volume applications.
- .5 Provide refrigerant leak detectors for installation in served space. Detector shall close refrigeration leak safety valve to limit charge released into space/atmosphere.
- .6 The Refrigerant detection system shall meet the requirements of CSA B52 and have the following functionality:
  - .1 Utilize a set point, nonadjustable in the field, to generate a digital output signal to initiate mitigation actions to both internal safeties and external components in the ductwork (dampers, electric coils etc.). Signal shall be generated in not more than 30 seconds from sensor exposure to refrigerant concentration of 25% LFL (+0\$, -1%)
  - .2 Field calibration of the system is not allowed.
  - .3 Be capable of detecting the refrigerant used in the system.
  - .4 Have self diagnostics
  - .5 Energize circulation fans in the event of a leak detection or failed self-diagnostics.
  - .6 Have a digital output signal for monitoring by other systems
  - .7 Activate refrigerant safety shut off valves in the event of a leak being detected.

**Part 3 Execution**

**3.1 GENERAL**

- .1 Install as indicated, to manufacturers' recommendations.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.
- .4 Provide concrete pad complete with 100 mm x 100 mm x 20 mm (4" x 4" x 3/4") neoprene type vibration isolation.

**3.2 EQUIPMENT**

- .1 Preparation and Start-Up
  - .1 Provide services of manufacturer's authorized factory trained mechanic to set and adjust equipment for operation as specified.
  - .2 Provide results in operation and maintenance manuals

**3.3 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
  - .2 Contractor hereby warrants refrigeration compressors for five (5) years.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General****1.1 GENERAL NOTES**

- .1 This section is to be read in conjunction with Division 1, the General Conditions, the General Requirements of the Mechanical Trades, the remainder of the Division 25 specifications and the documents required by the BIDDING REQUIREMENTS and CONDITION OF THE CONTRACT SECTIONS.

**1.2 BACNET INTEGRATION AND CONTROL POINTS**

- .1 The BAS contractor is responsible to provide a full and operable system that meets all required specifications and sequences.
- .2 The BAS contractor shall provide hard wired control points, sensors and all other components of the system as required to either supplement available BACNet points, or in the absence of a BACNet card make the system completely operable.
- .3 Sequences of operation may or may not be achievable through BACNet integration, as not all points required may be available from the unit manufacturer.
- .4 Not all equipment in the project has been specified with BACNet cards. The BAS contractor is responsible to review the entirety of the mechanical specification to confirm which equipment is being specified with BACNet integration cards and which equipment will not be provided with BACNet integration.

**1.3 RELATED SECTIONS**

- .1 This contractor shall review work specified elsewhere in the mechanical specifications to confirm integration methodology:
  - .1 Sections Plumbing and Drainage
  - .2 Sections Ventilation and Air Conditioning
  - .3 Sections Testing and Balancing
  - .4 Sections Integrated Automation Systems
  - .5 Division 26 Electrical

**1.4 PRODUCTS FURNISHED BUT NOT INSTALLED BY BAS CONTRACTOR**

- .1 Ductwork Accessories:
  - .1 Automatic Dampers (All actuators supplied by BAS contractor)
  - .2 Airflow Stations

**1.5 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THE BAS CONTRACTOR**

- .1 Rooftop Air-Handling Equipment:
  - .1 Discharge Air Temperature Control.
  - .2 Economizer Control.
  - .3 Volume Control.

- .2 VAV Terminal Units:
  - .1 Cross-Flow Velocity Sensor.
  - .2 Damper Control.

## 1.6 WORK INCLUDED

- .1 Provide all labour, materials, products, equipment and services to supply, install and commission the Building Management System, utilizing Direct Digital Control (DDC) and monitoring system with electronic actuation.
- .2 Provide all computer hardware and software, operator input/output communication devices, communication units, communication interface to digital system controllers, field sensors and controls as required to meet the specified performance.
- .3 Provide all labour, materials, products, equipment and services to supply, install and commission the electronic control and monitoring system to interface with the Owner's Operations Centre under Terminal Service Option communication protocol.
- .4 Provide all calibration, commissioning, software programming and data base generation of colour graphics and additional work necessary to provide a complete and fully operating system.
- .5 Provide all control wiring in accordance with Electrical Division as necessary to provide a complete and fully operating system as specified in this Section of the Specification.
- .6 120 Volt Wiring
  - .1 BAS contractor is responsible to provide and install all 120 volt wiring required for the BAS system from designated junction boxes above electrical panels that have had breakers assigned to "BAS Power." BAS contractor shall review electrical drawings prior to tender.  
**Any additional breakers or power requirements shall be provided and installed by the electrical contractor at the BAS contractors cost to ensure warranty of the panels.**
  - .2 All wiring shall be to the standards of Division 26.
- .7 Obtain Ontario Hydro Permits for work specified in this Section of the Specification and submit final certificates in manual.
- .8 Surge transient protection shall be incorporated in design of system to protect electrical components.
- .9 Testing, debugging, confirmation of total system operation and owner training on the complete operation of the system and the computer software shall also be provided in this section.

## 1.7 QUALITY ASSURANCE

- .1 Materials and equipment shall be the catalogue products of a single manufacturer regularly engaged in production and Installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

- .2 Install system using competent workmen who are fully trained in the installation of temperature control equipment. Single source responsibility of the supplier shall be the complete installation and proper operation of the DDC control system and BAS shall include debugging and proper calibration of each component in the entire system.

## 1.8 SHOP DRAWINGS

- .1 Product Data and Shop Drawings: meet requirements of general conditions on Shop Drawings, Product Data, and Samples. In addition, Contractor shall provide shop drawings or other submittals on all hardware, and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
- .2 Submittals shall be provided within 2 weeks of contract award. Submittals shall include:
  - .1 Direct Digital Control System Hardware:
    - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
    - .2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
      - .1 Direct Digital Controller (controller panels)
      - .2 Transducers/Transmitters
      - .3 Sensors (including accuracy data)
      - .4 Actuators
      - .5 Valves
      - .6 Relays/Switches
      - .7 Control Panels
      - .8 Power Supply
      - .9 Batteries
      - .10 Operator Interface Equipment
      - .11 Wiring
    - .3 Wiring diagrams and layouts for each control panel. Show all termination numbers.
    - .4 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
  - .2 Central System Hardware and Software:
    - .1 A complete bill of material of equipment used, indicating quantity, manufacturer, model number, and other relevant technical data.
    - .2 Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions for the items listed below and other relevant items not listed below:
      - .1 Central Processing Unit
      - .2 Power Supply



- .3 Battery Backup
- .4 Interface Equipment Between CPU and Control Panels
- .5 Operating System Software
- .6 Operator Interface Software
- .7 Color Graphic Software
- .8 Third-Party Software
- .9 Software License
- .3 Schematic diagrams for all control, communication, and power wiring.
- .4 Riser diagrams of wiring between central control unit and all control panels.
- .5 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
- .3 Controlled Systems:
  - .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
  - .2 A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. All terminals shall be labeled.
  - .3 An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
  - .4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
  - .5 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
  - .6 A list of trended points and alarms.
- .4 Provide a riser diagram showing the physical location of building control system equipment and the system architecture. DDC controller trunk conductors shall also be shown on a floor plan.
- .5 Testing and commissioning plan.
- .6 Provide 24 VAC power layout and load calculation for each transformer.

## 1.9

### REFERENCE STANDARDS

- .1 Provide electrical material and installation in accordance with the appropriate sections of the current edition of the applicable local codes for signaling systems. Install wiring in conduit or approved totally enclosed raceways. Do not use cable raceways or troughs.

- .2 Provide materials and equipment, which are standard components regularly manufactured and guaranteed to be available as regular inventory as replacement parts.
- .3 Provide electrical and electronic equipment which is CSA or Ontario Hydro approved where such approvals are required by the regulatory authorities.
- .4 Provide ASCII American Standard for Communication and Information Interchange code input/output devices with standard EIA Electronic Industry Association interface.

#### **1.10 DOCUMENTATION – GENERAL**

- .1 Provide documentation for the BAS before the commencement of acceptance testing.
- .2 Provide two (2) sets of operator and programmer manuals to serve the diverse needs of personnel concerned with the operation, and maintenance of the facility.
- .3 Provide prior to project completion three (3) sets of maintenance documentation of a standard, which would enable the Owner to undertake planned maintenance, repair, calibration and other adjustments as may be necessary from time to time, on any component provided under this Contract without additional documentation being required and without assistance from others.

#### **1.11 AS BUILT DRAWINGS AND INFORMATION**

- .1 Upon completion of the work, the BMS Contractor shall submit three (3) copies of all Operating and Maintenance Manuals for equipment and materials supplied, and one set of "As-Built" plans showing reasonably exact routes of all cabling, specifications marked "As-Built", plans and specifications marked "As-Built".
- .2 Provide a manual divided into 3 sections describing the following functions:
  - .1 System Hardware Specification Manual, which provides a functional description of all hardware component installation/configuration with detailed instructions.
  - .2 System Operator's Manual, which provides concise instructions for operation of each system an explanation recovery route for all system alarms.
  - .3 System Data Manual, which provides the applications data, programmed into the system including a list of virtual points and a print out of the programs and point labels.
  - .4 A complete English language description of each control program for each system shall be provided. Clearly identify the function of each point reference used in the program for each system and/or equipment.
  - .5 Calibrate these points and establish units, limits and alarms;
  - .6 Incorporate these points in screen displays and reports;
  - .7 Incorporate these points in software sequences and control loops.
  - .8 Incorporate these points dynamically in graphic displays.
  - .9 Modify designation of control and virtual points.
- .3 A description of all maintenance procedures for each system's components, including inspection, periodic preventive maintenance, fault diagnosis and repair or replacement of defective module shall be provided. This shall include calibration, maintenance and repair of sensors, transmitters, transducers and panels plus diagnostics and repair or replacement of all system hardware.

- .4 Control damper schedules with construction details and dimensions. Identify dampers in accordance with specification and drawings. Dampers shall be identified as parallel or opposed blade, c/w frame style and actuator position.
- .5 Valve schedules with construction details calculated, CVs, selected valve CV pressure drops and flows.
- .6 Specifications and data sheets for all control system components including relays, switches, thermostats, controllers, dampers, indicators, flow switches, sensors and similar components.
- .7 Two (2) copies of all software programs for controlled systems on disk
- .8 Revised points list, panel schedule and sequences of operations and all other information submitted with the original shop drawings, reflecting the "as built" condition.
- .1 The point list shall consist of the following information:

PHYSICAL POINT IDENTIFIER ON THE DDC	SIGNAL TYPE
POINT TYPE ( AI, AO, BI, BO)	TREND / TANTALIZATION
POINT NAME	ALARM
POINT DESCRIPTOR	CALIBRATED
PERIPHERAL DEVICE PART NUMBER	COMMISSIONED
WIRE NUMBER	
COMMENT	

- .2 The as-built drawings shall consist of a single page showing the system architecture with BACnet ( MSTP & I/P )network numbers, instance and MAC address.

#### 1.12 Units

- .1 All equipment and instrumentation shall be graduated in System International (SI) units.

#### 1.13 OWNERSHIP OF PROPRIETARY MATERIALS

- .1 All project developed software and documentation shall become property of the owner. These include, but are not limited to:
  - .1 Project graphic images
  - .2 As-built drawings
  - .3 Project database
  - .4 Project specific application programming code
  - .5 All documentation

**Part 2 Products****2.1 ACCEPTABLE MANUFACTURERS (WRTIER TO EDIT)**

- .1 The following are the approved Control System Contractors and Manufacturers

Company Name	Manufacturer (Niagara Based)	Location	Contact
Energy Controls	Distech	Kitchener	Terry McCaskie
Accu-temp Heating and Cooling	Honeywell	Kitchener	Alex Voll
HTS	Alerton	Mississauga	Steve Davis
Convergint	Schneider	Toronto	Steve Chadwick
Viridian	Delta	Oakville	Jeff Volkers

- .2 Notes

- .1 The contractor shall use only products from the corresponding manufacturer and product line listed.
- .2 The above list of manufacturers applies to operator workstation software, controller software, the custom application program language and controllers.
- .3 All other products specified in the Building Automation specifications need not be manufactured by the above manufacturers (i.e. sensors, valves, dampers and actuators)

**2.2 DESCRIPTION OF SYSTEM**

- .1 The BAS shall include control of the following systems as detailed in this Section of the Specification under Sequence of Operation:
- .1 FAN PLANT
- .1 HVAC Equipment (RTUs and Fans).
- .2 FLOOR LEVEL CONTROL
- .1 VAV Terminal.
- .2 VVT Dampers and Bypass.
- .3 Dx Split Systems.
- .4 Supply, Return and Exhaust Fans.
- .5 Reheat Electric Heaters.
- .6 Misc. Mechanical and Electrical Room Temperature Control.
- .3 OUTDOOR LIGHTING
- .2 Refer to sequences of operation section for full description of systems.

**2.3 LICENSE**

- .1 The system shall be licensed to the owner.
- .2 Provide license for minimum of three years.

**2.4 GENERAL SYSTEM REQUIREMENTS**

- .1 All applications programs shall be pre-engineered and pre-tested.
  - .1 All the controllers used on the project must use the same programming language, and programs developed for one model of controller must be cross platform transferable to any other model of controller that has sufficient RAM and suitable input/output points.
- .2 Temperature control system shall be completely microprocessor based Direct Digital Control (DDC) electrically and /or electronically operated except where otherwise stated. System shall be installed by competent mechanics and electricians regularly employed by the BMS Company. Energy management system shall be an integral part of BMS.
- .3 In event of power or system failure, equipment shall fail safe, and heating valves open, dampers closed, cooling off. Provide spring return feature on all valves to ensure this condition. (Exception: valve and damper actuators on radiation, reheat valves, etc.) Floating point valves shall not be accepted. Wax valves shall not be acceptable
- .4 All system hardware and associated equipment shall be standard OEM items regularly manufactured for this and/or other systems and not custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use. All electronic circuits shall be self-diagnostic.
- .5 Design scope documents establish minimum acceptable system and component capability. They are not all inclusive. All additional construction, equipment, interfaces and software required for a complete and operating systems providing the specified functions are required.
- .6 The fire/life safety system (F/LS) shall have priority with respect to control of equipment that is subject to control by both the F/LS and BMS. The BMS Contractor shall coordinate installation of the BMS to ensure that interfacing and connection of BMS to such equipment and H-O-A switches shall not pass or interfere with F/LS operation under either normal mode or failure mode operation of the BMS.
- .7 Freeze stats and other safety controls shall have priority with respect to control of equipment that is also controlled by the BMS. Contractor shall co-ordinate installation of the BMS to ensure that interfacing and connections of the BMS and H-O-A switches to such equipment shall not by-pass or interfere with freeze stats or other safety controls.

- .8 System shall be fully modular, permitting point expansion by adding computer memory, remote terminal units, or applications software without obsolescence of existing communication or processing equipment.
  - .1 Provide licences for the software packages normally used by the BMS contractor to create, modify and add programming and graphics to the system. The software shall enable owner to add points to system and to program complex routines. Owner shall be able to add and modify all point information. Owner accessible software shall include:
    - .1 Direct Digital Control Library.
    - .2 Report Generation Library.
    - .3 Energy Management Library.
    - .4 Graphics Library.
    - .5 Programming Tool.
    - .6 Engineering Graphics Tool.
  - .2 Once programmed, the results may be used to start/stop points, and readjust set points, sequence equipment, report abnormal conditions, etc.
- .9 Set points and values given are for initial set-up only. All points shall be adjustable from the operator workstation.
- .10 All electrical and electronic components shall be CSA; ULC, UL or Ontario Hydro approved where such approvals are required by the regulatory authorities.
- .11 Failure of any Direct Digital Controller Unit (DDC) or its communication link in the system shall not affect the proper operation of the operator workstation or any other Direct Digital Controllers.
- .12 If the Host Computer (CPU) or transmission network fails but power to the DDC does not, the DDC shall continue to monitor all changes of state and/or values and shall retain the most recent values. The DDC shall also maintain all analog set points and command positions.
- .13 Components shall not require any customizing other than setting of jumpers and switches, adding of firmware modules or software modules or any software programming to perform required functions. System shall be a true distributed processing system without any form of network management device used. All software control functions shall be performed by intelligent field panels and by intelligent unit controllers as appropriate.

## 2.5 GENERAL MATERIALS REQUIREMENTS

- .1 The CPU and peripheral equipment shall operate in the following conditions:
  - .1 Temperature 15 C to 27 C
  - .2 Humidity 20% to 80% (non condensing)
  - .3 Power 120 VAC +/-10%
  - .4 Frequency 60HZ +/-3HZ
  - .5 Power factor 0.6 to 1.0

- .2 Local field panels and peripheral equipment shall be rated to operate in following conditions:
  - .1 Temperature 0° C to 50° C
  - .2 Humidity 10% to 90% RH (non condensing)
  - .3 Power 120 VAC + 10% on primary side of control transformers and plus or minus 25% of nominal voltage on the secondary side.
  - .4 Frequency 60 Hz + 3 Hz
  - .5 Power Factor 0.6 to 1
- .3 Controls shall be D.D.C. solid state type as noted elsewhere, and with exception of actuators, contain no moving parts.
- .4 Sensor accuracy shall be within 0.6% of maximum range, maximum  $\pm 0.25^{\circ}\text{C}$ . Mixed air sensors must give a true average across duct cross section.

## 2.6 GENERAL SYSTEM PERFORMANCE REQUIREMENTS

- .1 Comply with the following performance requirements:
  - .1 Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
  - .2 Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 5 seconds.
  - .3 Object Command: Reaction time of less than 5 seconds between operator command of a binary object and device reaction.
  - .4 Object Scan: Transmit change of state and change of analogue values to control units or workstation within 5 seconds.
  - .5 Alarm Response Time: Annunciate alarm at workstation within 2 seconds. Multiple workstations must receive alarms within five seconds of each other.
  - .6 Program Execution Frequency: Programmable controllers shall execute DDC PI control loops, and scan and update process values and outputs at least once per second.
- .2 Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
  - .1 Space Temperature: Plus or minus  $0.25^{\circ}\text{C}$ .
  - .2 Ducted Air Temperature: Plus or minus  $0.25^{\circ}\text{C}$ .
  - .3 Outside Air Temperature: Plus or minus  $0.5^{\circ}\text{C}$ .
  - .4 Dew Point Temperature: Plus or minus  $0.75^{\circ}\text{C}$ .
  - .5 Temperature Differential: Plus or minus  $0.25^{\circ}\text{C}$ .
  - .6 Relative Humidity: Plus or minus 2%.
  - .7 Airflow (Pressurized Spaces): Plus or minus 3% of full scale.
  - .8 Airflow (Measuring Stations): Plus or minus 5% of full scale.
  - .9 Airflow (Terminal): Plus or minus 10% of full scale.
  - .10 Air Pressure (Space): Plus or minus 0.01-inch wg.
  - .11 Air Pressure (Ducts): Plus or minus 0.1-inch wg.

- .12 Carbon Monoxide: Plus or minus 5% of reading.
- .13 Carbon Dioxide: Plus or minus 50 ppm.
- .14 Electrical: Plus or minus 5% of reading.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/consultant for resolution before rough-in work is started.
- .2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the consultant for resolution before rough-in work is started.
- .3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the consultant and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by-and at the expense of-this contractor.

#### **3.2 A2L REFRIGERANT CONTAINING EQUIPMENT**

- .1 A2L refrigerants are classified as mildly flammable. CSA B52-2023 has specific safety clauses related to the use of refrigerants with this classification within buildings.
- .2 This contractor shall be responsible to ensure that the installation requirements of CSA B52-2023 are met.
- .3 Throughout this specification various pieces of equipment have been specified with refrigerant leak detection systems. Field wiring of the alarm status of this system to various downstream system components is required under Annex P of the standard and is the responsibility of this contractor. These devices include the following:
  - .1 Open all zone dampers connected to the affected system.
  - .2 Disable electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves on the affected refrigeration systems
  - .4 De-energize any potential sources of ignition with the ductwork system of the affected system.
  - .5 Energize fans within the ductwork system.
  - .6 Activate any designated refrigeration leak ventilation systems.

#### **3.3 PROTECTION**

- .1 The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.



- .2 The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

### **3.4 INSTALLATION**

- .1 Install all equipment, accessories, conduit and interconnecting wiring in a neat and protected manner by skilled and qualified work persons using the latest standard practices of the industry.
- .2 Meet Owner's requirements.
- .3 Cooperate with the air and water balance technicians during the balancing of the system.
- .4 Trip test high and low temperature protection devices to ensure satisfactory operation, in the presence of the Owner.
- .5 Unless otherwise specified, meet manufacturer's latest printed instructions for materials, planned maintenance and installation methods.
- .6 Notify Consultant in writing of any conflict between these Specifications and manufacturer's instructions.
- .7 Install equipment so as to allow for easy maintenance access and such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- .8 Shield and ground communication trunk wiring at a single end.
- .9 Do not splice trunk line.
- .10 Provide complete installation, testing, debugging and interfacing of specified software.

### **3.5 LABELLING**

- .1 Provide engraved black and white Lamicoid plastic nameplates, 25 x 65 mm minimum at all duct mounted instruments, reset controls, thermometers and panels so as to clearly indicate service of particular device. All manual switches unless they come with standard nameplate shall be similarly labeled.

### **3.6 NAMING**

- .1 Object and Point Naming
  - .1 All BACnet objects and points programmed under these specifications, shall conform to the following case sensitive convention:
    - .1 First group of characters = Building Unique Identifier (Enterprise systems only)
    - .2 Second group of characters = Network number
    - .3 Third group of characters = Device number
    - .4 Fourth group of characters = Controller / Equipment Identifier
    - .5 Last segment = Point name abbreviation
  - .2 Example: S1156\_2\_15\_HP10\_RmTemp

- .3 Object name segment shall be delimited by ( ) character, however, must be consistent by Vendor across all owner sites
- .2 Controller and Device Addressing and Naming
  - .1 Each device or network installed and programmed under these specifications, shall be addressed and/or named as follows:
    - .2 Device Instance
      - .1 First group of characters = Building Unique Identifier (Enterprise systems only)
      - .2 Second group of characters = Network number
      - .3 Third group of characters = Device number
      - .4 Fourth group of characters = Controller / Equipment Identifier
      - .5 Example: S1156\_2\_15\_HP10
    - .3 BACnet Network Number
      - .1 First group of characters = Building Unique Identifier (Enterprise systems only)
      - .2 Second group of characters = Network number
      - .3 Third group of characters = Network and Type
      - .4 Example: S1156\_2\_1 (S1156 = Forest Trail, 2 = Network 2, 1 = 1st MS/TP network)
    - .4 MAC Addresses
      - .1 B-BC
      - .2 Maintenance Connection
      - .3 Reserved
      - .4 -127. Master Range
      - .5 128.– 254. Slave Range
      - .6 255. Broadcast
    - .5 Object name segment shall be delimited by ( ) character, however, must be consistent by Vendor across all owner sites
  - .1
- .3 Controller and Equipment identifiers shall match the standard adopted within the owner's enterprise level network. In the case of no enterprise level network or owner standard identifiers shall match the drawings.

### 3.7

#### COORDINATION

- .1 Site
  - .1 Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
  - .2 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

- .2 Submittals. Refer to the "Submittals" article in Part 1 of this specification for requirements.
- .3 Test and Balance
  - .1 The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
  - .2 The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
  - .3 In addition, the contractor shall provide a qualified technician to assist in the test and balance process.
  - .4 The tools used during the test and balance process will be returned at the completion of the testing and balancing.
  - .5 During the system testing and balancing by an independent agency fully demonstrate the operation of all sensors, dampers, actuators, controls, valves, etc. This contractor shall be present during the testing and balancing and make adjustments as often as necessary to satisfy the testing and balancing agency.
- .4 Life Safety
  - .1 Duct smoke detectors required for air handler shutdown are supplied under the mechanical section of this specification. The contractor shall interlock smoke detectors to air handlers for shutdown as described in Part 3, "Sequences of Operation."
  - .2 Smoke dampers and actuators required for duct smoke isolation are provided under mechanical section. The contractor shall interlock these dampers to the air handlers as described in Part 3, "Sequences of Operation."
  - .3 Fire/smoke dampers and actuators required for fire rated walls are provided under another Section of mechanical section. Control of these dampers shall be by electrical. The contractor shall monitor the position of these dampers.
- .5 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
  - .1 All communication media and equipment shall be provided as specified in Part 2, "Communication" of this specification.
  - .2 Each supplier of a controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
  - .3 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
  - .4 The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
  - .5 The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

**3.8 ACCEPTANCE TESTING**

- .1 Upon completion of the system control contractor will request, in writing, to the Engineer and Owner that the acceptance procedures can commence.
- .2 After installation forward submittal data relevant to point index, functions, limits, sequences, interlocks, software routines and associated parameters and other pertinent information for the operating system and data base to the Owners authorized representative. Enter software into the central computer and debug.
- .3 Prior to on-line operation perform a complete demonstration and readout of the computer real-time responsibilities of surveillance and command in the presence of the Owner's authorized representative.
- .4 Adjust all devices and components to ensure that the operations are performed correctly and that all analog values are displays to the accuracy specified. Check all alarms, start/stop and status conditions to ensure proper operation.
- .5 Upon successful completion of on-line operation provide the Owner's authorized representative with written confirmation, inspection and approval of the satisfactory operation of the building automation system.
- .6 Complete all outstanding deficiencies as determined by the Owner's representative in his inspection report, after which a resubmission of formal acceptance shall be made. Repeat this procedure, if necessary, until acceptable performance has been established.

**3.9 CONTROL SYSTEM CHECKOUT AND TESTING BY BAS CONTRACTOR**

- .1 Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. Submit test worksheets to the consultant. This testing shall be completed before the owner's representative is notified of the system demonstration.
  - .1 The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
  - .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
  - .3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
  - .4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are rect.
  - .5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
  - .6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.

- .7 Alarms and Interlocks:
  - .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
  - .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
  - .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

- .2 Submit copies of test sheets to the consultant and include in as-built information.

### **3.10 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE**

- .1 Verify to the Owner's Representative and Architect/Engineer in letter form that supplier has in place support facility. Letter shall show location of support facility, name and titles of technical staff, engineers, supervisors, fitters, electricians, managers and all other personnel responsible for the completion of the work on this project.
- .2 Demonstration
  - .1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
  - .2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The consultant will be present to observe and review these tests. The consultant shall be notified at least 10 days in advance of the start of the testing procedures.
  - .3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
  - .4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
  - .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
  - .6 Demonstrate compliance with Part 1, "System Performance."
  - .7 Demonstrate compliance with sequences of operation through all modes of operation.
  - .8 Manually generate an alarm at a remote DDC Controller as selected by the Architect/Engineer to demonstrate the capability of the workstation and alarm printer to receive alarms within 5 seconds.

- .9 Disconnect an operator workstation in the central control room and manually generate an alarm at a remote DDC Controller to demonstrate the capability of the system printer to receive alarms when the workstation is disconnected from the system.
- .10 Disconnect one DDC Controller from the network to demonstrate that a single device failure shall not disrupt or halt peer to peer communication. Panel to be disconnected shall be selected by the Architect/Engineer.
- .11 At an ASC of the Architect/Engineer's choice, disconnect the LAN connection to demonstrate its lack of reliance on a DDC Controller to maintain full control functionality.
- .12 Demonstrate complete operation of operator interface.
- .13 Additionally, the following items shall be demonstrated:
  - .1 DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
  - .2 Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
  - .3 Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
  - .4 Interface to the building fire alarm system.
  - .5 Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/consultant. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
- .14 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

.3 Acceptance

- .1 All tests described in this specification shall have been performed to the satisfaction of both the consultant and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the consultant. Such tests shall then be performed as part of the warranty.

**3.11 TRAINING**

- .1 The Contractor shall provide a competent instructor to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed, rather than a general training course.
- .2 Provide 16 hours of training for Owner's operating personnel. Training shall include:
- .1 Explanation of drawings, operations and maintenance manuals
- .2 Walk-through of the job to locate control components
- .3 DDC Controller
- .4 Explanation of adjustment, calibration and replacement procedures
- .5 Review of Operator Work Station Functions (set point adjustment, scheduling etc.)
- .3 Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If such training is required by the Owner, it will be contracted at a later date. Provide description of available local and factory customer training.

**3.12 WARRANTY AND SERVICE**

- .1 Warranty Start Date:
- .1 Warranty period starts as of the date of Ready for Takeover.
- .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
- .1 One (1) year warranty period applies.
- .3 Warrant in writing, all provided equipment, accessories, installations, software, and firmware against defects in workmanship and materials for a period of one year commencing from the date of issue of the Certificate of Substantial Performance.
- .4 Maintain the affected parts operational during repair of defective equipment covered by the warranty.
- .5 Provide warranty service at no cost to the owner for the guarantee period, this shall include, but not limited to the following:
- .1 Repair service on hour basis during warranty. Provide emergency service where malfunction would result in property damage. If not emergency, respond to site within 24 hours and resolve issue within three (3) days.
- .2 Replacing defective parts and components as required.

- .3 Servicing by factory trained and employed service representatives of system manufacture.
- .6 Supplier shall have an in-place support facility within 100 km of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.
- .7 Provide all labour, associated travel and expenses, materials, and equipment necessary for the successful operation of this system for a period of 12 months from the date of Ready for Takeover.
- .8 In addition, provide three (3) visits for testing and evaluating the performance of the hardware and software installed per this specification, to be coordinated with the owner's Building Automation Manager. One visit shall be during the cooling season, one visit shall be during the heating season, and one visit shall be during a shoulder season, either spring or fall. Provide a written report after each visit is complete. This service visit shall include, but not be limited to, the following:
  - .1 Check calibration and re-calibrate if needed instrumentation sensors for air flow, liquid flow, pressure, humidity, temperature, and transducers. Written records shall be kept indicating the performance of such calibrations along with pertinent data.
  - .2 Check the operation of dampers and damper actuators to assure no lock up has occurred and stroke is proper. Written records shall be kept indicating the performance of such calibrations along with pertinent data.
  - .3 Check the overall system field operations by performing a review of all points. Verify that all monitoring and command points are valid and active. Written records shall be kept indicating the performance of such exercises.
- .9 If a problem develops at any time during the warranty/service period, the affected BAS point/object shall be monitored and logged for the remainder of the warranty/service period. "A problem" in the above statement will refer to an incident in which any of the following occur:
  - .1 An alarm occurs due to a defective control system component(s), improper installation or programming.
  - .2 Overall performance of the system is compromised due to a defective control component(s), improper installation or programming.
  - .3 Major recalibration (by greater than 5 times the catalogued accuracy) is required for a sensor during one of the service visits.
  - .4 Changes required to meet design, compliance, and functionality, that were not part of the Demonstration and Acceptance process, will be made at no cost to the Owner.
  - .5 Any changes to programming, inclusive of but not limited to set-points, schedules, sequences, alarms, history, network addressing, object naming, etc.
- .10 Run all diagnostics and correct all previously diagnosed problems.
- .11 Resolve and correct any previous outstanding problems.
- .12 Software: Provide all software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and shall be incorporated into the operations and maintenance manuals, and software documentation.



- .13 Warranty Coverage:
  - .1 Applies to parts and labour.

### **3.13 WARNING LABELS**

- .1 Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
  - .1 Labels shall use white lettering (12-point type or larger) on a red background.
  - .2 Warning labels shall read as follows:

**CAUTION**

“Operating under automatic control”. “Switch disconnect to “Off” position before servicing”.
- .2 Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
  - .1 Labels shall use white lettering (12-point type or larger) on a red background.
  - .2 Warning labels shall read as follows:

**CAUTION**

“Fed from more than one power source”.

### **3.14 CLEANING**

- .1 The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- .2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- .3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.
- .4 All equipment shall be cleaned, including interior and exterior surfaces at completion of the work.

**END OF SECTION**

**Part 1 General****1.1 SYSTEM ARCHITECTURE DESCRIPTION**

- .1 The Building Automation System as detailed in this Section shall be based on a hierarchical architecture incorporating the Niagara 4 Framework® through Tier 1 and 2 inclusive. Systems not developed on the Niagara 4 Framework® platform are unacceptable.**
- .2 All Niagara 4 Framework® components shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification.**
- .3 All devices supplied under this specification, excluding sensors, shall be connected to the site LAN and shall communicate natively using the following BACnet/IP, BACnet MS/TP, Peer to Peer, or Ethernet (ISO 8802-3), as defined in the ANSI/ASHRAE Standard 135, latest or Peer-to-Peer using Niagara's Fox Protocol or SNMP.
- .4 The network architecture shall consist of multiple levels for communication efficiency:
  - .1 A management level ethernet network based on BACNet IP protocol with other standardized protocols, such as web services, html, JAVA, SOAP, XML, etc. to transmit data to non-BAS software applications and databases. The BAS Server and Operator workstation shall reside on this level of the network.
  - .2 Building level ethernet network based on BACNet IP protocol. This network shall connect the building controllers to the BAS Server and Operator Workstation. Controllers for central plant equipment and large infrastructure shall reside on this network.
  - .3 A floor level network will connect all DDC controlled terminal heating and cooling equipment on a floor or in a system that is controlled by Advanced Application or Application Specific Controllers. Devices on this network shall be connected to a router that connects to the building level ethernet network. A router will be provided for each subnetwork and be capable of handling all of the BACNet interoperability building blocks that are listed for the controllers that reside on the network.
- .5 Program data-bases, data acquisition, and all control sequence logic shall reside in the respective controller. Each device shall, to the greatest extent possible, perform its programmed sequence. Operation of each device shall not be dependent on a connection to a server or master controller.
- .6 Mechanical and Electrical Systems i.e., VFD's, chillers, boilers, unitary equipment, etc. units that are equipped with manufacturers furnished controls shall be BTL certified. Gateways are not to be used unless prior written approval has been acquired. A single controller can be used in combination with the manufacturer supplied controls, only where the manufacturer's controls are unable to meet the functional intent.
- .7 The use of multiple application controllers used to control a single piece of equipment is strictly prohibited, except those specifically noted.

- .8 The network shall permit the automatic transferring of all point values from one controller to the other on a planned, prioritized basis. The transfer of point values shall be performed directly between controllers. Systems that relay on a control, network, master or gateway controllers to perform these functions are not acceptable.
- .9 Controller firmware must be flash upgradeable over the network.
- .10 The Building Controller shall be connected to the owner's VLAN and be accessible from the web on any computer.**

## **1.2 NETWORK TOPOLOGY**

- .1 Management/Enterprise Level Network
  - .1 A single ethernet connection shall be provided on site for a controller to reside on the owner's VLAN. This controller shall interface to the owner's existing Management Level Network/Enterprise level server.
  - .2 Contractor shall connect the operator work station to the Building Level Network.
- .2 Building Level Network
  - .1 Each building level controller shall be provided with a homerun ethernet connection to the building level controller that interfaces to the Management Level Network.
  - .2 Each building level controller shall be provided with a homerun ethernet connection to the nearest owner provided network switch. The controller shall reside on the owners LAN/VLAN. This contractor is responsible for all wiring to the network switch.
  - .3 Each building level controller shall be provided with a homerun ethernet connection to the nearest owner provided network switch. The controller shall reside on the owners LAN/VLAN. The data wiring contractor shall provide a network drop in the vicinity of each building level controller.
- .3 Floor Level Network
  - .1 BACNet IP Network:
    - .1 Ring Topology shall be used.
    - .2 Daisy Chain Topology shall be used.
    - .3 Star Topology shall be used
  - .2 This contractor shall provide all network infrastructure, switches etc. to enable this topology.
  - .3 BACNet MS/TP Networks: Daisy Chain

## **1.3 WIRING RESPONSIBILITY OF THIS CONTRACTOR**

- .1 This contractor is responsible for the following wiring:
  - .1 All fibre cabling required to implement the ethernet network.**
  - .2 All ethernet wiring, switches etc. required to implement the Building Level Network.**
  - .3 All ethernet wiring, switches, routers etc. required to implement the Floor Level Network(s).**

- .4 All BACnet MS/TP wiring required to implement the Floor Level Network(s).**
- .5 All 120V wiring associated with control device power and line voltage control devices, including, but not limited to actuators, line voltage thermostats etc.
- .6 All low voltage electrical wiring between sensors, starters, etc. and control device input and output wiring as required to provide a complete and operable system.
- .7 All raceways, boxes, cables, circuit breakers, grounding, relays, motors, starters and wirings from existing panel boards or switchgear through splitters, starters and field disconnect switches to complete power supply required for equipment supplied under this Contract not indicated on the electrical plans and specifications.
- .8 All horizontal copper communications cabling shall be terminated within local IT closet within patch panel. Provide appropriate length patch panel for final termination to owner's network switch.**

#### **1.4 PERMITS, INSPECTIONS AND TESTING**

- .1 Contractor will arrange for submission to the Electrical Safety Authority (ESA) for review of this project and pay all associated fees. Provide Certificate(s) of Acceptance from ESA and other Authorities having jurisdiction upon completion of the Work.
- .2 Where modification to mechanical or electrical equipment control wiring is necessary to meet the requirements of the specifications, the contractor is responsible for arranging any testing required by the Authority Having Jurisdiction to maintain the required certification and ensure the safe operation of the equipment modified.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

#### **2.2 BACnet ETHERNET COMMUNICATION CABLING**

- .1 Data cable shall Category 6 or better Ethernet cable.
- .2 Data cable shall be four twisted pair 24 AWG solid copper, Plenum Rated FT-6 / CMP or Riser Rated FT-4 / CMR (as required by local codes) unshielded twisted cable meeting EIA / TIA 568B.1 Category 5e classification.
- .3 The maximum cable length for each run shall be limited to 90 meters.
- .4 All cables must be Power Sum accepted and recognized by the manufacturer.
- .5 Cable Skew must be specified as 20Ns or less per 100 meters.
- .6 Cables must display the manufacturer's stamp stating that the cable is included in the latest UL verified publication for respective Category standards.
- .7 Cables shall be rated for installation in return air plenums (where allowed in this specification).

- .8 Cables shall be colored to match owner's BAS standard. If owner does not have a standard a different color than the data contractor shall be used.

### **2.3 120 VOLT WIRING**

- .1 This contractor is responsible to provide all of their own power wiring, including 120V to transformers. Wiring shall meet the requirements of the Electrical Division specifications.

### **2.4 LOW VOLTAGE AND CONTROL WIRING**

- .1 Minimum #20 AWG stranded copper conductors (larger gauge wire/cable shall be provided where required by BAS equipment and where applications warrant (e.g. rated load, long runs, etc.).
- .2 Wire type used for MSTP, RS-485 twisted pair communications must be balanced twisted pair with 100 to 120 Ohms Characteristic Impedance. The wire shall be less than 30 pF per foot, and preferred 20 AWG or lower. A shield wire shall be included for ground connection.
- .3 All BMS input/output point wire/cable and communication cable shall be shielded.
- .4 Non-shielded cables may be approved for BAS input and output field point wiring following certification from the BAS manufacturer that non-shielded cables will function satisfactorily for the life of the building and that the use of non-shielded cables will not negatively affect other building systems/cabling.
- .5 The manufacturers certification shall guarantee to the Board that should it be determined that BAS system performance is negatively affected or another building system or equipment is negatively affected due to the non-shielded cable, the BAS manufacturer shall replace the cable at no cost to the Board.
- .6 Provide FT-6 rated cable where cable is run free air.

### **2.5 POWER SUPPLIES AND LINE FILTERING**

- .1 Control transformers shall be ULC listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
  - .1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
    - .1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
    - .2 Line voltage units shall be UL recognized and CSA approved.

- .2 Power line filtering.
  - .1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
    - .1 Dielectric strength of 1000 volts minimum
    - .2 Response time of 10 nanoseconds or less
    - .3 Transverse mode noise attenuation of 65 dB or greater
    - .4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.
- .3 Battery Backup with Surge Protection.
  - .1 Provide a battery backup unit with surge protection on the supply to the Supervisory Controller with a minimum capacity of 1000 Volt-amps.

### **Part 3 Execution**

#### **3.1 GENERAL WORKMANSHIP**

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Install wiring in EMT conduit in exposed areas and drops in walls. Comply with all requirements of Electrical Division.
- .3 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .4 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- .5 Control system wiring and cabling installed for this project shall be performed by professionals in a workmanlike manner and in accordance with National Electric Code (NFPA 70), CSA C22.2 and latest NEMA standards, FCC, and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).
- .6 All materials must be CSA and NEMA approved. Where this is not possible, arrange and pay for unconditional Electrical Safety Authority approval.
- .7 Follow manufacturer recommendations for installation of all wiring
- .8 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- .9 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .10 Free air cabling installed in non-combustible rated buildings shall be fire rated cable with a minimum rating of FT-6.
- .11 Wiring located in combustible rated buildings above T-bar ceiling shall be run in free air using fire rated cable with a minimum rating of FT-6.

- .12 Note: all free air cabling used in combustible rated buildings to interface to security or fire alarm systems shall be FT-6 rated.
- .13 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .14 Cables be installed in bundles resting in a cabling support system (J-hooks) where provided by the Electrical Division.
- .15 Cable supports shall be attached to the wall or ceiling of the area they are running through. Cable supports shall not be attached to:
  - .1 Electrical raceways,
  - .2 Duct work,
  - .3 Ceiling suspension systems,
  - .4 Piping,
  - .5 Wilson joists.
  - .6 All wire/cable terminations shall be made at screw type terminal strips. Wire nut terminations and butt splices shall not be acceptable. Wiring runs shall be continuous runs without splices.
- .16 All BAS equipment and components shall be grounded to building ground facilities.
- .17 BAS shall only be capable of controlling electric motors when the associated hand/off/auto (HOA) motor control switches are in the "auto" position. BAS control shall be wired into the auto circuit of the hand/off/auto motor control circuit only. Where hand/off/auto switches do not exist they shall be provided by the Controls Contractor.
- .18 Life safety and equipment protection interlocks shall be wired to override equipment whenever it is in operation.
- .19 Existing interlocks and override control should typically not be removed or overridden by the application of new BAS control without the specific instruction and/or approval of the Owner.
- .20 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .21 Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
- .22 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- .23 Adhere to this specification's Electrical Division requirements where raceway crosses building expansion joints.
- .24 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- .25 Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

- .26 All wiring in mechanical, electrical, or service rooms-or where subject to mechanical damage- shall be installed in raceway at levels below 3 m (loft).
- .27 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- .28 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

### **3.2 ETHERNET WIRING**

- .1 Cabling shall be installed as continuous links, including shielding. Field splices are strictly prohibited.
- .2 Network installation shall strictly adhere to the manufacturer's network installation instructions and procedures.
- .3 Data cabling shall be run separately from power and signal wiring
- .4 Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/AHRAE Standard 135, latest will be followed. Those include but are not limited to:
  - .1 The maximum length and cabling type of an MS/TP segment shall be in accordance with manufacturers specifications and shall comply with EIA-485.
  - .2 Each internetwork LAN must have a unique Network Number (1 - 65,545).
  - .3 The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard.
- .5 Primary LAN Network wire and cable shall be run separately from all other wiring.
- .6 Other LAN Network wire and cabling shall be installed separate from any wiring over thirty (30) volts.
- .7 All communications shielding shall be grounded as per Networked System manufacturer's recommendations.

### **3.3 120 VOLT WIRING**

- .1 All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and the Electrical Division requirements.
- .2 Power wiring for all enclosures and equipment, including branch circuit wiring from circuit breaker panels shall be the responsibility of the System Contractor unless specifically shown on the Plans or Specifications.
- .3 The Building Controller panel shall be served from isolated ground receptacle via UPS by dedicated branch circuits.
- .4 Power shall NOT be obtained by tapping into miscellaneous circuit that could inadvertently be switched off.
- .5 Power for controls equipment shall be from a dedicated circuit. Where a controller is dedicated to controlling a single piece of equipment, power may be obtained directly from that equipment.
- .6 All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.



**3.4 LOW-VOLTAGE ELECTRICAL AND CONTROL WIRING**

- .1 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)
- .2 Cabling shall be installed as continuous links, including shielding. Field splices are strictly prohibited.
- .3 Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- .4 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- .5 Maximum allowable voltage for control wiring shall be 120-volts.

**3.5 POWER CONDITIONING**

- .1 Provide integral or supplementary power conditioning equipment for all BAS hardware so as to ensure that power line noise or electrical spikes, noise, bursts, sags or surges shall not damage equipment or software or cause erroneous computations.

**3.6 IDENTIFICATION OF HARDWARE AND WIRING**

- .1 All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- .2 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- .3 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .4 Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplates.
- .5 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- .6 Identify room sensors relating to terminal box or valves with nameplates.
- .7 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- .8 Identifiers shall match as-built documents.
- .9 Ethernet cabling shall be a separate color than the building data cabling and be labelled as BUILDING AUTOMATION SYSTEM at 20 foot intervals.

**END OF SECTION**

**Part 1            General**  
**Not Used**

**Part 2            Products**

**2.1                ACCEPTABLE MANUFACTURER**

- .1        Operator software shall be matched to the Building Automation System supplier.

**2.2                BUILDING AUTOMATION SYSTEM SERVER AND OPERATOR WORKSTATION  
HARDWARE**

- .1        The owner shall provide the operator workstation. Software shall be compatible with 64 bit Windows operating systems.
- .2        Install all software necessary to permit the operator to create, modify, delete, file and recall all graphics. The package shall encompass all graphics, control, control schematics and wiring details for all points and systems contained in the Input/output Point Summary. Provide a separate, valid license, complete with manuals, disks, and documentation for the graphics engineering software. Provide a separate valid license for of the software necessary to view the graphics with each Operator Workstation,
- .3        Set up an icon on the desktop to take the Owner directly to the BAS system login page.
- .4        Provide a copy of the software (or all software's if there are multiple) used to program and download sequences to controllers.
- .5        Provide a backup of the all of the programs used in the system for storage by the Owner.

**2.3                OPERATOR WORKSTATION SOFTWARE - GENERAL**

- .1        Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
- .2        Operator workstation interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software.
- .3        Interface software shall simultaneously communicate with and share data between any combination of dedicated, modem autodial, and Ethernet-connected building level networks. The software shall provide, as a minimum, the following functionality:
  - .1        Real-time graphical viewing and control of the BAS environment.
  - .2        Reporting of real time and historical information.
  - .3        Scheduling and override of building operations.
  - .4        Collection and analysis of historical data.

- .5 Point database editing, storage, and downloading of controller databases. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database. The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the DDC Controllers.
- .6 The workstation software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.
- .7 Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
- .8 Alarm reporting, routing, messaging, and acknowledgment.
- .9 "Collapsible tree," dynamic system architecture diagram application:
  - .1 Showing the real-time status and definition details of all workstations and devices on an enterprise level network.
  - .2 Showing the real-time status and definition details of all DDC and HVAC Mechanical Controllers at the building level.
  - .3 Showing the status and definition details of all field-level application controllers.
- .10 Definition and construction of dynamic colour graphic displays.
- .11 Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
- .12 On-screen access to User Documentation, via online help or PDF-format electronic file.
- .13 Automatic and manual database backup at the workstation for database changes initiated at DDC Controller operator interface terminals.
  - .1 Backups shall produce a configuration file that contains pertinent details regarding the specific backup. This log file shall be created each time a backup is run and be stored in the backup directory.
  - .2 Restore dialog box shall list detailed information to facilitate the restore of the correct database.
  - .3 Ability to restore selected components of a backup.
  - .4 Delete old backup directories automatically or individually from a detailed list.
- .14 Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk.
- .15 Display dynamic trend data graphical plot.
  - .1 Must be able to run multiple plots simultaneously.
  - .2 Each plot must be capable of supporting 10 pts/plot minimum.
  - .3 Must be able to plot both real-time and historical trend data.

- .4 Must be able to plot real time data without prior configuration.
- .16 Program editing.
- .17 Transfer trend data to 3rd party spreadsheet software.
- .18 Scheduling reports.
- .19 Operator Activity Log.
- .20 Open communications via BACnet Client & Server option.
- .21 Tracking of supervised objects.
- .22 A colour graphics application to build and edit graphics.
- .23 Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):
  - .1 Dynamic colour graphics application.
  - .2 Alarm management application.
  - .3 Scheduling application.
  - .4 Dynamic trend graph data plotter application.
  - .5 Dynamic system architecture diagram application.
  - .6 Control Program and Point database editing applications.
  - .7 Reporting applications.
  - .8 Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.
- .4 Standard Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information

## **2.4 CLIENT SERVER CONNECTIVITY**

- .1 Client sessions must be allowed to run on the server and on other devices connected to the server via Intranet, Extranet, or Internet connections.
- .2 Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support remote access features.
- .3 The following client options must be supported:
  - .1 Installed Client.
    - .1 Software application installed from installation media on to the client machine.
    - .2 Installed client software must be configurable to allow it to run in a Closed Mode such that the BAS software can lock down the client machine and prevent users without permission from minimizing the application or running other Windows applications that might cover the BAS software interface.

- .3 Communication between the server and Installed Clients must be monitored so that any break in communication between the server and an installed client results in notification at the Server and Installed Client machine
- .4 Installed client machines communicate directly with the BAS server.
- .2 Web Client.
  - .1 Software that runs in a browser on the client machine as a Full Trust client application.
  - .2 Connected to the BAS software server via Microsoft IIS Server.
- .3 Windows App.
  - .1 Software application downloaded from the BAS server to run on the client machine like an installed application.
  - .2 Application must be automatically updated whenever new apps are available at the server.
  - .3 Connected to the BAS software server via Microsoft IIS Server.
- .4 Each of the client options shall provide the same functionalities including operation and configuration capabilities.

## **2.5 CERTIFICATIONS AND APPROVALS**

- .1 BAS software shall have been tested against the following norms and standards:
  - .1 BACnet Revision 1.13, certified by BACnet Testing Laboratory as BACnet Advanced Workstation Software (BTL B-AWS).
  - .2 IT security compliant with the ISA-99/IEC 62443 Security Level: SL1.
  - .3 OPC DA V2.05a and V3.0 Server, certified by the OPC Foundation certification program.
  - .4 UL-listed to UL864 9th edition Standard for Control Units and Accessories (when installed on a UL-approved computer).

## **2.6 ACCESS RIGHTS AND USER PRIVILEGES**

- .1 Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BAS workstation application. And each BAS workstation user account shall use a Windows user account as a foundation.
- .2 The workstation software shall also include an application to track the actions of each individual operator, such as alarm acknowledgement, point commanding, schedule overriding, database editing, and logon/logoff. The application shall list each of the actions in a tabular format and shall have sorting capabilities based on parameters such as ascending or descending time of the action, or name of the object on which the action was performed. The application shall also allow querying based on object name, operator, action, or time range.

## **2.7 WORKSTATION APPLICATION EDITORS**

- .1 Each PC system shall support editing of all system applications. Provide editors for each application at the workstation. The applications shall be downloaded and executed at one or more of the controller panels.
  - .1 Colour Graphics Application. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
  - .2 Scheduling Application. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.
  - .3 Custom Application Programming Application: Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded.

## **2.8 DYNAMIC COLOUR GRAPHICS APPLICATION**

- .1 Must include graphic editing and modifying capabilities.
- .2 Graphics shall be available with the same look and functionality whether they are displayed at an installed client workstation or via browser interface.
- .3 User shall be able to add/delete/modify system graphics for floor plan displays and system schematics for each piece of mechanical equipment from the standard user interface without need for specialized tools.
- .4 Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
- .5 A library of standard control application graphics and symbols must be included. A library of minimum 400 symbols will be provided consisting of common systems, including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams, piping and laboratory symbols.
- .6 In the development of a graphic picture, the graphics software shall support all operator actions necessary to:
  - .1 Define the background;
  - .2 Establish colours;
  - .3 Locate, orient and size the symbols;
  - .4 Position and edit alphanumeric descriptors;
  - .5 Establish connecting lines;
  - .6 Establish sources of real time data and location of their readouts.

- .7 The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
- .8 The Graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic based on what the object represents (fan, duct sensor, damper, etc.) when the object is placed on a graphic. The user shall be able to override the assigned symbol if desired.
- .9 User shall be able to add custom symbols to the symbol library.
- .10 Software shall permit the importing of AutoCAD or scanned pictures for use in graphics.
- .11 Must be able to command points directly off graphics application.
- .12 Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks. At a minimum animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed. Animation shall also indicate the priority and alarm status of the point.
- .13 Animation status indicators shall give you a quick visual indication of a point's value, priority, or status in the form of an icon.
- .14 Software shall provide animation that depicts movement of mechanical equipment, or air or fluid flow.
- .15 Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure or view recently opened graphics through a backward and forward paging.
- .16 Graphics viewing shall include dynamic pan and zoom capabilities.
- .17 Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
- .18 Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed based on zoom level.
- .19 The software must provide the ability to create dashboard views consisting of gauges and charts that graphically display system and/or energy performance.
- .20 Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), Internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
- .21 Colours shall be used to indicate status and change as the status of the equipment changes. The state colours shall be user definable.
- .22 The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands.

## 2.9 REPORTS

- .1 Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
- .2 Provide ability for the owner to readily customize these reports:
  - .1 All Objects: All system (or subsystem) objects and their current values.
  - .2 Alarm Summary: All current alarms (except those in alarm lockout).
  - .3 Disabled Objects: All objects that are disabled.
  - .4 Alarm Lockout Objects: All objects in alarm lockout (whether manual or automatic).
  - .5 Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.
  - .6 Logs:
    - .1 Alarm History
    - .2 System Messages
    - .3 System Events
    - .4 Trends
- .3 Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.
- .4 Override Reports. Provide a monthly report showing the daily total time in hours that each system has requested after-hours HVAC and lighting services. Provide an annual summary report that shows the override usage on a monthly basis.
- .5 Reports shall be generated on demand or via pre-defined schedule, and directed to displays, printers, or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:
  - .1 A general listing of all or selected points in the network.
  - .2 A status report showing present value and alarm status.
  - .3 List of all points currently in alarm.
  - .4 List of all points currently in override status.
  - .5 List of all disabled points.
  - .6 List of all points currently locked out.
  - .7 List of user accounts and access levels.
  - .8 List all weekly schedules and events.
  - .9 List of holiday programming.
  - .10 List of control limits and dead bands.



- .11 Custom reports from 3rd party software.
- .12 System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points.
- .13 List of programs.
- .14 List of point definitions.
- .15 List of logical point groups.
- .16 List of alarm strategy definitions.
- .17 List of DDC Control panels.
- .18 Point totalization report.
- .19 Point Trend data listings.
- .20 Initial Values report.
- .21 User activity report.

## **2.10 SCHEDULING AND OVERRIDE**

- .1 The software shall provide a calendar type format for simplification of time and date scheduling and overrides of building operations.
- .2 The software shall support the definition of BACnet schedules that are defined at the workstation and are downloaded to Building Controller to ensure time equipment scheduling when PC is off-line, such that the operating software is not required to execute time scheduling. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
  - .1 Fully support all BACnet Schedule, Calendar, and Command objects.
  - .2 Daily and Weekly schedules.
  - .3 Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights).
  - .4 Ability to schedule for a minimum of up to ten (10) years in advance.
- .3 The software shall support the definition of schedules that are configured and executed to run at the workstation, to support scheduling of workstation software activities and to support field systems that do not include internal scheduling mechanisms. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
  - .1 Schedule predefined reports.
  - .2 Schedule Trend collections.
  - .3 Schedule automated system backups.
  - .4 Schedule commands to be sent to field panels.
  - .5 Daily and weekly schedules.
  - .6 Setting up and executing Holiday schedules.
  - .7 Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., all Building 1 lights).
  - .8 Ability to schedule for a minimum of up to ten (10) years in advance.

- .4 The software shall support the definition of Schedules Objects that are defined at the workstation and are downloaded to Building Controller to ensure time equipment scheduling when PC is off-line, such that the operating software is not required to execute time scheduling. The software must provide the following capabilities for BACnet scheduling capabilities as a minimum:
  - .1 Equipment schedule Zones.
  - .2 Equipment schedule Events.
  - .3 Configuration of Daily, Weekly, Monthly schedules.
  - .4 Configuration of Replacement Days.
- .5 The software shall provide the ability for users to override regular weekly schedules through menu selection, graphical mouse action or function key.
- .6 The software shall provide a timeline view, showing the results of any number of combined selected workstation and field panel controller schedules for an overview of facility operation.
- .7 Additionally, the scheduling application shall:
  - .1 Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report).
  - .2 Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report).
  - .3 Provide searching capabilities of schedules based on name – with wildcarding options.

## **2.11 COLLECTION AND ANALYSIS OF HISTORICAL DATA**

- .1 Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
- .2 The software must support configuration of panels that have a trending level threshold, above which the data will be automatically uploaded to the BMS server to prevent overwriting the data in the field panel. The trending level will be user defined in % of available space (e.g., automatically upload when the trend buffer is at 75% of allocated space).
- .3 The entire collection process shall be automated so that the data collection definition, amount of data to be collected, collection report and scheduling take the form a wizard, or online assist utility, in order to complete this process within a small amount of time for a large group of points.

- .4 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.
- .5 Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of fifteen points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At any time, the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point. Operator shall be able to zoom in on a specific time range within a plot. Operator must be able to configure separate left and right axis for easier differentiation of point values and be able to display historical data for the same group of points at different times simultaneously for easy comparison of system behaviour over time. The dynamic trend plotting application shall support the following types of graphs, with option to graph in 3D: line graph, area graph, curve graph, area-curve graph, step graph, and scatter graph. Each graph may be customized by the user, for graph type, graph text, titles, line styles and weight, colours, and configurable x- and y-axes.

## **2.12 ALARM MANAGEMENT**

- .1 Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.
- .2 Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.
- .3 Only events for which the logged on user has privileges to view shall be displayed on each workstation.
- .4 The software shall provide the ability to users to limit the list of events displayed at each workstation, no matter who is logged on (i.e. workstation will only show fire events).
- .5 Each event shall have the ability to sound an audible notification based on the category of the event.
- .6 Alarm Display shall have the ability to list & sort the alarms based on alarm status, point name, ascending or descending alarm time.

- .7 Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.
- .8 Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm, which can be viewed from the alarm display screen, graphic display screen, and anytime the point is being commanded to a new value or state.
- .9 Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs.
- .10 Software shall provide the option to configure detailed operating procedures that guide a user through predetermined standard operating procedures for handling critical events. Users shall be able to log completion of each operating step as it is performed.
- .11 Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BAS system management.
- .12 Remote notification of messages
  - .1 Workstation shall be configured to send out messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition. A point's alarm status will be configurable for remote notification whether the point is in a specific alarm priority, has returned to normal, failed, out of service, in trouble, alarm disabled by program or operator and alarm by command.
  - .2 There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices, which can receive messages from the system.
  - .3 On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
  - .4 Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.
  - .5 System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.
  - .6 Message detail shall be configurable on a per user basis.
  - .7 During a mass influx of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.

- .8 Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
- .9 Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.
- .10 Ability to configure Fire and Life Safety points for remote notification through the point editor application.
- .13 Expanded Alarm Issue Management
  - .1 As optional functionality, configurable point-by-point, the system shall impose an ordered process for managing the lifecycle of an alarm. The process requires the operator to:
    - .1 Acknowledge the alarm.
    - .2 Assign the alarm issue to a contact (e.g., tradesperson or trained staff).
    - .3 Answer – an explanation of the diagnosis or solution to the alarm.
    - .4 Resolve – this happens when at least one Answer is provided and the point has returned to a stable Normal state.
    - .5 Clear – the operator may clear the alarm issue from the display.
  - .2 Each step in the lifecycle is automatically recorded for audit trail historical purposes.
- .14 Provide alarm priority functionality to meet requirements of sequences of operation.

## **2.13 AUDIT TRAIL OF USER ACTIONS**

- .1 To protect against inadvertent changes damaging critical system functions, and to enable audit-trail tracking on selected database objects, optional functionality shall be provided to configure selected objects for increased supervision. The additional supervision functionality shall allow for designation of points, control programs, trend collection reports, panels on a building level network and user account objects for detailed tracking of user modifications and deletions. Display an icon, which indicates the level of supervision for an object within specified applications.
  - .1 The minimal setting for additional supervision shall warn the user that he is attempting to modify or delete a supervised object and will require the user to input a reason-for-change in order to proceed. The warning shall be customizable for each object.
  - .2 Additional supervision levels shall be optional to require the user to re-enter his user password, and/or require that a “supervisor” enter his user password, in order to proceed with the modification or deletion of the supervised object.
  - .3 Supervised objects shall be assigned a dedicated “revision number,” and the revision number shall be incremented automatically by the system upon each user modification. This revision number may serve as a method for tracking changes to objects.
  - .4 Point in an alarm state can have annotations added which can be viewed from the alarm display screen, graphic display screen, and anytime the point is being commanded to a new value or state. For supervised objects, the point annotation will automatically populate the reason for change field.

- .2 Audit Trail tracking of supervised objects shall record the following:
  - .1 The property of the object that was changed.
  - .2 The value of the property before the change.
  - .3 The value of the property after the change.
  - .4 Who made the change.
  - .5 The reason for change (entered by the operator).
  - .6 Who the change was authorized by (if configured for this level of supervision).

## **2.14 EXTERNAL DATA ACCESS**

- .1 The software shall provide the ability to expose configuration properties and real-time values through CSV files, OPC DA, OPC UA, or REST-based Web Services.
- .2 The software shall provide the ability for external applications to change configuration and real-time values through OPC DA, OPC UA, or REST-based Web Services.
- .3 The software shall provide the ability for external applications to access historical Trend data through CSV files or REST-based Web Services.
- .4 External data access must be secured using the level of permissions configured for users and operator workstations.
- .5 Web service interfaces must allow for exchanging data (object's values, events and trend series) between workstation and external applications such as facility management systems, enterprise applications, mobile applications or other value-added services.
- .6 Documentation describing web services interfaces must be included to allow external developers to write applications that leverage the data exchange.

## **2.15 DATA SECURITY**

- .1 Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. All system security data shall be stored in an encrypted format.
- .2 The BAS software must allow that all communication paths between clients and the server are encrypted and protected against replay attacks as well as data manipulation.
- .3 Any runtime data transfer between the system server and Web Server (IIS) must be allowed to be encrypted by Designo CC.
- .4 Communication between any Web Server (IIS) and the Web Clients must be allowed to be encrypted.
- .5 Passwords must be handled with encrypted storage and transmission

- .6 The software must support the use of public domain algorithms for cryptographic functions, including AES, DiffieHellmann, RSA, and SHA-2. No self-coded algorithms shall be allowed.
- .7 All symmetrical encryption must use 256 bit AES or stronger.
- .8 All asymmetrical encryption must use 2048 bit or stronger.
- .9 The software must support the use of commercial certificates for securing client-server communications.
- .10 The software must support the use of self-signed certificates to allow local deployments without the overhead of obtaining commercial certificates.
- .11 The BAS software shall be compatible with the following Virus Scanners:
  - .1 Kaspersky.
  - .2 Avira.
  - .3 McAfee.
  - .4 Bitdefender.
  - .5 TrendMicro Office Scan.

## **2.16 SUBSYSTEM CONNECTIVITY**

- .1 The BAS application software must be capable of connecting simultaneously to multiple control systems and data sources.
- .2 Interface software shall simultaneously communicate with and share data between multiple Ethernet-connected building level networks.
- .3 The BAS application software must support the following standard protocols:
  - .1 BACnet IP (standard Revision 1.13).
  - .2 OPC (OLE for Process Control) OPC DA 2.05, 3.0.
  - .3 Modbus TCP.
  - .4 SNMP (Agent V1 and V2).
- .4 Any break in system controller communication must result in a notification at the server.

## **2.17 BACnet INTEROPERABILITY**

- .1 The Operator Workstation Software shall be capable of BACnet IP communications.
- .2 The Operator Workstation Software shall have demonstrated interoperability during at least one BTL Interoperability Workshop.
- .3 The Operator Workstation Software shall have demonstrated compliance to BTL B-AWS device classification through BTL listing as specified in ANSI/ASHRAE 135 under revision 1.13 or higher.
- .4 The BAS software shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Workstation (B-OWS) and shall support all BACnet BIBBs required to deliver a full and operable system.

- .5 The BAS Server and Workstations shall support the following Data Link Layers:
  - .1 BACnet IP Annex J.
  - .2 BACnet IP Annex J Foreign Device.
  - .3 ISO 8802-3, Ethernet (Clause 7).
- .6 The BAS Server and Workstations shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
  - .1 Calendar – Creatable, Deletable.
  - .2 Command – Creatable, Deletable.
  - .3 Event Enrollment – Creatable, Deletable.
  - .4 Notification Class – Creatable, Deletable.
  - .5 Schedule - Creatable, Deletable.
- .7 The BAS Server and Workstations shall support transmitting and receiving segmented messages.
- .8 The BAS Server and Workstation shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

**Part 3 Execution**

**3.1 GRAPHICS**

- .1 Provide linked graphic pictures as follows:
  - .1 Building Identification front plate with menu.
  - .2 Photo of front elevation of building.
  - .3 Floor Plan of each building level.
  - .4 Schematic for each system.
  - .5 Tables summarizing temperatures in each zone.
  - .6 Tables summarizing the monitored functions off all air handling units.
  - .7 Table summarizing weekly schedules.
  - .8 Tables summarizing fault detection results.
  - .9 Outside Lighting Schematic.
  - .10 Time of Day schedules.
  - .11 Up to five additional graphics as defined by the owner.
  - .12 Global Setpoints, summarizing items such as Min/Max Setpoints, Override Period, etc.
  - .13 Global Statistics, summarizing lowest temp, highest temp, number of heat pumps heating/cooling, number of zones occupied, number of zones in override, etc.
  - .14 The graphics shall be submitted to the Owner for preapproval before final implementation.



**.2 Graphic Display Screens**

- .1 Individual schematics shall include, where applicable:**
  - .1 Navigation buttons to each major system in the building which indicate current screen display by a change in button colour.
  - .2 Outdoor air temperature shall be displayed on every graphic screen.
  - .3 Access links to all global schedules or specific screens affecting entire building operation.
  - .4 Access buttons links to Set Time, Holiday Schedule, Alarms, Points on Manual, Conversion °C - °F, 24 Hour Clock, Operations Manual, Autocad Drawings, BAS Manual, and Work Orders
  - .5 Status of monitored and controlled on/off points;
  - .6 Current value of analog input;
  - .7 Identification for each point;
  - .8 Current value of the setpoint & DDC output for each control loop;
  - .9 Current state of each control loop (computer auto/computer manual);
  - .10 Schematic and systems identification;
  - .11 Point alarm lock-out status;
  - .12 Equipment symbolic information (pump, fan, etc);
  - .13 Alarm/normal indication
  - .14 All points pertinent to one system shall be on one screen.
  - .15 Symbols shall have the ability to change colour, depending on the status.
  - .16 Animations are to indicate point status. Animations are to include pumps, fans and boilers. The BMS contractor shall obtain from the owner the final numbering and name convention to be used for all spaces in the building for incorporation in the "As Built" drawings and manuals.
- .2 System Architecture.**
  - .1 Control panel layout and network architecture.
  - .2 Indicating BAS panels and panel type (model).
  - .3 Panel locations room number text on screen.
  - .4 Systems controlled by each panel.
  - .5 Links to points list accessible from each panel.
- .3 Architecture Panel Layout (Locations on Floor Plans)**
  - .1 Locations of each panel on each floor plan level.
  - .2 Panel types indicated by different icon.
  - .3 Controls transformers locations.
  - .4 Main network wiring and sub-network wiring layout.
- .4 Floor Plans Graphics**
  - .1 Room numbers accurate as per room signage.
  - .2 Mechanical rooms locations and signage tags.

- .3 space temperatures for every temperature on each floor in appropriate room.
- .4 space focus pick area for individual room control where applicable shall be yellow text.
- .5 Air Handler symbols indicating areas of the floor plan serviced by each air handler by a corresponding colour.
- .6 Status of Air Handler by colour change Red for off status, or text indication.
- .7 Supply air temperature for each air handler.
- .5 HVAC/AHU Unit Graphic
  - .1 Accurate representation of the HVAC design.
  - .2 All associated control points to be displayed.
  - .3 A calculated percentage of fresh air shall be indicated on the HVAC graphic.
  - .4 Operator offset adjustment of the supply air setpoint, adjustable directly from the graphic.
  - .5 HVAC physical location shall be indicated on the graphic.
  - .6 Weekly occupied time of day schedule for the associated HVAC shall be accessible directly from the graphic by selecting an icon.
  - .7 Trend logs shall be accessible directly from the graphic by selecting an icon.
- .6 Exhaust Fans Graphic
  - .1 Exhaust fans control shall be editable directly from the graphic.
  - .2 Exhaust fan status shall be indicated in text and a change in the exhaust fan icon.
  - .3 Exhaust fan physical location shall be indicated on the graphic.
  - .4 Area of the building being exhausted shall be indicated on the graphic.
- .7 Terminal Units/Misc. Items
  - .1 Accurate representation of equipment.
  - .2 All associated control points to be displayed.
  - .3 Space temperature.
  - .4 Mode of operation.
  - .5 Current setpoint.
  - .6 Trend logs shall be accessible directly from the graphic by selecting an icon.

**END OF SECTION**

**Part 1            General**

**1.1            RELATED SECTIONS**

- .1        This section is to be read in conjunction with the remainder of the Division 25 specifications.

**Part 2            Products**

**2.1            ACCEPTABLE MANUFACTURERS**

- .1        Controller shall be matched to the Building Automation System supplier.

**2.2            GENERAL REQUIREMENTS**

- .1        Provide BACnet controllers. DDC controllers that are not BACnet compliant shall not be acceptable under this specification and are strictly prohibited.
- .2        All BAS DDC Devices at all levels shall be fully custom-programmable in the field using the standard Operators Workstation Software. No configurable, canned program application specific controllers will be permitted unless specifically noted in this specification.
- .3        All BAS controllers shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL)
- .4        The BACnet operating stack must be embedded directly in every Device at the board level, and in all operator interface software packages.
- .5        No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the BAS installation pursuant with this specification section. Gateways may only be used as required for communication to existing systems or systems installed pursuant with other specification sections.
- .6        Program database, data acquisition, and all control sequence logic shall reside in each DDC Device. The Building Level Network shall not be dependent upon connection to a Server or Master Controller for performance of the Sequence of Operation. Each individual Device shall, to the greatest possible extent, perform its programmed sequence without reliance on the Building Level Network.
- .7        All BAS DDC Devices shall be capable of updating firmware using software via internetwork without replacing any hardware, microprocessors or chips.
- .8        All binary output points shall be protected from short cycling via output configuration and/or programming. This feature shall allow minimum on time and off-time to be configurable.
- .9        Panels shall use only following signal types to interface with field data points:
  - .1        Binary Input (BI) also known as Digital Input (DI) contacts. Internal voltage source shall be dry contact or 0-5 V.D.C.

- .2 Analogue Input (AI) is to be standard 4 - 20 ma transmitter, 0 – 5 VDC, 2-10 VDC or 0-10 VDC.
- .3 Binary Output (BO) also known as Digital Output contacts rated at 24 V.D.C., 20 mA.
- .4 Analogue Output (AO) to be standard 4 to 20 mA or 0-10 V.D.C. @ 20 mA maximum.
- .10 Each output on major controllers shall have an ON, OFF, AUTO select with status indication lamp and internal voltage source.
- .11 Controls shall be D.D.C. solid state type as noted elsewhere, and with exception of actuators, contain no moving parts.
- .12 Building level controllers must have real time clocks. Time keeping methods that depend on the clock speed of the processor chip are not accurate enough and are not acceptable. One designated controller shall keep the time for the entire system.
- .13 Control algorithms shall be available and resident in digital system controller to permit proportional, integral derivative, incremental, floating and two position control modes in any combination to meet requirements of application.
- .14 Canned packages shall not be permitted in controllers. Controllers must be flexible enough to accommodate custom programs and additional points.
- .15 Digital system controller shall be expandable by adding additional field interface units that operate through processor of digital controller to expand its control loop and energy management point capacity, without making any of the original equipment redundant.
- .16 To maintain long term analog accuracy in controller sensing circuits, digital controller shall sense voltage being supplied to resistance sensing element and through firmware compensate for power supply.
- .17 The non-volatile EPROM memory shall, as a minimum, support the operating system. Tape or disk media is not acceptable. All control languages, application functions and operating data or software shall reside in SuperCap or battery backed RAM. Data or control software (such as I/O point characteristics, schedules, set points and alarm limits) must remain in RAM and, hence, modifiable on-line through an operators terminal connected to any panel on the system or from a remote location via modem without the use of specialized software not provided in this contract. Controllers using batteries that require periodic replacement shall not be used. Standard off the shelf communications software packages are acceptable but in no case shall a hardware key or any other protection method be permitted that restricts the Board from connection to the system from multiple remote locations to display system command language and graphics displays.
- .18 All BMS components must be internally protected from loss of memory or operation due to power surges and brown outs. Controllers must be capable of operating without overheating or other damage at as little as 75% of nominal voltage, and as much as 125% of nominal voltage on the secondary side of the control transformers.

## 2.3 BUILDING CONTROLLERS

- .1 The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.
- .2 Provide all processors, power supplies, and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- .3 DDC controllers shall use the same programming language and tools. DDC controllers, which require different programming language or tools on a network, are not acceptable.
- .4 Modular Controller
  - .1 This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall the BACNet BIBBs required to provide a complete and operable system:
  - .2 The Building Level Controller shall support the following Data Link Layers:
    - .1 BACnet IP Annex J.
    - .2 BACnet IP Annex J Foreign Device.
    - .3 MS/TP Master (Claus 9).
  - .3 The Building Level Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
    - .1 Calendar – Creatable, Deletable.
    - .2 Command – Creatable, Deletable.
    - .3 Event Enrollment – Creatable, Deletable.
    - .4 Notification Class – Creatable, Deletable.
    - .5 Schedule - Creatable, Deletable.
  - .4 The Building Level Controller shall support transmitting and receiving segmented messages.
  - .5 The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.
  - .6 The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.
  - .7 Computing power and memory minimum
    - .1 A 32 bit, stand alone, multi tasking, multi user, real-time 100MHz digital control microprocessor module.
    - .2 Inputs shall be 16-bit minimum analog-to-digital resolution.
    - .3 Outputs shall be 10-bit minimum digital-to-analog resolution.
    - .4 Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, password protected operator I/O, dial up communications.

- .5 Real time clock and battery.
- .6 Data collection/ Data Trend module sized for 10,000 data samples.
- .7 Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.
- .8 Onboard or Modular hardware and connections:
  - .1 Primary Network communication module, if needed for primary network communications.
  - .2 Secondary Network communication module, if needed for secondary network communications.
  - .3 RJ45 port 10/100Mbaud.
  - .4 RS485 ports for subnetworks and point expansion.
  - .5 Man to Machine Interface port (MMI).
  - .6 USB Port.
- .9 Input and Output Points Hardware
  - .1 Input/output point modules as required including spare capacity.
  - .2 Input/output point modules shall have removable terminal blocks.
  - .3 Monitoring of the status of all hand off auto switches.
  - .4 Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
  - .5 Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
  - .6 Graduated intensity LEDs or analog indication of value for each analog output.
- .10 Accessories:
  - .1 Appropriate NEMA rated metal enclosure.
  - .2 Power supplies as required for all associated modules, sensors, actuators, etc.
- .5 Compact Controllers
  - .1 Compact Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
  - .2 Each Compact Controller shall have sufficient memory to support its own operating system and databases, including:
    - .1 Control processes.
    - .2 Energy management applications.
    - .3 Alarm management applications including custom alarm messages for each level alarm for each point in the system.
    - .4 Historical/trend data for points specified.
    - .5 Maintenance support applications.

- .6 Custom processes.
- .7 Operator I/O.
- .8 Network communications.
- .3 Compact Controllers shall provide a data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
- .4 Compact Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- .5 Accessories:
  - .1 Appropriate NEMA rated metal enclosure.
  - .2 Power supplies as required for all associated modules, sensors, actuators, etc.
- .6 The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.
- .7 Each Building Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- .8 Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.
- .9 Building Level control panels shall provide at least two data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.
- .10 Building Level Controllers shall have the capability to serve as a gateway between Modbus subnetworks and BACnet objects. Provide software, drives and programming.
- .11 Immunity to power and noise:
  - .1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
  - .2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- .12 In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.
  - .1 Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

- .2 Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local connection port, via telephone line dial-in or from a network workstation PC.

## **2.4 BUILDING LEVEL CONTROLLER LEVEL SOFTWARE**

- .1 General
  - .1 The software programs specified in this section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.
  - .2 The software application shall be accessible from a PC using the Windows environment but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems based viruses.
  - .3 The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop and have demonstrated compliance to BTL through BTL listing.
- .2 System Security
  - .1 User access shall be secured using individual security passwords and user names.
  - .2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
  - .3 Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.
  - .4 User Log On/Log Off attempts shall be recorded.
  - .5 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
  - .6 Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.
  - .7 Passwords shall have the option to be configured to expire within a selected timeframe (1-365 days).
  - .8 Configuring the password expiration shall also enable the functionality to lock out a user account after three failed log-on attempts.
- .3 User Defined Control Applications: The application software shall program DDC routines to meet the sequences of operations.
  - .1 The Building Controllers shall have the ability to perform the following pre tested control algorithms:
    - .1 Two position with differential control and time delays
    - .2 Floating control



- .3 Proportional control
- .4 Proportional plus integral control
- .5 Proportional, integral, plus derivative control
- .6 Automatic tuning of control loops
- .7 Model-free adaptive control
- .8 Start Stop Time Optimization
- .2 Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- .3 Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
- .4 DDC Controllers shall have the ability to perform energy management routines for the purposes of optimizing energy consumption while maintaining occupant comfort. Routines shall include but are not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
  - .1 Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions.
    - .1 The SSTO program shall operate in both the heating and cooling seasons.
      - .1 It shall be possible to apply the SSTO program to individual fan systems.
      - .2 The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
    - .2 The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
  - .2 Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
    - .1 It shall be possible to individually command a point or group of points.
    - .2 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and stop within that group.

- .3 The operator shall be able to define the following information:
  - .1 Time, day
  - .2 Commands such as on, off, auto, occupied, unoccupied and so forth.
  - .3 Time delays between successive commands.
  - .4 There shall be provisions for manual overriding of each schedule by an appropriate operator.
- .4 It shall be possible to schedule events up to one year in advance.
  - .1 Scheduling shall be calendar based.
  - .2 Holidays and exceptions shall allow for different schedules.
- .3 Enthalpy switchover (economizer). The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry-bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
- .4 Temperature-compensated duty cycling.
  - .1 The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
  - .2 The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
- .5 Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- .6 Night setback control: The system shall provide the ability to automatically adjust set points for night control.
- .7 The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
  - .1 PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
  - .2 PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
  - .3 If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
  - .4 Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

- .5 A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30-character, English language point names, structured for searching and logs.
- .6 DDC Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task-orientated information from the user manual.
- .4 Peer-to-peer access to other DDC controllers
  - .1 It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system without dependence upon a central or intermediate processing device.
  - .2 Any process shall be able to issue commands to points in any and all other controllers in the system.
  - .3 Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:
    - .1 Generate a report
    - .2 Annunciate an alarm
    - .3 Issue a text message or email
  - .4 DDC and HVAC mechanical equipment controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device.
  - .5 The peer-to-peer network shall also allow any DDC and HVAC mechanical equipment controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
- .5 Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC mechanical equipment controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC controllers ability to report alarms be affected by either operator or activity at a pc workstation, local i/o device, or communications with other panels on the network.
  - .1 All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
  - .2 Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
  - .3 An alarm "shelving" feature shall be provided to disable alarms during testing of systems.
  - .4 Binary Alarms shall be set to alarm based on the operator specified state. Provide the capability to automatically and manually disable alarming.
  - .5 Analog alarms shall have both high and low alarm limits. Provide the capability to automatically and manually disable alarming.

- .6 The user shall be able to define the specific system reaction for each point. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
  - .7 Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) or based on priority.
  - .8 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
  - .9 Operator selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
  - .10 An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.
  - .11 Remote Communication. The system shall have the ability to remotely communicate to the remote monitoring station.
- .6 Provide a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be accessible from the operator workstation.
- .7 Adaptive Loop Tuning
- .1 Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.
  - .2 For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).
  - .3 For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
    - .1 In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
    - .2 Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

- .8 Logic programming: Provide a software routine that can build ladder logic to control using many conditional statements.
  - .1 The logic programming syntax shall be able to combine ladder logic with other software features, such as combining status, scheduling, PDL and alarm conditions into one conditional decision.
  - .2 Logic programming shall be able to reference conditions in any other controller in the system.
- .9 Staggered Start:
  - .1 This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and shall not require written scripts or ladder logic.
  - .2 Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
- .10 Totalization Features:
  - .1 Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
  - .2 Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
  - .3 Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.
- .11 A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the i/o summary. The entire collection process shall be automated so that the data collection definition, amount of data to be collected, collection report and scheduling take the form a wizard, or online assist utility, in order to complete this process within a short amount of time for a large group of points. Ability to produce a summary of changes in a log file.
- .12 Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC shall have a dedicated RAM-based buffer for trend data and shall be capable of storing data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
  - .1 Time-interval based trending shall have the capability of synchronizing the trend sampling of discrete points. This allows for the comparison of values of several different points at the same moment in time.

- .2 Trended points shall have the option of sampling data values based on the condition of a “trigger” point (i.e., conditional trending). Options for sampling shall include always sampling as defined, only sampling when the trended point is in the alarm condition, or not sampling.
- .13 System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.

## **2.5 ADVANCED APPLICATION CONTROLLERS**

- .1 The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.
- .2 The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile. Support all required BACnet BIBBS that are required to provide a complete and operable system.
- .3 The Advanced Application Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
  - .1 Calendar – Creatable, Deletable.
  - .2 Command – Creatable, Deletable.
  - .3 Event Enrollment – Creatable, Deletable.
  - .4 Notification Class – Creatable, Deletable.
  - .5 Schedule - Creatable, Deletable.
- .4 The Advanced Application Controller shall support transmitting and receiving segmented messages.
- .5 Communication: The Advanced Application Controller shall support the communications protocols and methodologies indicated in Specification Section 25 05 02 – Network Architecture and Wiring.
- .6 Serial Communication: Temporary use of portable devices shall not interrupt the BAS communication, nor the normal operation of permanently connected printers or terminals.
  - .1 Provide at least one EIA-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals.
  - .2 A USB port shall alternatively be available to support local HMI tools connection.
- .7 Input/Outputs
  - .1 Inputs shall be 16-bit minimum digital resolution.
  - .2 Outputs shall be 10-bit minimum digital resolution.

- .8 The following I/O port types shall be available on the controller
  - .1 Universal Input (software configurable):
  - .2 Digital Input choices:
    - .1 Pulse Accumulator.
    - .2 Contact Closure Sensing.
    - .3 Dry Contact/Potential Free inputs only.
    - .4 Digital Input (10 ms settling time).
    - .5 Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed).
  - .3 Analog Input Choices:
    - .1 0-10 Vdc.
    - .2 4-20 Ma.
    - .3 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K).
    - .4 1K Pt RTD (375 or 385 alpha) @ 32°F.
    - .5 10K NTC Type 2 or Type 3 Thermistor.
    - .6 100K NTC Type 2 Thermistor.
  - .4 Universal Input or Output (software configurable):
    - .1 All of the above input types.
    - .2 Analog Output Types:
      - .1 0 to 10 Vdc @ 1 mA max
  - .5 Super Universal Input or Output (software configurable):
    - .1 All of the above input types.
    - .2 All of the above output types.
    - .3 Super digital output type:
      - .1 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)
    - .4 Super Analog Output Choices:
      - .1 0 to 20 mA @ 650 Ω max.
  - .6 Provide software configurable I/O ports such that a programmer make a port either an input or an output.
- .9 Each System Level Control Panel shall, at a minimum, be provided with:
  - .1 A 32 bit, multi tasking, real-time 100 MHz digital control microprocessor with plug-in, enclosed processors.
  - .2 Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.
  - .3 Real time clock and battery.
  - .4 Data collection/ Data Trend module sized for 10,000 data samples.
  - .5 Power supplies as required for all associated modules, sensors, actuators, etc.

- .6 Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
- .7 Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device.
- .8 Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
- .9 Graduated intensity LEDs or analog indication of value for each analog output.
- .10 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
  - .1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
  - .2 Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
  - .3 Battery backup shall be provided to support the real-time clock for 10 years
  - .4 The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.
- .11 Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.
- .12 Each System Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- .13 Each Control Panel shall support firmware upgrades without the need to replace hardware.
- .14 System Level control panels shall provide at least two data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Control panels shall allow temporary use of portable operator interface devices without interrupting the normal communications.
- .15 Immunity to noise: Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

## **2.6 ADVANCED APPLICATION CONTROLLER SOFTWARE**

- .1 General
  - .1 Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.
  - .2 The software programs specified in this section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.



- .3 The software application shall be accessible from a PC using the Windows environment but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems based viruses.
- .2 Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to
  - .1 scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides
  - .2 automatic daylight savings time switch over
  - .3 night setback control
  - .4 economizer switch over using enthalpy, dry bulb or a combination
  - .5 peak demand limiting,
  - .6 temperature-compensated duty cycling
  - .7 heating/cooling interlock
  - .8 supply temperature reset
  - .9 priority load shedding
  - .10 power failure restart
- .3 The software shall have a routine for automatic tuning of control loops
- .4 System Security in the Field Panel
  - .1 User access shall be secured using individual security passwords and user names.
  - .2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
  - .3 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
  - .4 Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.
- .5 User Defined Control Applications:
  - .1 Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.
  - .2 Programs shall combine control logic, control loop algorithms, and energy management routines
  - .3 Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
  - .4 Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual
- .2 Adaptive Loop Control:
  - .1 Each AAC controller shall come standard with an Adaptive Control Loop Algorithm
    - .1 Tuning parameter shall automatically adjust for non-linear applications

- .2 Model-Free Adaptive (MFA) algorithm
  - .1 The algorithm shall not require modeling of the non-linear system in order to maintain control at all points of the non-linear load.
  - .2 The controlled variable, setpoint, and weighting parameters shall be user-selectable.
- .3 Output shall be analog or shall stage a series of outputs.
- .4 Adaptive Control shall take the place of Proportional, Proportional + Integral, and PID type algorithms for non-linear applications. Adaptive Control routines shall:
  - .1 Improve response time.
  - .2 Improve System efficiency.
  - .3 Improve Stability.
  - .4 Result in Consistent outputs.
  - .5 Reduce cycling and repositioning.
  - .6 Reduce wear and tear on actuators.
- .5 Adaptive control shall auto-adjust to compensate for
  - .1 Mode changes.
  - .2 Load changes.
  - .3 Seasonal changes.
  - .4 Heating and cooling changeover.
  - .5 Heating or cooling capacity changes on the primary side.
  - .6 Flow changes on the primary or secondary side.
  - .7 Airflow changes across coil.
  - .8 Flow across a heat exchanger.
- .6 Adaptive control shall auto-adjust to compensate for
  - .1 Non-linear coils and heat exchangers.
  - .2 Hot water and chilled water reset routines.
  - .3 Water flow reset routines.
  - .4 Duct Static reset routines.
- .7 Auto-Tune PID loops are not acceptable substitutions.
- .8 If Adaptive Loop Control is not available, then the BAS contractor shall provide re-tuning of the control loops for coils and heat exchangers for each of the following conditions:
  - .1 Low heating supply water, high heating supply water.
  - .2 Low load on steam coil, high load on steam coil.
  - .3 Chilled water coil, non dehumidification and condensing.
  - .4 Chilled water coil, low airflow, high airflow, economizer.
  - .5 Dual temperature systems tune for heating and cooling modes.
  - .6 Each of 4 seasons.

**2.7 APPLICATION SPECIFIC CONTROLLERS (ASC)**

- .1 Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
- .2 All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the floor, building or management level networks is not acceptable.
- .3 Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
  - .1 Provide for control of each piece of terminal equipment where indicated.
  - .2 Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal controllers utilizing proprietary control signals and actuators shall not be acceptable.
  - .3 Each controller performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type providing the minimum performance requirements of +/- .6 deg. C accuracy, operating in the range of +/- .6 C° ( $\pm 1^{\circ}\text{F}$ ) accuracy, operating in the range of 2 to 46°C (36°F to 115°F), adjustable between 2°C to 30°C (36°F to 86°F).
  - .4 Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. The temperature indicator shall be digital readout visible without removing the sensor cover.
  - .5 Each controller shall perform its primary control function independent of other DDC Controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during interruption is not acceptable. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications.
  - .6 Provide each terminal equipment controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or 72-hour battery backup shall be provided. Controllers that require factory changes of all applications are not acceptable.

**Part 3 Execution****3.1 CONTROLLER APPLICATIONS**

- .1 Building Level Controllers shall be used for the following types of systems. It is intended that each unique system be provided with its own point resident DDC Controller.
  - .1 VAV air handlers.

- .2 Systems with over 24 input/output points.
- .2 Advanced Application Controllers shall be used for systems with custom sequences that meet all of the criteria below:
  - .1 Air handlers up to 15,000 cfm.
  - .2 Systems up to 20 input/output points.
  - .3 BAS Network or Architecture or Sequences do not require the system to be on an IP network.
  - .4 When application specific controllers are not allowed.
  - .5 Rooftop systems.
- .3 Application Specific Controllers are intended to be used for only the following systems:
  - .1 Variable Air Volume (VAV) boxes
  - .2 Constant Air Volume (CAV) boxes
  - .3 Unit Conditioners

### **3.2 CONTROLLER INSTALLATION**

- .1 Install all DDC controllers in heated space. Keep all electronic equipment away from temperature extremes and wild fluctuations and shielded from electromagnetic interference.
- .2 Proposed panel locations shall be approved by Engineer/Board. Panels containing controllers shall be installed only in heated areas not subject to extremes of temperature or rapid temperature variations.
- .3 Label all wiring at termination point, reflect labelling in as-built shop drawings.
- .4 Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587 1980.
- .5 Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
  - .1 RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3 V.
  - .2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
  - .3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.
  - .4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
- .6 Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
  - .1 IEEE Standard 587-1980.
  - .2 UL 864 Supply Line Transients.
  - .3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11).
- .7 Install all panels in a metal enclosure. Use of controller plastic enclosures is not acceptable.

**3.3 FUTURE EXPANSION**

- .1 Controllers shall perform all of the functions described in these specifications, including all of the options described even if the options are not required in the initial work.
- .2 Controllers shall have an allowance of a minimum of 10% in spare points for each type of point.
- .3 If a certain type of point is not associated with a specific panel, the required minimum spare points shall be two (2).

**3.4 PANELS**

- .1 Local equipment cabinets shall be provided for each controller or group of controllers, of free standing or wall mounted type. Respective controllers, transducers, shall be mounted within cabinet. Relays, transformers and any other devices using a voltage above 24 VAC must be housed in a separate enclosure from the controllers. Transformers may be enclosed type, mounted outside of the enclosures. Panel instruments shall be designated as to type and function of black Lamicaid tags 6.4 mm white engraved, secured with drive screws. Cabinets shall be located where shown or as later directed and may be grouped per Mechanical Room.
- .2 Control panels shall be fully enclosed cabinets with all steel constructions. Cabinets shall have hinged door with locking latch or bolt on cover plate. All cabinet locks shall be common keyed.
- .3 Controller Panels
  - .1 Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.
  - .2 Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.
  - .3 Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.
- .4 Provide power supplies for control voltage power.
- .5 Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations.
- .6 Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.
- .7 All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.
- .8 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
- .9 All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.
- .10 Provide a pocket to hold documentation.

- .11 Panels shall be wall mounted or free standing and shall be as located on the mechanical drawings.
- .12 All relays, transducers etc., shall be located within the control panels.
- .13 Each DDC Controller enclosure shall have a standard duplex AC power receptacle located within the enclosure to provide power for test equipment, operation communication devices.
- .14 Enclosures shall be large enough to accommodate the components without crowding, after allowing sufficient space for good wiring management. In all cases, the local field panel must have a minimum of 25% free mounting area within the enclosure
- .15 If the DDC controllers come with plastic enclosures, the plastic enclosures must be themselves enclosed in a metal enclosure.

### **3.5 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1**            **General**  
**Not Used**

**Part 2**            **Products**

**2.1**                **ACCEPTABLE MANUFACTURERS**

- .1            Any devices listed in this specification shall be branded by the BAS supplier or one of the following manufacturers:

.1            Sensors, Relays Etc.

- .1            Greystones
- .2            Enercorp
- .3            Johnson
- .4            Siemens
- .5            ACI
- .6            Honeywell
- .7            Setra

.2            Thermostats

- .1            Match BAS provider

.3            Control Valves

- .1            Siemens
- .2            Belimo
- .3            Johnson Controls

.4            Actuators

- .1            Siemens
- .2            Belimo
- .3            Johnson Controls
- .4            Honeywell
- .5            Schneider Electric

**2.2**                **GENERAL REQUIREMENTS**

- .1            Actuation of control devices shall be electronic. Spring return fail-safe actuation shall be provided when loss of property and/or property damage is possible and where specified.
- .2            All equipment, unless specified to contrary, shall be fully proportioning, modulating in operation.
- .3            Space and duct sensors shall be electronic suitably located for specific application. Space sensing units shall be mounted 1500 mm from floor to centre for non-adjustable and 1200 mm from floor for adjustable unless otherwise noted or agreed to by the consultant.

- .4 Sensors shall meet or exceed the specified standards.
- .5 All sensors shall be capable of operating over the expected operating range and humidity.
- .6 **Detectors and electrical components within the airstream shall be classified for use in a Class I, Zone 2 system (as defined by the Electrical Safety Code).**

## 2.3 **MOTORIZED CONTROL DAMPERS**

- .1 Control dampers shall be the parallel or opposed blade type as below or as scheduled on drawings.
  - .1 Outdoor and/or return air mixing dampers and face and bypass (F & BP) dampers shall be parallel blade, arranged to direct air-streams toward each other.
  - .2 Other modulating dampers shall be the opposed blade type.
  - .3 Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
- .2 Damper frames shall be 13 gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.
- .3 Damper blades shall not exceed 20 cm (8") in width or 125 cm (48") in length. Blades are to be suitable for medium velocity performance (10 m/s [2000 fpm]). Blades shall be not less than 16 gauge.
- .4 Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better.
- .5 All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 1% of total flow based on a approach velocity of 7.62 m/s (1500 ft/min) at 1000 Pa (4 in. w.g.) differential pressure. Provide air foil blades suitable for a wide-open face velocity of 7.5 m/s (1500 fpm).
- .6 Individual damper sections shall not be larger than 125 cm x 150 cm (48" x 60"). Provide a minimum of one damper actuator per section.
- .7 Modulating dampers shall provide a linear flow characteristic where possible.
- .8 Dampers shall have exposed linkages.

## 2.4 **ELECTRONIC DAMPER AND VALVE ACTUATORS**

- .1 General
  - .1 Electric control shall be direct coupled actuators.
  - .2 Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
  - .3 The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard 1/2" diameter shaft or damper blade.
  - .4 Actuators shall be designed for mounting directly to the shaft without the need for connecting linkages.



- .5 All actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered.
- .6 All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.
- .7 All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.
- .8 All actuators shall be designed and manufactured using ISO900 registered procedures and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 I.
- .9 Provide visual scale indicating percent of travel.
- .10 Provide feedback signal on all control valves over 2 inches and all damper actuators where specified.
- .11 Actuators shall be UL and CSA listed.
- .2 Electronic Valve Actuators
  - .1 The valves shall be provided with an actuator by the same manufacturer, factory installed.
  - .2 All actuators shall have visual position indication.
  - .3 No external programming device shall be required.
  - .4 Actuator shall be electric motor driving, microprocessor signal controlled.
  - .5 Electric Control Rangeability: 40:1
  - .6 Control Signal 0 to 10 VDC or 0 to 20 mA signal. 2 to 10 VDC or 4 to 20 mA operating range.
  - .7 Power 24 VAC, 50-60 Hz
  - .8 Fail Safe: Valves actuators shall position the valve in a fail safe position when the power supply is disrupted or the signal goes to 0. Fail-safe according to the following guidelines unless otherwise stated in the sequence of operations
    - .1 Power fail safe shall be via spring loaded mechanical means
    - .2 Any AHU hot water exposed to ventilation air shall fail open
    - .3 AHU Chilled water coils exposed to ventilation air in possible freezing conditions shall be fail open
    - .4 Terminal unit valves shall fail-in-place
  - .9 Fail in place valves on primary equipment such as chilled water systems, hot water systems and condenser water systems shall have a means to manually open the valve when power is not available, such as a hand wheel or a geared crank with a clutch.
  - .10 The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).

- .11 Actuator shall provide minimum torque required for proper valve close-off. The close-off differential pressure rating of the valve shall exceed the highest possible head pressure available at the pump plus 10% and still be rated for a Class IV leakage.
  - .12 The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.
  - .13 All automatic control valves installed in locations exposed to the elements shall be provided with weather resistant housings and heaters for climates that reach below freezing.
- .3 Electronic Damper Actuators
- .1 Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
  - .2 Damper operators shall be of the replaceable diaphragm piston type with external adjustable stops to limit the length of stroke in either direction. Operators shall be mounted on adjustable brackets. Operating arms shall have double yoke linkages and double set screws for fastening to damper shaft.
  - .3 Damper operators shall be selected to operate maximum damper loads of 2.6 m<sup>2</sup> (135 ft<sup>2</sup>). Where damper sizes exceed this area rating, multiple damper operators shall be provided.
  - .4 Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
  - .5 For power-failure/safety applications, a mechanical, spring return mechanism

## 2.5 DAMPER STATUS SWITCHES

- .1 Damper status switches shall be a lever operated, activated by damper blade movement and mounted securely on damper frame.
- .2 Damper switch shall have contact rating of 5 amperes at 120V AC and be CSA approved.

## 2.6 DIFFERENTIAL PRESSURE SENSORS

- .1 Differential pressure sensors shall be provided for water differential pressure air and static pressure applications.
  - .1 Monitoring Range To suit application
  - .2 Output Signal 4 to 20 mA
  - .3 Accuracy +/- 1.0% full scale
- .2 Select materials suitable for the measured variable, i.e. water and air, and to withstand a minimum of twice the normal pressure.
- .3 The transmitter output shall be linear proportional signal over the full operating range.

**2.7 FILTER BANK STATUS DIFFERENTIAL PRESSURE SWITCHES**

- .1 Provide switches with SPDT contacts rated at 9 amperes at 120 VAC and be CSA approved.
- .2 Select the differential pressure range of the switch to suit the application.
- .3 Provide switches with adjustable setpoint.
- .4 Mounted switches with diaphragm in a vertical plane.

**2.8 TEMPERATURE THERMOSTAT (DDC)**

- .1 Digital room sensors without LCD display, day / night override button, and setpoint slide adjustment to  $\pm 5^{\circ}\text{C}$  adjustment and override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment.
  - .1 Temperature monitoring range +20/120°F -13° to 49°C)
  - .2 Output signal Changing resistance
  - .3 Accuracy at Calibration point  $\pm 0.5^{\circ}\text{F}$  (+/- 0.3°C)
  - .4 Set Point and Display Range 55° to 95° F (13° to 35°C)
- .2 Provide metal guards on thermostat in common areas and gymnasiums. Common area thermostats shall not have temperature adjustment.
- .3 Sensor to be 10k wire, thermistor style
- .4 **Sensor shall have integral CO2 sensor. Refer to CO2 sensor details for requirements.**

**2.9 LINE VOLTAGE ROOM THERMOSTATS**

- .1 Provide electric wall mounted 120 volt thermostats as indicated. Each thermostat shall be equipped with a thermometer and shall be tamperproof with locking covers.
- .2 A metal guard and adapter plate shall be supplied for all thermostats mounted in storage areas.

**2.10 SEPARABLE BRASS THERMOWELLS**

- .1 These shall be provided with immersion type bulbs for installation by plumbing section. (Stainless steel shall be used for immersion in glycol solutions.) Wells shall be packed with thermal conductive grease to increase speed of response. Thermowells shall have 1/2" IPS threads to receive sensor and be of suitable length for the pipe diameter.

**2.11 AIR TEMPERATURE SENSORS**

- .1 Sensors shall be a minimum of 1.5m (5ft) in length per 1 square meter of duct cross section.
- .2 All supply air sensors and mixed air sensors shall be 100 or 1000 OHM platinum, resistance temperature detector (RTD) type with a 7.5 m (25') averaging element. Each RTD may be provided with an industry standard, 4-20mA, transmitter mounted at the RTD as required.
  - .1 Temperature monitoring range -7°C to 49°C (20°F to 120°F)
  - .2 Output signal Changing resistance
  - .3 Accuracy at calibration point  $\pm 0.3\text{C}$  ( $\pm 0.5\text{F}^{\circ}$ )

- .3 All return air sensors shall be RTD or thermistor type temperature detectors. The sensor probe shall have a minimum length of 450 mm (18"). Each RTD may be provided with an industry standard, 4-20mA, transmitter mounted at the RTD as required.
  - .1 Temperature and monitoring range 4°C to 66°C (40°F to 150°F).
  - .2 Output Signal Changing Resistance
  - .3 Accuracy and calibration point 0.3C ( $\pm 0.5^\circ\text{F}$ )
- .4 Outdoor air sensor shall be the PT-100 platinum 3 wire RTD type with a 4-20mA transmitter mounted at the sensor. The RTD shall be mounted in a weatherproof enclosure, the 4-20mA transmitter shall be mounted inside the building within an electrical box.
  - .1 Temperature and monitoring range -18°C to 49°C (0°F to 120°F).
  - .2 Output Signal Changing Resistance
  - .3 Accuracy at calibration point  $\pm 0.3\text{C}$  ( $\pm 0.5^\circ\text{F}$ ) over a range of
- .5 Sensors shall be provided with vented protective covers, mounted 1500 mm (60") from floor level.

## 2.12 CO2 DETECTOR

- .1 The sensor shall be the non-dispersive infrared style.
- .2 The sensor shall meet the following operating characteristics
  - .1 Range 0 to 5000 ppm
  - .2 Output Signal 0 to 10 vDC or 4-20 mA
  - .3 Accuracy  $\pm 50$  ppm
- .3 Outputs shall be configured using optional software package to provide advanced control strategies using CO<sub>2</sub>.
- .4 Sensor shall be self calibrating.
- .5 Wall mounting or duct mounting, depending on application.

## 2.13 ELECTRICAL DEVICES

- .1 Relays
  - .1 Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
  - .2 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable  $\pm 200\%$  (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
- .2 Override timers.
  - .1 Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.

- .3 Current transmitters.
  - .1 AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and +1 % full-scale accuracy at 500 ohm maximum burden.
  - .2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.
  - .3 Unit shall be split-core type for clamp-on installation on existing wiring.
- .4 Current transformers.
  - .1 AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.
  - .2 Transformers shall be available in various current ratios and shall be selected for  $\pm 1$  % accuracy at 5 A full-scale output.
  - .3 Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.
  - .4 Status inputs for motors (pumps and fans) shall use inductive coils to monitor current draw from one phase of power.
  - .5 Current transformers shall be selected and configured for appropriate amperage range, and shall have 0 to 5 Volt output
  - .6 BMS shall use AI points to monitor current transformers.
- .5 Voltage transmitters.
  - .1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
  - .2 Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with  $\pm 1$  % full-scale accuracy with 500 ohm maximum burden.
  - .3 Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.
- .6 Voltage transformers.
  - .1 AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.
  - .2 Transformers shall be suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and shall provide  $\pm 0.5\%$  accuracy at 24 VAC and a 5 VA load.
  - .3 Windings (except for terminals) shall be completely enclosed with metal or plastic material.
- .7 Power monitors.
  - .1 Power monitors shall be the three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.

- .2 They shall provide a selectable rate pulse output for kWh reading and a 4 to 20mA output for kW reading. They shall operate with 5 A current inputs with a maximum error of  $\pm 2\%$  at 1.0 power factor or  $\pm 2.5\%$  at 0.5 power factor.
- .8 Current switches.
  - .1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system. Switch shall be complete with LED and have four turn adjustment.

## **2.14 PHOTO SENSOR**

- .1 Weathertight.
- .2 Operating Temperature  $-30$  to  $+70$  C.
- .3 Resistance at 0 Lux 15 Kohms minimum.
- .4 Resistance at 10 Lux 3 Kohms typical.

## **Part 3 Execution**

### **3.1 NAMEPLATES**

- .1 Duct and pipe mounted sensors and panels shall be provided with minimum size 75 x 25 x 3.2 mm nameplates, clearly identifying the equipment and functions with letter and number designation. Nameplates shall be mechanically secured and listed in the Operating and Maintenance manual.

### **3.2 ACTUATORS**

- .1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum  $5^\circ$  available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
- .2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.
- .3 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- .4 Provide all mounting hardware and linkages for actuator installation.
- .5 The controls contractor shall provide wiring as follows:
  - .1 All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power panel. Coordinate with electrical trade.
  - .2 All wiring between the central control system (ATC/BMS) and the valve actuator shall be wired by the controls contractor.

- .3 All wiring between the valve actuator and their associated thermostats, pressure switches, control devices, etc. shall be wired by the controls' contractor.
- .4 All wiring shall comply with code requirements. Segregate high and low voltage wiring and circuits and segregate the FAS and controls (BMS) terminals.

### **3.3 CONTROL DAMPER INSTALLATION**

- .1 Damper style and construction shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- .2 Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4". larger than damper dimensions and shall be square, straight, and level.
- .3 Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8") of each other.
- .4 Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- .5 Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- .6 Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- .7 Provide a visible and accessible indication of damper position on the drive shaft end.
- .8 Support ductwork in area of damper when required to prevent sagging due to damper weight.
- .9 After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

### **3.4 INSTALLATION OF THERMOSTATS**

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- .4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- .5 Install thermostats at handicapped elevations 1200 mm above finish floor (AFF).
- .6 Where not indicated on drawing, place where directed by consultant.
- .7 Co-ordinate location with architectural and electrical items.

**3.5 INSTALLATION OF SENSORS - GENERAL**

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 All wires attached to sensors shall be air in EMT raceways.
- .4 All din rail or screw mounted transmitters, shall be mounted in steel box of suitable size with removable cover and secured in place.

**3.6 AIR TEMPERATURE SENSORS**

- .1 Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- .2 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (10 ft.) of sensing element for each 1m<sup>2</sup> (1 ft of sensing element for each 1 ft<sup>2</sup>) of coil area.

**3.7 OUTDOOR AIR TEMPERATURE SENSORS**

- .1 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

**3.8 DIFFERENTIAL PRESSURE SENSORS**

- .1 Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
- .2 Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
- .3 Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
- .4 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
- .5 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

**3.9 FLOW SWITCH INSTALLATION**

- .1 Adjust flow switch in accordance with manufacturer's instructions.



**3.10 WARRANTY**

- .1 Warranty Start Date:
  - .1 Warranty period starts as of the date of Ready for Takeover.
  - .2 Warranty start dates based on shipment date, start up date, substantial completion date, etc. are not applicable.
- .2 Warranty Duration:
  - .1 One (1) year warranty period applies.
- .3 Warranty Coverage:
  - .1 Applies to parts and labour.

**END OF SECTION**

**Part 1 General****1.1 RELATED SECTIONS**

- .1 This section is to be read in conjunction with 25 10 01 Building Automation Systems – General Requirements and the remaining Section 25 specifications.

**1.2 BACNET INTEGRATION AND CONTROL POINTS**

- .1 The BAS contractor is responsible to provide a full and operable system that meets all required specifications and sequences.
- .2 The BAS contractor shall provide hard wired control points, sensors and all other components of the system as required to either supplement available BACNet points, or in the absence of a BACNet card make the system completely operable.
- .3 Sequences of operation may or may not be achievable through BACNet integration, as not all points required may be available from the unit manufacturer.
- .4 Not all equipment in the project has been specified with BACNet cards. The BAS contractor is responsible to review the entirety of the mechanical specification to confirm which equipment is being specified with BACNet integration cards and which equipment will not be provided with BACNet integration.

**Part 2 Products**

Not Used.

**Part 3 Execution****3.1 SYSTEM CONTROL STABILITY AND ACCURACY**

- .1 Control Stability and Accuracy shall maintain measured variable at set-point within tolerances listed below:

Control Stability and Accuracy		
Controlled Variable	Control Accuracy	Range of Medium Accuracy
Air Pressure	±50 Pa (±0.2 in. w.g.)	0-1.5 kPa (0-6 in. w.g.)
	±3 Pa (±0.01 in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1°C (±2°F)	
Duct Temperature	±1.5°C (±3°F)	
Fluid Pressure	±10 kPa (±1.5 psi)	MPa (1-150 psi)
	±250 Pa (±1 in. w.g.)	0-12.5 kPa (0-5 in. w.g.) differential

**3.2 A2L REFRIGERANT CONTAINING EQUIPMENT**

- .1 A2L refrigerants are classified as mildly flammable. CSA B52-2023 has specific safety clauses related to the use of refrigerants with this classification within buildings.

- .2 This contractor shall be responsible to ensure that the installation requirements of CSA B52-2023 are met.
- .3 Throughout this specification various pieces of equipment have been specified with refrigerant leak detection systems. Field wiring of the alarm status of this system to various downstream system components is required under Annex P of the standard and is the responsibility of this contractor. These devices include the following:
  - .1 Open all zone dampers connected to the affected system.
  - .2 Disable electric reheat coils within the affected system.
  - .3 Activate field installed safety shut off valves on the affected refrigeration systems
  - .4 De-energize any potential sources of ignition with the ductwork system of the affected system.
  - .5 Energize fans within the ductwork system.
  - .6 Activate any designated refrigeration leak ventilation systems.

### **3.3 NAMING OF POINTS AND CONTROLLERS**

- .1 Refer to section 25 05 02 Building Automation Systems – General Requirements

### **3.4 START-UP AFTER POWER FAILURE**

- .1 System shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started; along with the time delay between starts shall be user adjustable.

### **3.5 REQUIREMENTS TYPICAL TO ALL SEQUENCES**

- .1 BAS contractor is responsible to provide a full and complete system that is capable of meeting all sequences, alarms, trends etc. specified. A point not being listed on a points list does not absolve the contractor from providing it if it is necessary to meet the Sequence of Operation.
- .2 All set points, reset curves etc. shall be adjustable by the operator.
- .3 This building is designed to comply with the prescriptive approach of the OBC SB-10 and ASHRAE 90.1 All mandatory control functions listed in the latest edition of ASHRAE 90.1 shall be included in sequences. These functions include, but are not limited to:
  - .1 Zone thermostatic control, complete with dead bands between heating and cooling set points.
  - .2 Set-point overlap protection
  - .3 Off-Hour Controls consisting of:
    - .1 Automatic shut down
    - .2 Temperature set back
  - .4 Optimum start controls

- .5 Zone Isolation or grouping of HVAC equipment that is not expected to operate on the same schedule. All equipment in a single zone shall be scheduled together unless it was designed to operate 24/7. Each zone shall be capable of being provided it's own schedule or being scheduled together. As per ASHRAE 90.1 a zone shall not span more than one floor or be greater than 25,000 square feet.
- .6 Provide logic to identify zones that may be excessively driving reset logic and generate an alarm for system operator to review. Provide functionality to remove any zone from reset logic.

### 3.6

#### ALARMS

- .1 Provide alarms, alarm hierarchy and alarm suppression as indicated in ASHRAE Guideline 36. Provide an alarm system capable of providing the following:
  - .1 Time and date is listed on the alarm
  - .2 Alarm Level. User shall be able to set alarm level for each individual alarm. The 4 levels of alarm shall be as follows:
    - .1 Level 1: Life-safety message
    - .2 Level 2: Critical equipment message
    - .3 Level 3: Urgent Message
    - .4 Level 4: Normal Message
  - .3 Sort alarms by level in the user interface
  - .4 Provide alarm description
  - .5 Provide equipment tags of units in alarm.
  - .6 Provide possible cause of alarm, if detected by fault detection routines.
  - .7 User adjustable entry delay for alarms. The default time delays are as follows:
    - .1 Level 1: 1 second
    - .2 Level 2: 10 seconds
    - .3 Level 3: 1 minute
    - .4 Level 4: 5 minutes
  - .8 Alarms shall be configured as latching or nonlatching. A latching alarm requires acknowledgement from operators before return to normal, even if exit deadband has been met. A nonlatching alarm does not require acknowledgement. Default latching status is as follows:
    - .1 Level 1 alarms: Latching
    - .2 Level 2 alarm: latching
    - .3 Level 3 alarms: nonlatching
    - .4 Level 4 alarms: nonlatching
  - .9 Postexit suppression delay shall be provided to limit the number of alarms. Once an alarm has been triggered and reset it shall not be triggered again for a period of time. Default delay is as follows:
    - .1 Level 1 alarms: 0 minutes
    - .2 Level 2 alarm: 5 minutes
    - .3 Level 3 alarms: 24 hours

- .4 Level 4 alarms: 7 days
- .10 Hierarchical Alarm Suppression. Provide a mechanism by which alarms in downstream equipment in the hierarchy are not presented to the operator if the source of the error is likely due to an alarm elsewhere in the building. (i.e. do not alarm that a VAV box cannot maintain discharge air temperature if the boiler plant or main circulation pumps are in alarm). Failure to start, Level 1, and command/status mismatch alarms are not subject to this hierarchy.

### 3.7 FAULT DETECTION ROUTINES

- .1 Provide automatic fault detection routines that will alert the operator to problems with sensors within the existing BAS system. There shall be a summary page provided which tabulates each Air Handling Unit with the list of following faults. Each fault limit shall be user adjustable by air handling unit:
  - .1 Duct Static Pressure Too Low with fan at full speed
  - .2 Mixed Air Temperature Too Low (not between RAT and OAT)
  - .3 Mixed Air Temperature Too High (not between RAT and OAT)
  - .4 Too Many Changes in OS (Set points have changed more than 10 times in last 60 minutes)
  - .5 SAT below MAT
  - .6 OA airflow is not within acceptable range for damper command
  - .7 SAT too low in full heating or too high in full cooling
  - .8 Temperature drop across coil with cooling inactive
  - .9 Temperature rise across coil with heating inactive
  - .10 OAT too high for free cooling but mechanical cooling disabled.
  - .11 SAT and MAT are not approximately equal in free cooling mode
- .2 Full formulas and definitions of these fault conditions are included in ASHRAE Guideline 36, High-Performance Sequences of Operation for HVAC Systems.
- .3 Provide indication of potential fault cause as per ASHRAE Guideline 36.

### 3.8 TRENDS

- .1 Provide Trends as follows:
  - .1 For HVAC Units:
    - .1 Unit/Fan Command and Status
    - .2 Unit Discharge Air Setpoint
    - .3 Heating/Cooling Status (if applicable)
    - .4 Unit Supply and Return Air Temperatures
  - .2 Exhaust Fans
    - .1 At owner request
  - .3 Misc. Heating Elements
    - .1 At owner request
  - .4 VAV/VVT Boxes
    - .1 At owner request

**3.9 SCHEDULES**

- .1 All equipment shall be assigned to logical zone groupings of equipment with each group having its own defined schedule.
- .2 Provide a standard schedule complete with options for both holiday and exception schedules for each zone.
- .3 User shall be able to assign multiple zones to the same schedule where appropriate.

**3.10 ROOM TEMPERATURE SET POINTS**

- .1 Heating:
  - .1 Occupied: 21° C.
  - .2 Unoccupied: 16° C.
- .2 Cooling:
  - .1 Occupied: 24° C.
  - .2 Unoccupied: 27° C.

**3.11 GLOBAL TERMINAL UNIT INFORMATION DISPLAY**

- .1 The display shall be updated at least once a minute and include the following information:
  - .1 Total number of VAV boxes in occupied mode.
  - .2 Total number of VAV boxes in override mode.
  - .3 Total number of VAV boxes in cooling.
  - .4 Total number of VAV boxes in heating.
  - .5 Total number of VAV boxes in alarm.
  - .6 Average Space Temperature
  - .7 Lowest space temperature
  - .8 Average heating offset
  - .9 Greatest heating offset
  - .10 Average cooling offset
  - .11 Greatest cooling offset

**3.12 SINGLE ZONE VVT DAMPERS****.1 Description (Pressure Dependent)**

The system consists of a VVT damper and associated controls.

The damper is modulated between minimum and maximum positions to maintain space temperature. The space served by the VAV terminal unit is controlled in Occupied and Unoccupied modes as follows:

**.1 Occupied**

The damper is controlled within user defined maximum and minimum settings. The controller monitors the room temperature sensor and modulates the supply air damper to maintain the room temperature at set point. When room neutral air is being supplied by the HVAC unit the damper shall modulate to it's ventilation set point.

**.2 Unoccupied**

Should additional heat be required at night the controller may reset to the terminal unit to Occupied mode for a predetermined time period upon a signal from the control system or manually at the room sensor.

**.3 Upon signal from the associated HVAC unit's leak detection system:**

.1 Disable any electric reheat or other sources of ignition in the ductwork system.

.2 Fully open zone dampers within the ductwork system/close bypasses.

.3 Energize all fans within the duct system/general exhaust fans in area affected.

**.4 Points List**

<b>Name</b>	<b>AI</b>	<b>AO</b>	<b>DI</b>	<b>DO</b>
Damper Command		X		
Space Temperature	X			

**3.13 PACKAGED HVAC (VVT)****.1 General**

.1 The VVT HVAC unit consists of a mixing section with return air, outdoor air dampers, ERV wheel with exhaust and outdoor air supply fans, filter section, gas fired burner, DX cooling coil, and supply fan. Downstream zones are controlled by pressure dependent VVT boxes.

.2 A duct mounted bypass damper shall enable VVT operation of the unit. Unit to operate in constant speed. Bypass damper to maintain duct pressure.

.3 BAS contractor shall set two speed HVAC units to be at 60 and 55 Hz via unit control panel to enable VVT operation.

**.2 Limits and Safeties**

.1 Unit shall be equipped with a freeze stat.

- .2 Mechanical cooling low temperature protection: If the outdoor air temperature falls below its Mechanical Cooling Lockout setpoint, it will prevent the mechanical cooling stages from being energized.
- .3 Monitor units' refrigeration leak detection system. Upon signal from system :
  - .1 Disable any electric reheat or other sources of ignition in the ductwork system.
  - .2 Fully open zone dampers within the ductwork system/close bypasses.
  - .3 Energize all fans within the duct system/general exhaust fans in area affected.
- .3 Start/Stop
  - .1 Start-Stop: The unit is started and stopped based on a time of day schedule.
- .4 Control Strategy
  - .1 Fan Control

Occupied: Fan shall operate. Heating and cooling stages are available.

Unoccupied: The cooling and heating stages are disabled. The outdoor air and relief air dampers are fully closed and the return air damper is open. Unit can be recycled to maintain setpoint in the serviced spaces.

    - .1 Supply Fan Shutdown Delay: If the fan system is shut down while heating or cooling stages are energized, the stages will immediately de-energize and the fan will continue to run for 60 sec. (heating mode, adj.) or 30 sec. (cooling mode, adj.) more, then shut down.
    - .2 Manual Override Timer: The supply fan will also be started if the manual override timer switch is activated. The fan will then run until the switch times out.
  - .2 Control of Unit Heating and Cooling Stages
    - .1 The BAS shall determine the demand for heating or cooling based on the number of zones calling or the greatest demand for a particular mode. The BAS will establish the zone with the greatest demand as the Reference Zone.
    - .2 The BAS shall access zone demand for heating and cooling from each zone controller and use this information to control the HVAC unit based on zone demand.
    - .3 When any thermostat senses a temperature deviation of 1.0°C (1.5° F) or more from its current setpoint, it becomes a zone heating or cooling caller. When a zone becomes a caller, the BAS registers its demand and its heating or cooling caller status. Each zone shall be provided with a user adjustable weighting factor. Initial weighting factors shall be based on zone cfm. When the BAS registers the minimum sum of the weighted values, as determined by the system mode demand, a mode is enabled. The mode selected shall meet all lockout temperature criteria (if applicable). The BAS shall energize the required mode.



- .4 On a rise in the reference zone to 1.2° C (2° F) from setpoint, the monitor thermostat shall energize second stage if the temperature trending program allows second stage operation. When demand falls to 0.6° C (1.0° F), second stage is released. When the demand falls to 0.3° C (0.5° F), first stage will be released.
- .5 The BAS shall hold the system mode until the Reference Zone is within 0.3° C (0.5° F) of its setpoint or until the system mode reselect time limit has expired and the system demand is such that the monitor thermostat selects the opposite mode.
- .6 The system shall prioritize cooling over heating when the outdoor air temperature is above 14°C (adj). Below this value the system shall prioritize heating calls.
- .7 When prioritizing heating calls, the free cooling set point will be 2°C higher than base heating set point. When prioritizing cooling calls, the free cooling set point will be 1°C (adj) higher than the base heating set point. Mechanical cooling calls will be 3°C (adj) higher than heating set point.
- .8 All zones shall have common base global set points. Zones can be manually overridden.
- .9 Provide option for user to remove a zone from consideration in the logic.
- .3 Duct Static Pressure Control
  - .1 The bypass controller shall reposition its damper(s) to the maximum open position prior to system start-up. The bypass controller shall regulate pressure from minimum system pressure during startup to maximum system pressure during normal operating conditions. The bypass controller shall monitor supply air temperature. During changeover mode, the bypass controller shall open the bypass dampers to precondition the supply air temperature if it is needed by the Reference Zone.
  - .2 The individual zone controllers shall be capable of operating in the ventilation mode until the zone becomes 1.0° C (1.5° F) out of setpoint in either direction. At this point the zone controller shall request the appropriate mode from the monitor thermostat.
  - .3 Individual zone dampers shall be fully open in ventilation mode.
- .4 Mixing: Once per hour all zones shall be forced into ventilation mode (dampers fully open) and the bypass damper shall fully close. HVAC unit fan shall run for a user adjustable period of time to provide air mixing in the space.
- .5 Ventilation Control
  - .1 Provide CO<sub>2</sub> controls connected to the unit to override OA damper controls to allow more outside air to enter. Maintain CO<sub>2</sub> at 1000 ppm (adj). Limit outside air in order to prevent MAT falling below 13° C.
  - .2 Outside air dampers shall open to minimum position during occupied periods.

## .6 Economizer:

- .1 An economizer cycle shall be employed to return the outside air dampers to minimum position should the outside air temperature exceed the return air temperature.

## .5 Alarms

- .1 Fan System Failure Alarm: An alarm is generated whenever the supply fan fails to respond to start-stop commands.
- .2 Unit not cooling when commanded, as indicated by SAT (5 minute delay)
- .3 Unit not heating when commanded, as indicated by SAT (5 minute delay)
- .4 Supply air temperature above 35°C (5 minute delay)
- .5 Unit is running and return air CO<sub>2</sub> levels are above 800 ppm (1 hour delay)

## .6 Points List

- .1 Where available, points may be integrated via BACNet. Any points not available via BACNet shall be provided by this contractor.

Name	AI	AO	DI	DO
Space Temperature	X			
Fan Command				X
Fan Status	X			
Gas Heat Stage 1				X
Gas Heat Stage 2				X
Cooling Stage 1				X
Cooling Stage 2				X
Occupied/Unoccupied Command				X
Mix Air Temperature	X			
Supply Air Temperature	X			
Return Air CO <sub>2</sub>	X			
Return Air Temperature	X			
Unit Alarm			X	
Static Pressure Set point		X		
Bypass Damper Command		X		

**3.14 EXHAUST FANS (GENERAL)**

- .1 Start/stop exhaust fans on time of day schedule.
- .2 The DDC system uses a current switch to confirm fan operation. Provide a dual voltage relay adjacent to the BAS panel. DDC system generates an alarm if status deviates from DDC start/stop control.
- .3 Points List

Name	AI	AO	DI	DO
Exhaust Fan Command				X
Exhaust Fan Status	X			

**3.15 EXHAUST FANS (WASHROOM)**

- .1 Start/stop exhaust fans on time of day schedule.
- .2 The DDC system uses a current switch to confirm fan operation. Provide a dual voltage relay adjacent to the BAS panel. DDC system generates an alarm if status deviates from DDC start/stop control.
- .3 Points List

Name	AI	AO	DI	DO
Exhaust Fan Command				X
Exhaust Fan Status	X			

**3.16 ENERGY RECOVERY VENTILATORS**

- .1 General
  - .1 **ERV shall be integrated via Terminal Strip**
  - .2 ERV shall come with internal controller to control wheel modulation speed, fan status, free cooling and defrost cycles.
- .2 Safeties and Limits
  - .1 Unit shall be prevented from short cycling by the BAS.
  - .2 Monitor units' refrigeration leak detection system. Upon signal from system:
    - .1 Disable any electric reheat or other sources of ignition in the ductwork system.
    - .2 Fully open zone dampers within the ductwork system/close bypasses.
    - .3 Energize all fans within the duct system/general exhaust fans in area affected.
- .3 Start/Stop
  - .1 The unit shall be started and stopped by a time of day schedule.
- .4 Control Strategy
  - .1 The unit shall utilize internal controls.
- .5 Alarms
  - .1 Provide indication at OWS if unit is in alarm.
  - .2 If fan status does not match command. (10 minute delay)

## .6 Points List

- .1 Where available, points may be integrated via BACNet. Any points not available via BACNet shall be provided by this contractor.

Name	AI	AO	DI	DO
Unit Command				X
Supply Fan Status	X			
Exhaust Fan Status	X			
Unit Alarm			X	
ERV Wheel Status	X			
ERV Wheel Entering Air Temp	X			
ERV Wheel Leaving Air Temp	X			

**3.17 EXTERIOR LIGHTING CONTROL**

- .1 The outdoor lighting consists of two lighting zones (parking lot poles and wall packs) and one astrological clock.
- .2 The DDC will control using electric actuation Start/stop of each lighting zone on time of day schedule. Photocell will override program turning lights on should outdoor elements reach a low illumination during program stop period.
- .3 The DDC system will monitor lighting zone operation and generates an alarm if status deviates from DDC start/stop control.
- .4 Points List

Name	AI	AO	DI	DO
Zone Command (multiple)				X
Photocell			X	
Astrological Clock			X	

END OF SECTION